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The Self-Development of the Biosphere

The Laws of the Universe

Certainty and Uncertainty:
The Incoherence of the Physicists

W. Wertz

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Editorial — The Research and Development Policy of the Working Class: Assuming Responsibility for the Planet's Ecology

by Nikos Syvriotis

I. Emergency Food Project

In mid-January 1975, the International Caucus of Labor Committees' presently unfolding "One Hundred Days" campaign for a worldwide Emergency Food Program is intersecting the most profound collapse of production in the history of capitalism, precisely as we had predicted in early December 1974. Just as profound as the collapse in production is the intellectual bankruptcy of every layer of the capitalist class, from its top political executives around moral imbecile Nelson Rockefeller to its financial managers, all the way down to its kept intelligentsia in the numerous "think-tank" institutions: they are currently displaying the most grotesque inability to take even one elementary measure toward improving either the situation in the economy or their own increasingly precarious political situation.

The Labor Committees' Research & Development Project was formed shortly after the organization diagnosed the catastrophic world economic situation that was to break out in late winter-early spring of 1975. It was instructed to develop such specific studies, recommendations and proposals as necessary to reverse the process of world economic collapse *in the shortest feasible time*. The first such task was obviously to define the interconnected measures required to immediately remedy the collapse of the auto sector in the U. S. and Western Europe and to simultaneously reverse the inexorable slide toward destruction of world food production that threatens one hundred million human beings in the so-called Fourth World with death by starvation in 1975.

The first result was three legislative bills, presently being submitted to the U. S. Congress, calling for massive conversion of the auto industry to tractor production, secondly for emergency fiscal and administrative measures to the tune of $55 billion to salvage this year's spring planting and restore order in the agricultural sector for the remainder of the year, and thirdly for massive Congressional and/or other governmental intervention to stop the Environmental Protection Agency's sabotage of fertilizer production and to ensure that sufficient amounts of fertilizer will be produced for this year's needs.

The technical, economic and engineering aspects of these proposed measures were developed, in the course of only a few days, by the collaborative efforts and contributions of scores of skilled workers who brought into the research their special expertise and intimate knowledge of the industry, of dozens of production engineers, agronomists, industrial engineers from the auto, chemical, and machine-tools industries — and an occasional high-level theoretical physicist with a fond knack for things mechanical. The Labor Committees' R&D group took the responsibility for outlining the parameters of the situation and defining the problems to be solved. These were fed out throughout our communications and organizing networks. As responses started flowing back to the R&D coordinators, the result was the most eminently qualified programmatic proposals to reverse the economic crisis and restore feverish economic activity throughout the country in no more than two months.

This of course would require passage of these proposals by Congress, which is a problem...mostly a problem for Congress. When our Emergency Food and Tractor Conversion Bills hit Washington, D.C., the cackling geese on Capitol Hill were in panicked despair. While the Department of Commerce was releasing statistics showing the economy to be in the worst shape since the 1930s, Ford was mumbling incoherent grunts intended to be taken as the Administration's economic measures. Rockefeller was pushing for Cold War against the Soviet Union, Schlesinger for massive increase of war production, and First National City Bank was acknowledging that war production is now the only way out of the economic crisis. In the meantime, Ford's tax rebate undercut the federal budget's ability to underwrite war production and forced Secretary of Treasury Simon to more or less take over the country's bond market for the rest of the year in order to finance the federal deficit — thus leaving the country's major corporations without sources of financing when they needed it most. The combined effect of these idiotic measures is that corporate bankruptcies are accelerating and the federal government does not yet have the financial means to turn increased war production into a credible anti-depression strategy. The capitalists are now without a tactical plan.

What they do have, and what they are trying to push through Congress and across the country, is a massive austerity and productivity drive that Rockefeller, Arthur Burns, Denis Healey, and Sir Gordon Richardson decided on. But Congress cannot lift a finger in this direction; the men and women that are

supposed to be sped up and starved are already sending their own legislation to Washington. The working class and its social allies — scientists, engineers, production administrators — have started elaborating and proposing policies far more competent than anything Congress, or the Administration, or the elite financial institutions and their think-tanks have come up with.

II. The Tasks at Hand

For reasons whose significance will become more striking as this organizing-programmatic drive expands and develops, the tasks of the Research and Development Project cannot consist of a mere series of self-contained project studies, but must be continually reexamined and redefined from the standpoint of ever-expanding needs — from the standpoint of new needs generated as a result of actions taken to satisfy existing needs. The political implications of this necessary open-endedness in socialist planning, i.e., the superiority of "Soviet"-type class-for-itself democratic planning versus the USSR's traditional bureaucratic Gosplan procedures, are obvious enough to be merely identified here.

For now, let us stick to the problems at hand, which are of two interrelated types. First there are the immediate, practical problems of iron necessity that the present capitalist collapse-crisis tosses into our laps for solution (for example, the auto-industry/food production problem). Second, there are equally practical problems but of a different order of immediacy, problems which emerge directly out of the solution of the first type and which lead us directly to the practical issues of deliberately managing the planet's entire ecology, energy flows, biomass, all on the behalf of the human species as a whole. This already represents in germ form an altogether new conception of global socialist planning that involves the direct, urgent collaboration of Marxist economists, theoretical physicists, mathematicians, biologists, geographers, et al. Practically every single area of scientific endeavor is drawn in and directly endowed with a powerful task-orientation drive. There is nothing bureaucratic-dictatorial about this task orientation; it is fueled by the driving necessity to reverse the capitalist depression-collapse and spare the human race an otherwise inevitable ecological holocaust by the middle of the next decade.

In the course of R&D work the designation "Phase I Projects" has been adapted for the first type of problems that arise immediately from the depression collapse; the somewhat looser designation "Phase II-III" has begun to be used for the intermediate and longer-term projects designed to meet the needs that arise on the global-ecological level. At the far end of the Phase III designation, for instance, would be the development of fusion power technologies, the fundamental breakthroughs in theoretical physics, mathematics, etc. that that sort of global management of natural processes requires.

Let us begin with the Phase I type of projects. To any industrial worker, production engineer, or other qualified person it is obvious that this emergency planning does not end with the Emergency Food and Tractor Conversion projects. Morally weak, or simply imbecilic people told us that tractor conversion was impossible, utopian, unnecessary, etc. The same was said by such people about food production and fertilizer supplies. The workers and others who got down to work to supply the actual technical and other specifications that proved the feasibility of converting half the U.S. auto industry to tractor production in three months were also the people who perceived the open-endedness of the undertaking: problems of fuel supply, new machine tool capabilities, raw materials were raised mostly by the same people who helped solve the initial tractor problem. The same sort of experience is presently encountered with the Fertilizer Production Project. Once the problem is solved in a satisfactory way on one level, the next order of problems is posed: raw materials, energy, skilled labor supplies, new machine tool requirements, and so forth. As it happens, these problems are presently intersected by those created by the capitalist collapse. Take for instance the situation in machine tool in both the U.S. and Western Europe, as well as in Japan. The international machine tool industry is now on the verge of shutdown because it is burdened with the highest debt/liquidity ratios of any industry in the world — precisely the time we need it most. So the working class has no choice but to develop immediately the actual solutions to this problem, too.

The Development of Labor Power

As we proceed with the solution to these problems, as we must, it becomes obvious to more and more people that we are not dealing with particular problems but with actual global problems. Larger and larger masses of workers become directly engaged in global planning-organizing. In turn, this newly emerging moral quality of world-historical being fuels the awakening intellectual competence of workers to solve these problems of economic planning. At this point, workers in the advanced sector begin to have a sensuous appreciation of the need for culturally advanced labor power and this shapes their sense of practical-moral responsibility to their brothers and sisters in the underdeveloped world.

Given that the greatest shortage in the world today, the propaganda of Zero Growth lunatics notwithstand-

ing, is the shortage of qualified manpower, the working class has a major commitment to rapidly develop the material and cultural standards of Third World populations. The obvious economical, rational way to transmit industrial skills and complementary cultural levels to large populations that have been completely deprived of the advantages of industrial cultures is to massively move such working-class population to the advanced sector where industry is actually located. Coupled with rational policies of eventual voluntary repatriation, this policy represents the best way of pairing the solution to the problem of labor shortages in the advanced sector with the solution to the problem of low industrial-cultural standards among the working masses of the Third World. This would be the optimal solution for such regions as Central America, the Middle East, North Africa, the Italian South, Iberia, and so forth.

The raising of material standards in the Third World (the increase of protein consumption up to North American per capita levels, for example) can be best accomplished by rapid, mammoth projects such as the irrigation of the Sahel, which would make available to the world an arable land area five times that presently utilized in the U.S. with potentially twice the yield of the best American black soil! Equally necessary projects of similar magnitude are the ones presently proposed by the Labor Committees for the creation of marshes at the mouth of the silt-rich Amazon River and for similar utilization of the Ganges and Brahmaputra Rivers, which would result in a dramatic nutrient increase on the biomass in contiguous ocean waters. The projected Ganges-Brahmaputra project has the potential of ultimately feeding four billion people! Similar projects are being considered for the irrigation of the Middle East's famous fertile crescent, for the Mekong River, and so forth. The gardening of the Sahara Desert is also under consideration.

It is at such a point that methods and technologies of global ecological management are forced onto the agenda. What we are in fact proposing involves the drastic increase of the planet's biomass, a considerable increase of the amount of solar energy captured by photosynthesis likely to involve significant climatic transformations. Our irrigation/desalinization projects are likely to involve decisions about what we do with ocean levels: do we let them drop or do we chip down the polar caps? The sheer amounts of energy that will be demanded for the realization of these objectives immediately forces the issue of energy policy not only in the context of our standing commitment to developing fusion power within a few years but also the immediate short-term energy problem of the "meantime." Choices will have to be made on a global scale about short-term reliance on petroleum, coal, solar energy, etc. On the whole we are committed to maximum availability of conventional energy in anticipation of the fusion power breakthrough.

III. On the Threshold of a Great Awakening

Periods of great crisis such as the present one are periods of great *decisions*, as the etymology of the Greek word "crisis" suggests. As we find ourselves in the midst of modern civilization's gravest crisis, we are aware that not the slightest practical step is of any merit or competence unless it proceeds from the standpoint of global ecological planning implicit in the Labor Committees' present programmatic-organizing drive. Nothing stands between the human species and its destruction in an ecological holocaust in the next few years except its willingness to restore to itself the joys and responsibilities of acting as the "crown of creation." At this point in history, the willful, deliberate application of man's genius to the systematic management of all evolutionary processes on this planet has become a practical task on which man's survival depends.

Whether you deal with the immediate practical problems of restoring industrial production and meeting elementary human needs, or with the more advanced problems of natural science involved in global-ecological planning, you inevitably return to the key parameter: human cognitive powers. The material production bottlenecks cannot be solved unless the first task of any planning addresses the problem of vastly increasing the amount of culturally qualified manpower able to undertake the tasks of production.

In a similar fashion, as we find ourselves in the very beginning of an era of global-ecological socialist planning, where methods and techniques have to be developed from scratch; again, we know that the key strategic parameter is human cognitive powers. It would be wrong to imagine that breaking through the fusion-power problem is the only task of modern science. For decades theoretical physics has been stuck in the mud of a hopeless debate between determinism and entropic elementary disorder. As always in the past, this stagnation and morass in science will be swept away by the intervention of necessity. If the human race is to survive the holocaust organized by the imbecilic Rockefeller cabal, man must place himself in deliberate command of his actual universe and man's science must return to its anthropocentric roots.

At this point it becomes obvious that the key parameter that socialist global-ecological planning seeks to maximize at all points is the power of the human species as a whole to increase its cognitive powers. Proceeding from this it is obvious why the ICLC continues to emphasize what seems an apparently overwhelming concern with rapid economic development in the advanced sector as a first priority.

North America, Western Europe and, to an extent, Japan represent today the most culturally/industrially advanced working class. The accumulated productive and cognitive powers in the working classes of these sectors, along with the general productive industrial environment in which they function today, represent human society's "free energy," i.e., that power which when realized leads to a general rapid increase in the cognitive and productive powers of society as a whole. It is in this principled sense that we insist that the fastest way of developing the cultural and material standards of life in the Third World is by choosing that optimal course that leads to the fastest possible development of society's "free energy."

The Creative Climate

It is the same principled consideration that defines the policy of the political working class to its allies in the scientific milieu. In this period of complete degradation of scientific virtue, of commercialization of science, the scientist and his science, with a few happy exceptions, has been turned into the degraded whore of the corporate executive or the military bureaucrat. One of the important reasons that science is suffocating is because the moral stink in which scientists have no choice but to work is in complete violation of the true scientific mind.

Our task is to continuously provide that moral and social climate where scientific thought can flourish. For the working class, supplying its scientists with the moral, cultural, and material environment necessary for creative thought is, unlike for every other class in history, not a task of "patronizing the arts and sciences" but the central commitment for all economic planning. Since the Labor Committees have established beyond question that the *central, principled criterion of global-ecological socialist planning is the maximization of society's power to increase its cognitive powers,* no further elaboration is necessary of a true socialist policy toward the development of science, or of the premium placed on providing that necessary environment where the creativity of the individual human mind can flourish.

Our tasks as political revolutionary organizers are to force self-consciousness among scientists as we do among the industrial working class. The problems that the Labor Committees are posing for the scientific community's attention, of which the development of fusion power is only a minor one, are not of our own invention. They have been haunting the putrid air of the halls of science for decades now. Granted that "social conditions" did not encourage the emergence of Promethean Titans in science in the past half century, just the same, toleration of this placid and quiescent climate in science would cost the human race its existence.

From the way we defined the principled central criterion for global-ecological planning it is obvious that the human race is today on the verge of an entirely new historical era in which human mentation, self-consciously and deliberately guiding itself, becomes the crucial vanguard of all evolutionary processes. It is just this that Vernadski anticipated with his earlier concept of the noösphere, discussed elsewhere in this issue. This emerging world outlook is pregnant with challenging promises, with as yet unknown but wonderful implications for every field of scientific endeavor that men of science must bring to light and realization.

January 20, 1975

Fusion Energy Foundation

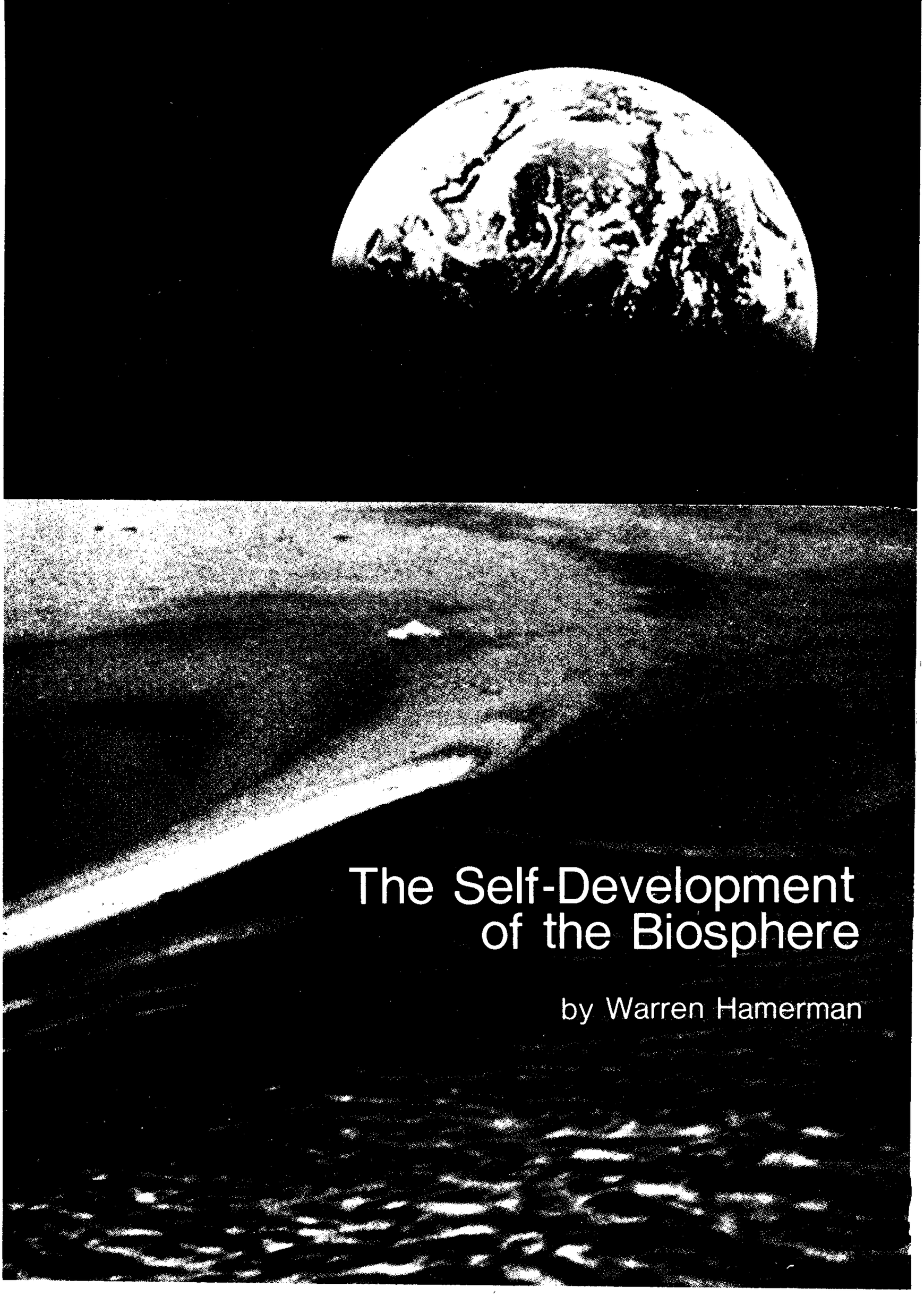
The FEF will shortly begin publication of its journal, ProFusion. For more information write to:

Fusion Energy Foundation
GPO Box 1901
New York, N.Y. 10001

The Fusion Energy Foundation was founded in November 1974, at a meeting attended by representatives of the United Nations, the International Atomic Energy Commission, scientists who have made significant contributions to fusion research, and interested laymen.

The purpose of the FEF is to provide a forum of independent, high-level scientific discussion of fusion from the standpoint of comprehensive policy-making. This will be accomplished in several ways:

- By educating the general public through various publications and through the holding of public forums.
- Through publication of a theoretical scientific journal which will examine fusion research from the standpoint of developing alternative research policy.
- By providing our findings to appropriate government agencies and laboratories so as to facilitate creation of a crash program for fusion power development.



The Self-Development of the Biosphere

by Warren Hamerman

There is no need for minds to be confined at all within limits!

R. Descartes, 1628

Whether mankind as we know it continues to exist even into the last decade of the 20th century is an open question. The nearly five-billion-year hylozoic development of the once sterile planet Earth into "man's world" — the modern biosphere — will be determined within the next months. Either the potentiality for ecological holocaust or the potentiality for human species creativity must become actualized on a world scale. In the first instance the biosphere as a whole, under the subhuman fascist grip of the Rockefellers, will careen uncontrollably down the pathway toward extinction, for all intents and purposes, this side of the year 1990. In the latter case the international working-class movement, as determining subject, will self-consciously "vectorize" the biosphere as a whole toward ever-accelerating negentropic development, ensuring the reconversion of the world economy to socialist expanded reproduction.

Engaged in a struggle for such ultimate stakes, the Labor Committees have from their founding been based upon the *necessity for coherence* between what the bourgeois reductionist world view defines as the separate "fields" of politics, philosophy, science, psychology, and the arts. It is the study of the way in which the individual human mind conceptualizes the process described by the 19th century poet Shelley as mind "bursting" its own circumference, which furnishes the appropriate model for understanding human political economy's dominant relation to the biosphere as a whole. Thus, the problem of generating a *common language* between revolutionary politics and advanced science (which only a psychotic with acute suicidal tendencies would deny is of the utmost urgency) is fundamentally a question of locating the rules for the direction of the universally creative minds of the world's population themselves taking overall social responsibility for not only surviving an ecological holocaust, but in that very process laying the foundations for the immediate reconstruction of the world economy. Thereby, socialist man takes on self-conscious responsibility for the further evolution and extension of the human biosphere.

In its fundamental features this transformation of the human biosphere beyond itself is embodied in V. I. Vernadski's cruder but essentially correct self-reflexive conception of the leap from the biosphere to the *noösphere*. As we shall see shortly, the creative work of Vernadski and his more famous contemporary A. I. Oparin, taken together, can only be understood from the more advanced standpoint of the Labor Committees' conception of negentropic development.*(1)* That the breakthroughs of Vernadski and Oparin took place within the Soviet Union in the immediate years after the revolutionary transformation of that society under Lenin's direction is itself immediate empirical demonstration of the coherence between politics and science. The fact that the views of Vernadski and Oparin contained within themselves unnecessary ideological flaws is not the fault of Vernadski and Oparin or even of the Bolshevik revolution. Their conceptions were born into a scientific world immersed in the muck of Darwinian evolutionary theory elevated to the level of a fundamental premise of bourgeois neurotic ideology. Vernadski and Oparin lacked a social context in which they could battle the notions of Darwin on the advanced theoretical sphere mediated through an institution engaged in *worldwide* class struggle. To that extent their own scientific works necessarily contained internal concessions to the surrounding milieu of bourgeois reductionist muck. Vernadski and Oparin are no more at fault for this than the Bangladesh victim of cholera or bubonic plague is to blame for the current threat of an epidemic, simply because he carries the parasites within him.

The Alternative Process

In contrast to the "confinement" of the minds of Vernadski and Oparin within bourgeois "limits," the alternative process is well illustrated by the unprecedented impact which the German edition of NCLC Chairman Lyn Marcus' *Beyond Psychoanalysis* had upon professional and other strata within the West German Federal Republic.*(2)* The mere publication of Marcus' work in West Germany threw the entire intellectual community of that country into an uproar.

As a related but not fundamental feature of the impact, the individuals responsible for translation of the document from English into German returned to the works of Kant, Hegel, Feuerbach, and Marx to utilize the more advanced conceptual potential of the language associated with German Critical Philosophy. The concepts developed by Marcus in his work appeared to have the "ring" of this earlier period. But merely this correspondence is not sufficient to explain the process behind the immediate polarization of key segments of the West German intellectual community.

The very polemic of the work forced many Germans to confront their own lost sense of history in the most profound sense. Why? Because their search for history immediately raises up the horrors and collective guilt of a nation at once victim to, but also participant in, the Nazi regime. To any middle-aged

German the images of the Schacht-Hitler era, immediately followed by the even worse horrors of the postwar period, of a nation of bestial scavengers pawing through bombed-out rubble, throw up such overwhelming feelings of agony and degradation that the entire sense of self is threatened. If one were not to block out those images, one would ultimately be faced with the fear of "coming apart," of going insane. That awesome fear is clinically associated with the dread that there is nothing behind the plastic masks of even one's closest comrades and loved ones, for they too must suffer as "I" without any identity in history.

Beyond Psychoanalysis, as a paradigm for creative scientific breakthroughs in general, confronted the roots of these fears in the most polemical fashion possible. "Yes, you have a history, an extremely profound one but not in anything explicitly German. If you search for a history in the Prussian monad sense of nationhood, your actual psychological identity would be just as insane as if you identified your past with the psychosis of the Third Reich. From a human standpoint, your own self estimation would be just as bestial and morally repulsive." *Beyond Psychoanalysis* locates a sense of identity in German Critical Philosophy and Karl Marx, not as "local beings" of the German nation but as world historical figures. "Your identity rests with Hegel and Marx to the extent that you, like they, strive to see yourself in world historic terms." To the extent to which all one's creative potential is currently mobilized to defeat Rockefeller and avert ecological holocaust, only to that extent can one locate one's own particular identity in history.

I. Marx versus Malthus

We can extend more compassion in a very real sense to the modern German struggling out of his emptiness than we can to the blunders associated with Friedrich Engels' banalization of Marx's method, in particular his implantation of the parasite of bourgeois reductionist science within the working-class movement, despite Engels' otherwise heroic contributions to the revolutionary struggle. Once an individual locates himself as a world historical figure, as Engels certainly did through his own achievements and his longstanding association with Marx, a different order of criteria are required. Wearing the mantle of the Marxian tradition alone within the world working-class movement after his comrade's death, Engels however drew back in terror, and his works during those later years are of a criminal and primitive character when measured against even his own earlier works!

An intensive study of Engels is currently being undertaken within the Labor Committees, and it is therefore not our intention to present here the tragedy associated with his merely primitive grasp of Marx's key conceptions of sensuous human historical experience within a worldwide expanding productive economy. For our present purposes it is sufficient to identify Engels' failure to assimilate the germ of the

Marxian world view in the early 1840s as the fundamental root of the later Engels' blunders with respect to bourgeois science. This failure to conceptualize the essence of Marxism in the epistemological sphere led to Engels' renunciation of the central polemic of his and Marx's career on the very day that he stood alone: the polemic against the views of Parson Thomas Malthus.

As he stood above the open grave of Marx on March 17, 1883, giving a eulogy he knew would be discussed and internalized by millions of workers and socialists around the world, Engels said, "As Darwin discovered the law of evolution in organic nature, so Marx discovered the law of evolution in human history; the simple fact, previously hidden under ideological growths, that human beings must first of all eat, drink, shelter and clothe themselves before they can turn their attention to politics, science and religion...."

Engels' capitulation is unconsciously revealed in this reversal of his previous insight into the base features of Charles Darwin. In his early studies of the oppressed conditions of the British working class, and throughout his years of collaboration with Marx, Engels identified Malthus' "overpopulation" theories and defense of Britain's brutal Poor Laws as the key ideological enemy of the working-class movement.

Yet now Engels' own incoherence between his dabbling relation to science and his own commitment to class politics led him to hold Darwin up as a model for Marx: the very same Darwin who traced his own theory of "natural selection" and "species variation" to — Parson Malthus!

> In October 1838, that is, fifteen months after I had begun my systematic enquiry, I happened to read for amusement Malthus *On Population*, and being well prepared to appreciate the struggle for existence which everywhere goes on from long-continued observation of the habits of animals and plants, it at once struck me that under these circumstances favourable variations would tend to be preserved and unfavorable ones to be destroyed. The result of this would be the formulation of new species. Here, then, I had at last got a theory by which to work.
>
> *Autobiography of Charles Darwin*

Darwin's basis in the tradition of Parson Malthus is no obscure scholarly fact, requiring years of sifting through yellowed manuscripts to discover. The Malthusian nature of Darwin's theories is the central core of Darwin's work, and in fact was common knowledge in the 19th century for Darwin himself paid his intellectual debt to Malthus in everything he wrote.

Marx was certainly well aware of the problem. In at least two sections of his notes on *The Theories of Surplus Value* he directly raises the problem of the relation between Malthus and Darwin for further study. In one instance he says that Darwin himself did not realize that "by discovering the 'geometrical' progression in the animal and plant kingdom, he *overthrew* Malthus' theory." In the second instance he mentions that the mere existence of man, with his existing mental capacities for technologically creating the preconditions for progress to higher levels of social reproduction, also directly refutes the Malthusian nature of Darwin's work.

Engels himself was certainly not ignorant of the Malthusian essence of Darwin's views and identified it explicitly while Marx was still alive. It was Engels who showed that the perfect Darwinian world was the bestial world of Thomas Hobbes' pit, where the jungle rules of "survival of the fittest" first reared their head in the service of political reaction:

> And because the condition of Man...is a condition of Warre of every one against every one; in which case every one is governed by his own Reason; and there is nothing he can make use of, that may not be a help unto him, in preserving his life against his enemyes; It followeth, that in such a condition, every man has a Right to every thing; even to one anothers body.
>
> *Leviathan (1651)*

Royalist Hobbes, the enemy of the English Revolution, was the student of Francis Bacon, the founding father of empirical philosophy — what Hegel describes as the acceptance of the "finite and worldly as such."

Engels, along with Marx, spent his life keeping Malthus out of the front door, so to speak. Yet from the first hours in which he stood alone, he allowed the bestial parson in through the servants' entrance in the guise of Darwinian reductionism. For this alone it is Engels, not Malthus, who better merits Marx's condemnation of "sin against science."

It is this "sin" which is behind the attempts of even Oparin and Vernadski (not to mention nearly 100 years of lesser biologists) to place their works within the "progressive" tradition of Darwin's evolution theory. With blind faith Western and Communist scientists have picked Darwinianism out of the gutter as a weapon against the religious dogmas of "Divine Will" or "Vital Force." Except for the British holists of the 1920s, whom we shall discuss later, all 20th century biology and related fields are based upon the foundations of Darwin. Oparin quotes Darwin and describes the biochemical history — the very history which itself is the best empirical proof for negentropy — as a process of "natural selection." Almost all textbooks written today in the fields of biophysics, bioenergetics, genetics, ecology, biochemistry, etc., begin with a preface upholding the progressive tradition of Darwin. Virtually every modern researcher in the biological sciences is proceeding with work on the microbiological level from the fundamental Darwinian assumption that evolutionary development has its locus within the individual member of the species and its

"individual competitive advantage" for survival on its own or by "mutating" such advantages.

The notorious worldwide debate which centered around the views of Soviet biologist Lysenko in the 1940s and Cold War era can only be understood in the more general epistemological context developed above. The rise of Lysenko and his collaborators to hegemony in Soviet biology in 1937 is associated with a rejection of the gene theory of inheritance in favor of "environmental determinism." In actual terms the *cause celebre* associated with Lysenkoism had absolutely nothing to do with whether a neo-Lamarckian view of the "inheritability of acquired characteristics" was valid or not. Evolution theory, modern genetics, and approaches to microbiological phenomena were relatively minor predicates to the raging polemics, as was evident from each combatant's inability to conduct the debate in the 20th century! The more substantive conceptual problems posed for modern science after the overthrow of the Newtonian Universe were never even approached, as the debate remained mired in the cesspool of mere ideology.

Ironically, what Western pamphleteers (in the worst Malthusian sense of the term) isolated as the most degenerate features of "communist science" — centralized control of research direction and theoretical discussion, science as a subsumed vehicle of overall socio-economic planning, and the necessity to mobilize scientific brainpower to the immediate concern of expanding agricultural production — were actually the best features of the Soviet scientific community (notwithstanding the peculiarly primitive ignorance of the scientific *administrator* Lysenko himself with regard to actual modern scientific theory).

To the extent that the Soviet critique, on the other hand, partially landed upon the implicit reactionary nature of the "genetics revolution" encased within positivist science, they were correct in so far as they went in that direction. Crapulent capitalist society is the favored breeding ground for "mad scientists" and other strains of anti-human vermin. Yet the Soviets, entrapped by their own bourgeois reductionist notions of science, committed themselves to fighting the battle on the ideological terms defined for them. They held up the "materialist determinist" nonsense of Engels and his even worse epigones in dialectical "theory" as their own positivist standard, further contributing to the total breakdown of morale among all modern scientific cadre.

As an immediate consequence of the ideological banality which the Lysenko debate evoked from both sides, the missing subject was never located: the modern scientist's acute moral crisis resulting from the failure of global socialist transformation after the First World War and the subsequent victory of fascism. The urgent necessity for science to synthesize modern biological/ecological investigation from the starting point of advanced mathematical physics and Marx's conception of expanded worldwide production was befogged for another generation and a half. With the door opened again, Darwinian reductionism rushed back into the room! At the subsequent conjunctural crisis of world capitalism, Rockefeller's spiffed-up Malthusian notion of "Zero Population Growth" emerged hegemonic within the scientific community.

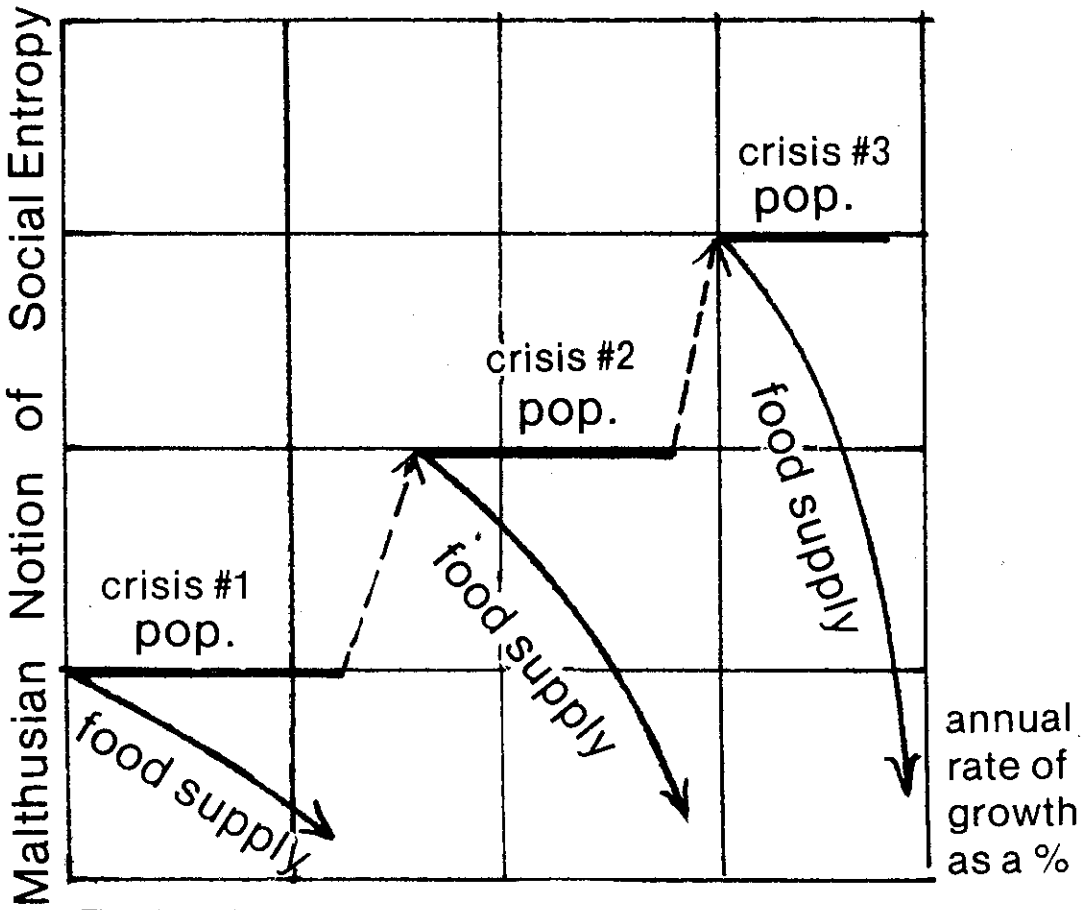
Modern science had indeed been disarmed! Harold F. Blum, in his *Time's Arrow and Evolution*, wrote that the second law of thermodynamics proves Darwinian evolution theory of natural selection. At the same time, Oparin, Schroedinger, Haldane, et al. (as we shall investigate shortly) wrote that the hylozoic evolution of organic from inorganic matter proves that entropy guides inorganic processes while Darwinian natural selection and negative entropy determine organic development. It is a lawful but tragic occurrence that even the leading "holist" scientists (in biology and physics) went down with the sinking ship. Today Malthus and his protege Darwin reign supreme in advanced biology on the sub-microscopic and ecologic-evolutionary levels, both among Western and Soviet scientists.

"Nature's Mighty Feast"

Darwinism is rampant precisely because Malthusianism is deliberately propagated by the ruling forces. The antihuman views of Parson Malthus come back nearly two centuries after the 1798 publication of his *Essay on the Principle of Population, As if Affects the Future Improvement of Society*, in the form of John D. Rockefeller III's "Zero Population Growth," i.e. the literal autocannibalization of the world working class. As Marx *and* Engels were the first to point out, it is the deliberate increase in the social-reproductive quality and quantity of society's labor power through technological improvement during the course of history which has allowed the human species to overcome the recurrent crisis of limited resources and seeming overpopulation. The only overpopulation problem in the past 176 years has been the overpopulation of the world by capitalists in general and Malthusians in particular at every recurrence of capitalist conjunctural crises. Every time the capitalist class has instituted domestic or imperialist looting methods to stave off collapse, Malthusians have arisen to scream that "unproductive consumers" must be eliminated in order to keep "parsons" and their masters well fed and to avoid the acceleration of the crisis. They have viewed that por-

Figure 1

Figure 1: Malthus' anti-human theory about the opposition between the geometric rise in population and the merely arithmetic rise in food supply was stolen outright from the reactionary section of the French nobility in the years immediately before the French Revolution. Contrary to the political fears of the reactionaries, human population has increased exponentially since the Neolithic Revolution in 8,000 B.C. precisely to the extent that forms of social organization have raised the basis for expanding human society in successive technological breakthroughs.



The above figure has absolutely no correspondence to reality. It should be noted that it is impossible to place any meaningful coordinates along either the x or y axis. For any geometric rise in population (namely any population growth rate greater than 0 per cent) the population growth rate does increase. Therefore, the horizontal "jumps up" unexplainedly to a higher level after a crisis has been passed. The food supply growth rate then "curves away" at an even steeper rate.

The exponential "take-off" point in the late 18th century should be noted — the bourgeois victories in the United States and France marking the beginning of the capitalist Industrial Revolution. If the graph were drawn to different scale, and our time line was extended to the left, one would notice an equally significant "take-off" point at approximately 8,000 B.C. — the so-called Neolithic Revolution in which man domesticated animals and initiated agriculture. Under a worldwide socialist economy within the years ahead, both curves extended slightly to the right will show another exponential leap

tion of the work force that they intend to squeeze out of the productive process as essentially non-human and fit for the scrap heap; these "useless eaters" (in Rockefeller's "modern" terminology, the Fourth World) have no right to "nature's mighty feast." The stated policy of Rockefeller's Marie Antoinette, Aurelio Peccei of the fascist Club of Rome, is "Let them eat each other!"

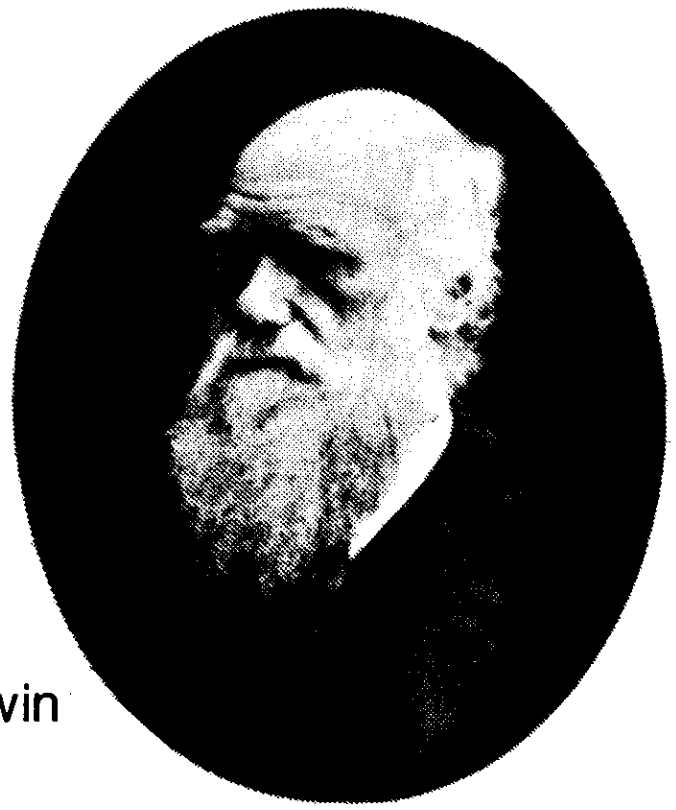
To understand the original Malthus and not the insane mutant strains represented by the Rockefellers, he must be situated within the context of the English reaction to the French Revolution. Malthus had a vested interest in keeping the dreaded upheaval in French society from spreading. By defending the landed aristocracy and the state church against the rising capitalist class, he thereby ensured the need for the propagation of parasites such as parsons upon productive society. To keep production from breaking down after the "useless consumers" were eliminated, Malthus urged that the accumulation of wealth be given to members of his own parasitical segment of society. As Marx noted, Malthus is little more than a "sweetener for the sojourn of the ruling class," since he plagiarized nearly every word he wrote.

It is a perilous irony that the thousands upon thousands of scientists who have placed themselves in the Darwinian "scientific" tradition during the 115 years since the publication of the *Origin of the Species* little realize that the Malthusian solution to development, reproduced in Darwin's views, opposes all technological/scientific intervention into the "natural course" of events.

> A struggle for existence inevitably follows from the high rate at which all organic beings tend to increase. Every being, which during its natural lifetime produces several eggs or seeds, must suffer destruction during some period of its life, and during some season or occasional year, otherwise, on the principle of geometrical increase, its numbers would quickly become so inordinately great that no country could support the product. Hence, as more individuals are produced than can possibly survive, there must in every case be a struggle for existence, either one individual with another of the same species, or with the individuals of distinct species, or with physical conditions of life. It is the doctrine of Malthus applied with manifold force to the whole animal and vegetable kingdoms; for in this case there can be no artificial increase of food, and no prudential restraint from marriage. Although some species may be now increasing, more or less rapidly, in numbers, all cannot do so, for the world would not hold them.
>
> *Origin of the Species*

What need, then, has the world for science?

The fundamental essence of Darwin's theories is that they were not his but Malthus'; the essence of Parson Malthus, in turn, was that he was a plagiarist, in addition to his other despicable qualities.



Charles Darwin

II. The Sewer Tradition of Natural Science

It was not merely that Darwin the naturalist cribbed his anarchist theories from Malthus the reactionary pamphleteer; it was Malthus the plagiarist who stole his material outright from the mid-18th century French nobility's last resort to the impending pulse of revolution — the gutter tradition of naturalism as a political weapon.

The race "science" of Hitler, Mussolini and the lunatics associated with the Rockefellers today has its roots in the French aristocracy's think-tankers in the decades immediately before the revolution, the right-wing elements of what has become known as the Encyclopaedists. Beginning in the late 1730s, a number of studies began appearing on the relationship between increasing urban population and decreasing food supplies. Reports on the East Indian orangutans, Cape Hottentots, American Indians and Australian aborigines began circulating in the boudoirs of Paris. It was from these studies that Parson Malthus stole his famous dictum about the geometric tise in population as opposed to the arithmetic increase in the food supply. (see Figure 1)

Most well-known and massive of these studies was the 44 volume *Histoire Naturelle* of the Comte de Buffon (1707-88), which began appearing in print in 1749. Buffon's basic theme was that since life multiplies so much faster than the food supply, the inexorable result was intense "struggle for existence" among the various species and *individuals* within each given species. "Improvement" in this order of things he termed "degeneration" away from the more natural states of God's creation: "Nature turns upon two steady pivots, unlimited fecundity which she has

given to all species; and those innumberable causes of destruction which reduce the product of this fecundity." The 20th century's eugenicists, behaviorists, and other accredited madmen would have little quibble with Buffon's formulation:

> You unjustly compare, it may be said, an ape who is a native of the forests with the man who resides in polished society. To form a proper judgment between them, a savage man and an ape should be viewed together; for we have no just idea of man in a pure state of nature....There is as great a distance between man in a pure state of nature and a Hottentot, as there is between a Hottentot and us.

It was Buffon's personal good fortune to die the year before the French Revolution. The *sans culottes* brought his son to the guillotine in his stead. The son, making the unfortunate tactical decision to use his world-famous father as recommendation against decapitation, was heard to remark, "But...but... Citizens, my name is Buffon!" — at which point the great blade fell.

Unhappily, this gutter tradition of "science" was not cut out so easily. Buffon's *Natural History* was the principal influence for the conceptions of evolutionary theory advanced by Erasmus Darwin (Charles' grandfather) in his 1794 *Zoonomia* and passed down to his grandson.

In the years of intense class struggle during the middle 19th century, Darwin and a host of other neo-Malthusians again performed informal "think tank" services for the European bourgeoisie. Darwin classified the Hottentot tribes of the Cape of Good Hope as members of the same species as orangutans. Three of Darwin's contemporaries, "enlightened" by Darwin's theories of evolution, are representative of the entire lot:

> Carl Vogt, *Lectures on Man* (1864): "Young orangs and chimpanzees are good-natured, amiable, intelligent beings, very apt to learn and become civilized. After the transformation they are obstinate savage beasts, incapable of any improvement. And so it is with the Negro."
>
> Pouchet, *The Plurality of the Human Race* (1864): "Examples are not wanting of races placed so low that they have quite naturally appeared to resemble the ape tribe. These people, much nearer than ourselves to a state of nature, deserve on that account every attention on the part of the anthropologist."
>
> Henry Piddington, *Memorandum on an Unkown Forest Race* (1855): "We have upon three points of continental India the indubitable fact...that there are wild tribes existing which the native traditional names liken to the Orang-Utang, and my own knowledge certainly bears them out; for in the gloom of a forest, the individual I saw might as well pass for an Orang-Utang as a man."

The tradition of social Darwinianism was used by imperialist European countries to justify their looting around the world as well as within Europe during the last four decades of the 19th century and up until the First World War. The German victory in the Franco-Prussian War of 1870-71 and the crushing of the Paris Commune led directly to proclamations of Teutonic "fitness" to survive and to rule, the most vicious celebration of German "local being." In the 20th century this sewer science tradition is more widely associated with the moral repugnance appropriate to the names Mussolini, Schacht, Hitler and, of course, the brothers Rockefeller.

Over the past four centuries, reductionist natural science has been mobilized on the side of political reaction at each moment of revolutionary social upheaval: Thomas Hobbes in the 17th century against the English Revolution, Buffon et al against the French Revolution in the 18th century, Malthus against the rising British proletariat in the first half of the 19th century, Darwin and the social Darwinians in the second half of the 19th century against the First International and the Paris Commune, German-Italian fascist science in the first half of the 20th century against the Russian Revolution and upsurge in the advanced sector, Rockefeller-fostered "Zero Population Growth" in the last decade against the imminent potential for world revolution.

In each instance of conjunctural crisis, the underlying terror that there is "no way out," i.e., the absence of a conception of man's creative potential to determine "progress" beyond the crisis point through scientific breakthroughs and social organization on a higher level, expresses itself in the political motif of "Every man for himself." Science as it exists for the mind of the empiricist, the mind which denies its own coherency, at such moments exposes its underlying vicious ideological prejudices by 'coming out' of the laboratory — onto the side of reaction.

We must view this process in its broadest sweep, in the context of the two philosophic traditions which emerged from the late Renaissance: the humanist and anti-humanist empiricist. The one reveals the struggle for, and the other the denial of, coherence between the individual creative mind, its infinitude, and the external world. The fundamental opposition between these two world views is epitomized in the contrasting minds of two 17th century philosophers, Rene Descartes and Francis Bacon. As discussed by Marcus in *Beyond Psychoanalysis* and elsewhere, the humanist tradition is reflected in the works of Descartes, Spinoza, Kant, Hegel, Feuerbach, Marx and in every creative artist, scientist, and musician over the past four centuries. Flowing from Bacon, the fearful tradition of empiricism is best associated with Locke, Berkely, Hume and every banal conception of science and art during the same time span. The tension between these two traditions has been expressed in an

array of fraudulent dualities: mind or matter, man or nature, organic or inorganic, practical invention or scientific theory, fixed laws or chaos, concrete or universal, religion or science, etc.

Bacon, the original encyclopaedist, resolved the dilemma inherited from the Middle Ages by negating the infinite in the here and now, while the brilliant Descartes located "perfection" in the continuously self-perfecting mental processes of the creative individual. In the Middle Ages Christianity had posed the problem of perfection, i.e., the true infinite, in a fashion unsolvable within the context of feudal society, where speculative thought was the sole domain of the clergy and doctors of theology, divorced from any general social context. Christianity placed the infinite in man's soul. Hegel described this as separating the "divine and supersensuous content" from the world and shutting itself up "within itself in the center-point of the individual." Consequently, the external *natural world* of heart and feeling, of human nature and temptation, had to be resisted. Bacon's solution was to deny universality as knowable.

Instead Bacon posited *experience as the only source of true and absolute knowledge.* His epistemology is incapable of conceptualizing any universal because the world in which man has his experiences is composed of distinct, unrelated things. The philosopher is left incoherent — either studying a decorticated metaphysics (the "science of causes") or a decapitated physics (the effects of these "causes" according to certain fixed laws). This incoherent world of man is the basis for "natural science" and "natural history."

Bacon's "natural science" places "the end of each individual man in himself," as a self-contained unit. *The ultimate end of every animal, man included,* according to Bacon, *is its own "self-preservation."* Survival of the fittest...The jungle psychology of capitalist individuality rears its head for the first time! Mind denying its own creative potential — the empiricist mind — is quite literally and expression of insanity. The act of self-menticide necessarily raises the most awesome terrors of death and impotence.

Darwin's *Autobiography*, two centuries later, is an excellent clinical study of the empiricist. "I worked on true Baconian principles," writes Darwin, "and without any theory collected facts on a wholesale scale." He describes as his "intellectual" pursuits beating dogs ("enjoying the sense of power"), shooting birds (through his adult life he kept a string attached to his belt; everytime he shot a bird he tied a knot in the string) and collecting beetles! The creatively dead mind, the mind enveloped in fat, labels, categorizes, weighs and collects. When Darwin returned from his famous voyage on the Beagle, his letters are filled with complaints about the "vile, smoky" London — modern industrial England. Two years later, in 1838, he picked up Parson Malthus "for amusement" and at long last discovered his theory.

At the very end of his life, Darwin looks back at himself:

> My mind seems to have become a kind of machine for grinding general laws out of large collections of facts, but why this should have caused the atrophy of that part of the brain alone, on which the higher tastes depend, I cannot conceive. A man with a mind more highly organized or better constituted than mine, would not, I suppose, have thus suffered; and if I had to live my life again, I would have made a rule to read some poetry and listen to some music at least once every week; for perhaps the part of my brain now atrophied would thus have been kept active through use...

We now have some comprehension of the enormity of Friedrich Engels' "sin against science" in comparing Marx to Darwin. One can react only with moral outrage at Engels! At just the moment when a world-historic presence was needed Engels introduced his own terror of intellectual potency, his unconscious fear that his creative inadequacies would prevent him from carrying on "the tradition." Therefore Engels substituted empiricism for 'Marxism'!

III. The Queen of the Sciences

In the year 1781 one man in Europe embodied all the mighty creative spirit of the French Revolution in the launching of the Critical Philosophers' war on empiricism. Immanuel Kant reaffirmed the infinite capacities of the human mind for self-expansion by mobilizing metaphysics, once Queen of the Sciences, to the offensive against empirical reason. In the first preface to his *Critique of Pure Reason* Kant founds the basis for all modern science. Human mind must now take on the most difficult of all tasks ever posed before by history, the struggle for a self-reflexive conception of knowledge. The thing-in-itself, the scientific fact is unknowable. *"I have made completeness my chief aim,"* shouts Kant into the world which had just witnessed what only he understood: the collective strength of human mentation to change the world. The critique of pure reason is Kant's "critical" method itself, the human mind's freedom under necessity of enquiry into self-knowledge:

> I have entered upon this path — the only one that has remained unexplored — and flatter myself that in following it I have found a way of guarding against all those errors which have hitherto set reason, in its non-empirical employment, at variance with itself. *I have not evaded its questions by pleading the insufficiency of human reason.*

Kant does not merely elevate old Queen Metaphysics back to her throne as she used to be — dogmatic, skeptical, weary, and indifferent to man's actions.

Kant's metaphysics becomes the battlefield upon which the struggle of freedom/necessity is fought. Self-reflexive human knowledge, continuously self-developing, provides philosophy with a completely new rigorous conception of metaphysics as *creative scientific enquiry*. From this standpoint, Kant proceeds to demolish the empiricist method as mere "opinion" about "appearances."

The development of human scientific knowledge as self-developing can now be posed as a progressive contribution to the organization of the world. It is with Hegel that modern science restores to itself its positive content through the union of the concrete and the universal in purposeful activity, "not only something appearing as a *result* of necessity, but, because it has returned to itself, the last or the result is just as much the first which starts the process, and is to itself the purpose which it realizes.

With Hegel's contributions to the understanding of the fundemental processes of human noetic activity we have the potential to focus the "concrete universal" for science on the scientist's own creative mental processes. *As coherent subject, the creative scientist through his own contributions to the progressive development of society as a whole has the task of reproducing in others that capacity to "progress" society to higher and higher modes of existence.*

With Feuerbach's extension of this self-developing creative process (freedom/necessity) into the realm of sensuous human species existence, as that which distinguishes man as a species, the preconditions were set for Marx's scientific breakthroughs in the early 1840s. The struggle for human *social* creative solution (freedom) beyond the constraints of present social organization of capitalist society (necessity) is a continuous process of expanding the world's social-reproductive organization to ever and ever higher modes. It is through man's own hegemonic relation to "nature," exercised in technological innovation, that crises of apparent material resource scarcities are superseded. As society as a whole transforms the social content of man's contributions *from labor power to human power*, the working class itself will evolve into a species of scientists. It is through the mediation of "nature" that man will create his own "natural" environment.

As a consequence of Engels' blunders and Marx's ignorance of developments in 19th century mathematical physics, Marx's conceptions were alienated from the most advanced work occurring in the 19th century. The 20th century scientist whose conceptual development crudely straddled the two pathways (the one of Marx, the other of Gauss, Riemann, Cantor, Kline and Einstein) before Marcus synthesized them into the subsuming gestalt of negentropy, was V. I. Vernadski.

IV. The "Holistic" Approach

It should not be surprising at this point to discover that most of the breakthroughs in approaching the question of evolution from a non-Darwinian standpoint took place immediately after the Russian Revolution, among biologists associated with either the working class movement in Great Britain or the Vernadski-Oparin school itself. Furthermore, in every instance the scientists concerned had each struggled through to a synthesis, in one form or another, between German Critical Philosophy and modern science.

J.B. S. Haldane had developed a passionate commitment to Kant before he entered upon his career as a biologist. C.H. Waddington was a neo-Hegelian who utilized Hegel to demolish Darwin's theory of "natural selection."

After discussing Hegel's conception of interrelated process between man and all organic and inorganic matter, Waddington offers the following "proof" of the "soundness" of Darwin's views. Suppose that a man decided to contemplate the relation between the acorn and the oak, but that when he approached the tree a great wind shook all the acorns to the ground. According to Darwin, chides Waddington, the man in question would immediately be attacked by a vicious army of acorns fighting for their "fitness" to surivie against man. Were they unable to defeat the man, they would obviously become extinct instantly.

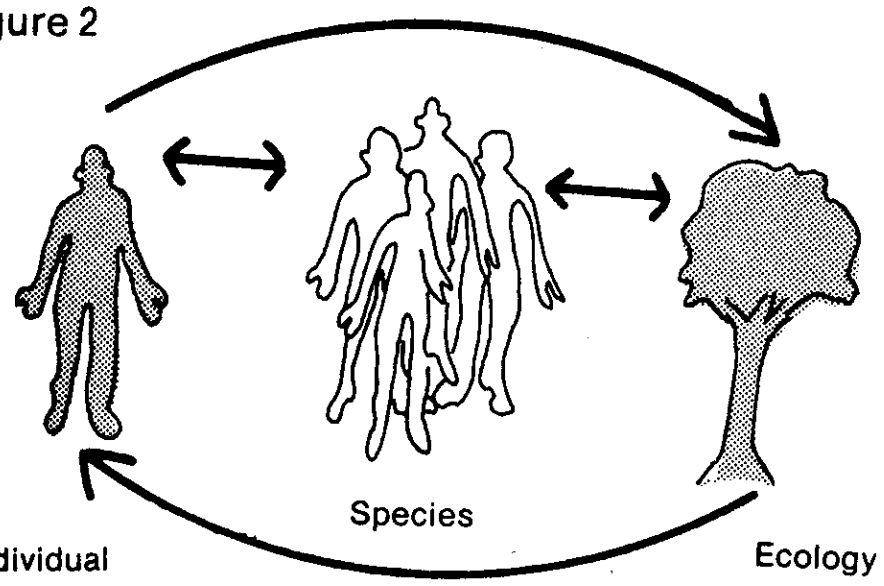
Oparin returned to the 6th century B.C. Ionian philosophers' notions of hylozoic development, the unity of inorganic and organic matter in a process of infinite change, to come at the modern humanist tradition from the unguarded rear. He, along, with Vernadski, also looked to the brilliant methodology of Louis Pasteur as a 19th century embodiment of the tradition of Cartesian science. Yet, most of all, Oparin developed his views in the scientific climate partially shaped by Vernadski himself.

It was Vernadski who self-consciously located his own work in the creative humanist tradition from the Late Renaissance through German Critical Philosophy, and in his later work attempted to synthesize the two pathways of the 19th century — Marxist humanism and mathematical physics. It is hardly surprising therefore that of them all, it is Vernadski's work alone which stands on its own feet from an advanced conceptual standpoint, and it is Vernadski's books which are least accessible in the modern world of empirical science.

The essence of the "holistic" approach can be seen by the fraudulent "aquarium" problem which is directly implied by a Darwinian approach to evolution and ecology. If one assumes that all modern plants and animals have a natural propensity to reproduce

themselves at the expense of other individuals, and that the fittest to survive will survive, then it is impossible for the number of individuals and species to grow exponentially, as they in fact have, unless one assumes that there is also an "aquarium keeper" (God, vital force, parsons, etc.) to change the water and charcoal filter. It is conceivable, at best, for a certain period of time to generate a Lamarckian aquarium of "all guppies" undergoing variations until one guppy adapts such that it is able to break through the glass, walk over and eat the startled laboratory assistant!

Figure 2



The anti-Darwinians approach the ecology from the interrelation down to the species individual and not the other way. Variations in individual species capability and behavior has an effect on an entire food chain, the food chain upon food "webs," and "food webs" upon the ecology as a whole. (see Figure 2) The Darwinian on the other hand would set up the "aquarium" concept, even, say, on the Galapadus Islands, focus in on two individuals and see who wins.

Vernadski's conception of "growth energy" is useful to introduce here. If one begins with the Darwinian bias toward the individual then that individual's potential to grow, barring obstacles and assuming favorable nutrients, is unlimited until the entire given volume is covered: wall to glass wall guppies. Under these circumstances it would take a primitive single-celled organism called the coccus (size:.000000000001 cubic centimeters) less than 36 hours to cover the globe; an elephant would take slightly longer, approximately 1,100 years because of the slower gestation period, lower growth energy, etc. Yet, this is not at all like the distribution of animals one finds in the modern biosphere.

Conscious Intervention

The "holist" approach in modern biology opened key avenues of investigation in evolutionary theory, giving man the ability to self-consciously intervene into his own ecological environment. In addition this approach settled once and for all the problem of "reversibility" inherent in Darwinian natural selection: the "logic" of Darwinian evolution places no necessary ecological value judgment on the continuing self-development of the evolutionary process. Contrary to "natural selection," however, the biosphere cannot survive if the human species is propelled backward toward advanced ape species existence.

A positive notion of evolutionary development must escape the realm of linear development entirely, something the "holists" were unable to do. Haldane, for instance, assumes that all genetic variations are fluctuations off a "species equilibrium." He defines the problem of hylozoic evolution from the standpoint of an assumed ecological balance, upon which the "force of genetic mutation" operates. This "force," acting over long periods of time, accounts for the extinction of old species and creation of new ones. Thus, Haldane, like Darwin, ultimately adopts the model of branches off an evolutionary tree to demonstrate the "blind alley" and "missing links" of phylogeny.

Species development, however, at once determines and is determined by the accelerating advance of energy throughput of the biomass as a whole. Within every given mode of biospheric energy throughput, the totality of species existence does indeed constitute an apparent "balance" of ecological relationships for that mode. The invariant feature of evolution, however, cannot be located at any fixed moment but only in the negentropic development of the biosphere as a totality to the next higher mode of energy throughput potential. The propagation of new species (unit gene "pools" for potential existence in a future ecology), and conversely the "extinction" of "outmoded" species, are subsumed features of the overall thermodynamics of the biosphere. A species comes to an evolutionary end (though it may persist) when it no longer alters its ecological interrelationships toward a net increase in free energy, thereby enhancing the total biosphere potential in the direction of the next highest energy mode.

With the development of modern man since the Pleistocene, the dominant species of the biosphere has evolved the capacity to conceptualize its species relationship to its own ecology. Homo sapiens sapiens has altered the ecological conditions for the evolutionary development of all animal and plant species, Homo sapiens sapiens included. The biosphere can "advance" to the next thermodynamic mode only if that hegemonic species itself self-consciously transforms qualitatively its control over the broader ecological and species relationships which it has unconsciously brought into being. The modern biosphere, in short, must "leap" to the socialist sphere

where human ecology assumes conscious responsibility for the negentropic invariant of evolution.

V. The Biosphere

Vladimir I. Vernadski (1863-1945) developed the modern conception of the biosphere in the early 1920s as the *medium of living matter* whose development processes can be measured in total solar energy throughput:

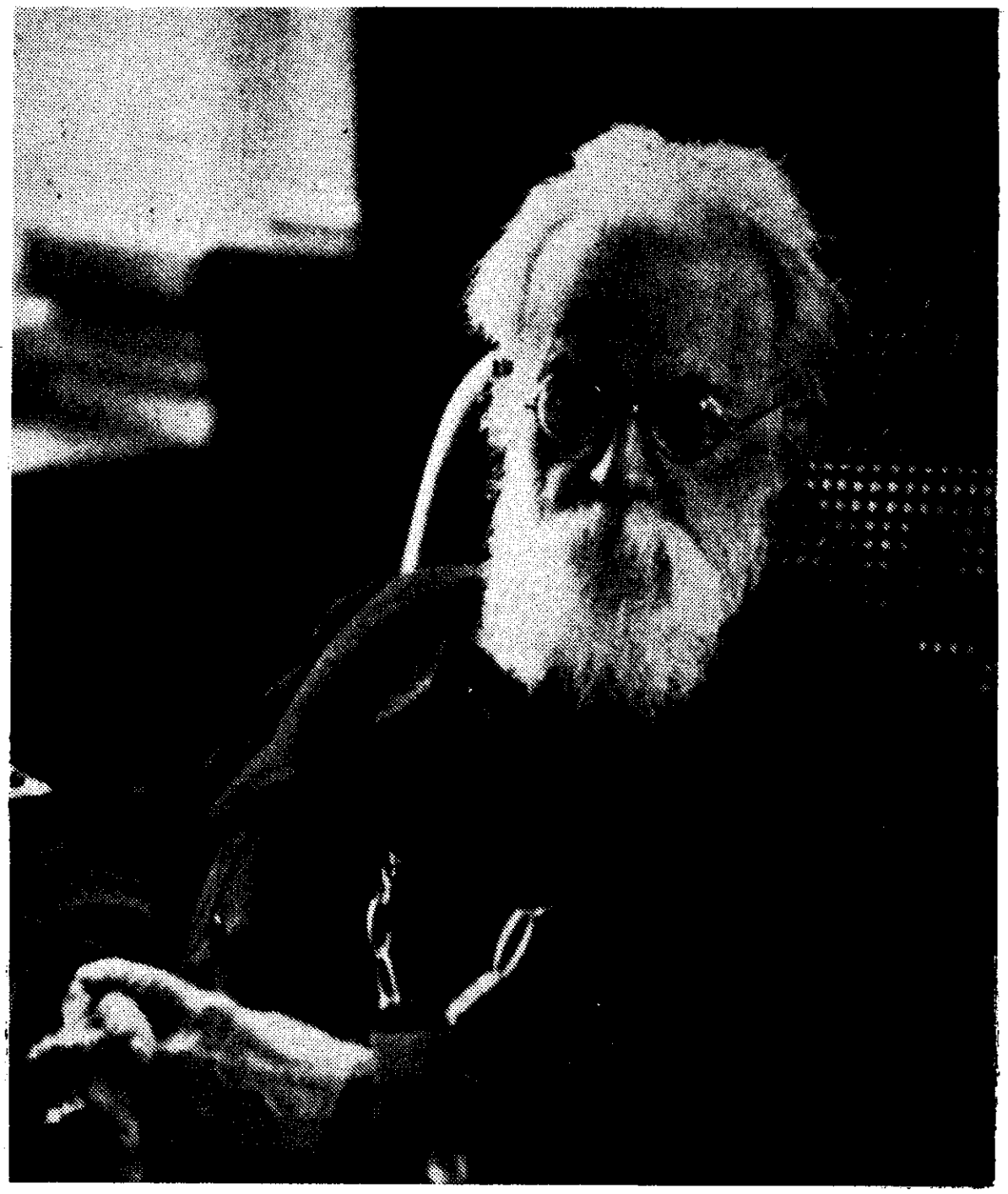
> The limits of this domain are defined with precision. The whole of the atmospheric troposphere belongs to the biosphere. Moreover, at present living organisms, man and his inevitable companions, insects, plants, and bacteria, are penetrating by themselves or with the help of apparatus, even higher, into the stratosphere. Simultaneously, civilized man, as well as his inevitable companions, penetrates deep below his relief, in contact with the troposphere, for several kilometers down below the land surface. The planetary importance of the existence of bacterial, mainly anaerobic, living matter, in the depths of the earth, down to three kilometers and possibly even more has moreover now become apparent.
> The lower boundary of the biosphere thus lies several kilometers below the level of the geoid. The whole world ocean is included in it.
> The biosphere represents a definite geological envelope markedly distinguished from all other geological envelopes of our planet. This is so not only because it is inhabited by living matter, which reveals itself as a geological force of immense importance, completely remaking the biosphere and changing its physical, chemical and mechanical properties, but also because the *biosphere is the only envelope of the planet into which cosmic energy penetrates in a noticeable way, changing it even more than does living matter. The chief source of this energy is the sun. The latter's energy, radiant and chemical, working in conjunction with the energy of chemical elements, is the primary source of the creation of living matter. (3)*

The term "biosphere" itself was first coined by the Austrian geologist Seuss in the late 1870s in reference to *the* "terrestrial envelope" in which life occurred. Vernadski considered the question not from the uniqueness of one envelope but from several "pockets" or "layers" which contained within themselves a more or less complete uniformity. The "ensemble" of all of these envelopes (each concentric to the others and containing its own distinct physical, chemical and biological characteristics) is the biosphere. Vernadski explains that while his own conception of these "envelopes" was purely a 20th century notion, he had to draw upon the *corpus scientarium*, the "whole range of humanistic sciences (including logic, psychology, and the history of philosophy or religion or art)" since the Renaissance. The *corpus scientarium*, the body of particular scientific contributions, is the basic content of science.

Several of the terrestrial envelopes, for instance the atmosphere, had been known for centuries, but known as unrelated to others. At the close of the 18th century, after the great age of exploration, the French chartmaker de Fleurieu recognized the "ensemble of all the known oceans and seas as the universal ocean." Vernadski traces this concept back to the similar ideas of the cartographers and geographers of the Renaissance, but it was he who synthesized the gestalt of the relation of the biosphere as a whole to the solar radiation energy source.

From the limited biographical material available, we know only the silhouette of Vernadski's life, yet even from limited information it is clear that his individual development represents a unique synthesis of the two 19th century strands of humanist tradition. He was born in St. Petersburg two years after the emancipation of the serfs and took his first university position at the University of Moscow 28 years later, the same year that construction began on the trans-Siberian railway. Thus, his own formative years intersected with the French and other intensive European banking investment in Imperial Russia. The concentrated period of "industrial revolution" in late 19th century Russia provided the necessity for an explosion in progressive scientific and technological education. His father, I. V. Vernadski, was a liberal professor of political economy at Kiev and Moscow Universities. It was undoubtedly the ideal milieu for a young student to assimilate the first translations of Hegel and Marx into Russian intellectual life. In the 1880s and again in the first decade of the 20th century Vernadski had the advantage of four extended trips to Western Europe, including working experience in the laboratories of the top experimental physicists, the Curies and Minkowsky, at precisely the time that they were engrossed in the conceptual work of assimilating the 19th century advanced mathematics of Riemann, Cantor et al.

Vernadski was appointed to the Soviet Academy of Sciences in 1906 but resigned from his university chair in 1911 in protest against tsarist educational policies. In 1915 he organized the Commission for the Study of National Productive Forces (KEPS), at the same time that he was working out his own notion of the need to synthesize the disparate "disciplines" of science. From the period immediately after the beginning of the First World War, he founded the field of "Biogeochemistry," which also included 19th century theoretical mathematics, the physics of Einstein and Minkowsky; in essence, the *corpus scientarium* had to be the common reservoir of scientific investigation in any particular field. Only from this sort of overview is the scientist capable of adjudging morally the potential of his own creative insights to shape the future course of man's development.



V.I.Vernadski

We are not surprised to find the basis for Vernadski's later commitment to the Bolshevik revolution. Already in 1910, reflecting on the significance of the Curies' work (themselves periphery of the French working class movement), Vernadski had written:

> We are approaching a great revolution in the history of humanity, which is beyond comparison in all its preceding history. The time is drawing near when man will harness atomic energy, a source of power which will enable him to shape his future at his will. This may come about in the near future or within a century, but at all events is inevitable. Will man be able to utilize this force for his benefit and not for his self-destruction? Has he advanced sufficiently to be able to utilize this force which science will inevitably place in his hands? The scientists should not shut their eyes to the possible consequences of their scientific work. They should feel responsible for the consequences of their discoveries. Their work should further the progress of mankind.

Vernadski's invocation of a Spinozan ethic for science with respect to the alternative uses of atomic energy has an edge which is unmistakably urgent for scientists around the world today, 63 years later. The survival of the human race is an open question, a Riemannian "historical crucial experiment" to use the image employed by Vernadski in 1935. He saw himself at that time living in an age of scientific transformation, "touching the future which opens before us," to participate in the creation of a qualitatively better future. He saw mankind as beginning to be conscious of the "invincible potency of free scientific thought, the greatest creative force of Homo sapiens."

It was clearly Vernadski who brought a humanist overview to several generations of scientists in the Soviet Union, that is, to the extent that that overview was not bounded. Vernadski's challenge was that the pursuit of any specific theoretical problem in biology, geology, chemistry etc. in the 20th century had to proceed from advanced scientific-philosophic conceptions. His writings are filled with the continuous restatement of otherwise narrow empiricist exercises from the standpoint of Riemannian geometry, Einstein's theories of relativity and the unity of space-time, and Wolfgang Koehler's work in gestalt psychology. With the exception of his conception of the biosphere, and his brilliant discussion of the implicit refutation of the Second Law of Thermodynamics in Pasteur's discoveries (which we will discuss separately), it is more the embodiment of this overview than any particular "discoveries" in themselves which distinguish Vernadski.

If we evaluate Vernadski and Oparin together, from the standpoint of *negentropic development*, we are

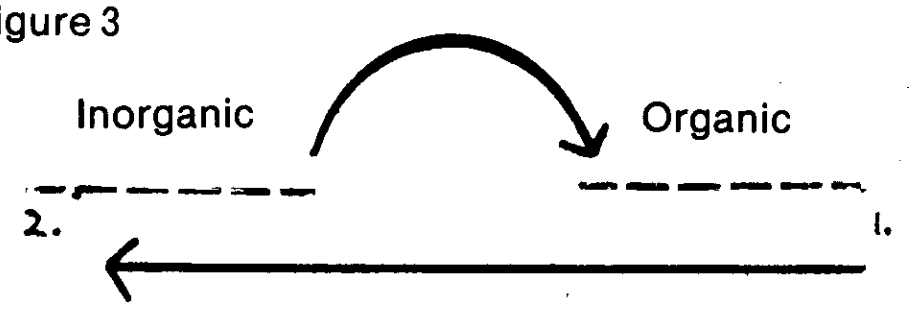
presented with a tremendously useful pedagogical problem. Vernadski, proceeding from the broad sweep, correctly argues that the question of space-time developing over time, the real problem of evolution, cannot be approached scientifically with the conceptions of "entropy" and "Euclidian geometry" once the fundamental assumptions of the fixed Newtonian universe have been overthrown! Although he had most of the key conceptual elements which are necessarily part of the solution, he was unable to synthesize a gestalt which could be developed rigorously, and made scientifically irrefutable in a fundamental sense.

Oparin proceeds in exactly the reverse fashion. His brilliant hylozoic history of the biochemical origin of life and its development is the best *empirical* proof that the actual conceptual solution to the problem of space-time and evolution is valid! Yet, Oparin, with none of the necessary conceptual tools of the four century humanist tradition, the mathematics of Riemann-Cantor, and the new physical universe of Einstein-Minkowski, has no way to explain to anyone else why his solution holds together theoretically.

With tragic irony, they both wind up in the same blind alley, along with Schroedinger and others: *The Second Law of Thermodynamics and Euclidian conceptions of space are invalid for organic processes developing over time. Organic evolution is understood as negative entropy in progressively higher-ordered geometries. However, the Second Law of Thermodynamics and entropy holds for the inorganic world.* (Note that Oparin actually picked up his solution from Schroedinger and did not independently derive the conception of negative entropy.)

We can restate the problem in the following fashion: how does one explain, beyond the "probable how," the "why" of the leap from inorganic to organic matter? In schematic terms our problem looks as follows, *depending on the standpoint of the observer.* (see Figure 3)

Figure 3



Oparin did, the evolution of inorganic to organic matter appears as one continuous development. In short, there are "no gaps" in our line, which crudely represents development over time. Why? Because, as we shall see, each development in the process can be explained according to scientifically sound processes, each and every one of which can be repeated in the laboratory. From point two looking forward we cannot see the continuation of the line after the gap; in fact, as Vernadski represents it, all we know is the necessity for the "leap" across the singularity, but we can have no prior sensuous knowledge of the "landing area." Lest the reader dismiss this out of hand as a foolish problem because there was obviously no conscious being at point two in time to worry about such a problem in the first place, we remind you that you are precisely at point two today. If we change the identifying aspects of the two segments, we can obviously substitute each such gap in the course of time: from a fermentative to a photosynthetic environment, from ape to man, from cave man to neolithic man, the domesticator of plants and animals 10,000 years ago, from the period of the Black Death to the Renaissance, from feudalism to capitalism, or from developing world fascism to worldwide socialism where failing to make the leap means ecological holocaust — the present statement of the freedom/necessity problem. In man's modern history, this problem has been posed at each and every point *prior to* a creative contribution to humanity!

VI. Oparin's Approach to the Origin of Life

Oparin developed his views on the hylozoic evolution of organic from inorganic matter in the Soviet Union in the years immediately after the end of the Civil War and before Lenin's death in 1924. As backdrop to his brilliant empirical demonstration of negentropic process, we begin with a heuristic device first presented by Oparin to introduce the mind to the meaning of the five-billion-year story of the biosphere's evolution.

Imagine a special library of ten volumes, five hundred pages each, with each page containing upon it what happened on the planet Earth for a given particular one million year period. The 5,000 pages of the library would together represent the entire five billion year history of the earth. The table of contents would then look as follows for the earth's major developments:

PREBIOLOGIC EVOLUTION (Volumes I-V)

- Approximate formation of the earth....Volume I, page 1
- Earth's crust melted by radioactive energy from the sun....Volume II, pages 1-300
- Formation of the ocean and rocks....Volume III, pages 1-400
- "Prebiotic ocean," the "hot, dilute soup" of heterotrophic metabolism. Fermentation processes ....Volumes IV-V

BIOLOGIC EVOLUTION (Volumes VI-X)
•Development of photosynthesis and nitrogen-fixing processes. Free oxygen in the atmosphere. Autotrophic organisms....Volume VI (complete)
•Development of species differentiation....Volumes VII-X
•Current biologic record....Volume X (complete)
•Existence of man (i.e., the last million years) ....Volume X, page 500

If we divide the last page of the last volume into 100 equal portions, then only the last of these portions will be used to describe the 10,000 years since the Neolithic Revolution in agriculture and domestic animals. If we divide this by now tiny last section once again into 100 equal parts, the resulting minute piece of paper must recount the events of the last decade of Marx's life and all which has occurred since! A bad, bad-infinite medieval exercise in problem-solving which would make a feudal scribe recoil in terror!

Oparin's basic approach is *hylozoic*, demonstrating the unity of forces in living and non-living matter based on the Ionian philosophers (600 B.C.). With precise clarity Oparin dismisses the possibility that "divine will" or an "elan vital" acts as an intervening factor at any one place along the evolutionary path to "pick up" a more primitive development and push it or carry it to the next level. The evolutionary line is one continuum which at no point "spontaneously generates" living matter from inorganic substances.

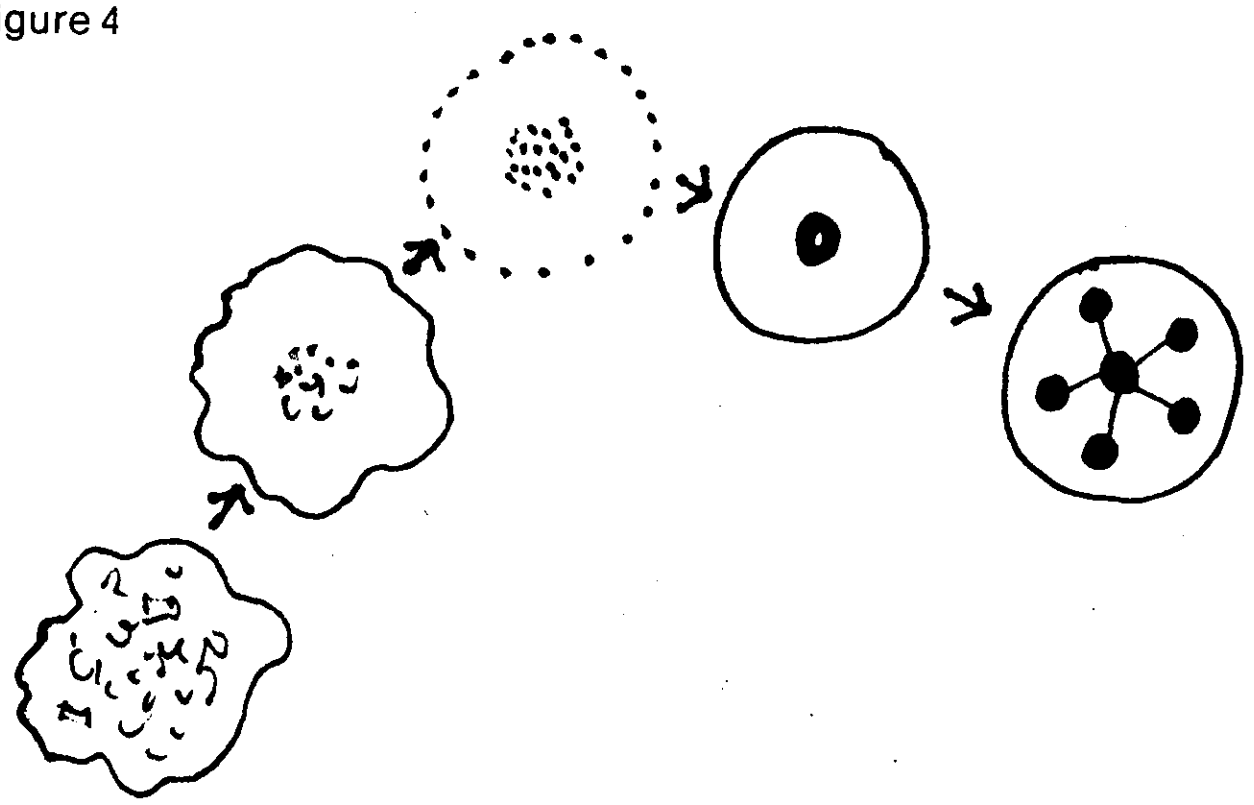
Instead, Oparin demonstrates the inexorable tendency for evolution to occur, creating higher and higher energy throughput levels on the planet as a whole. In the pre-biosphere (Volumes I-IV of our heuristic library above), the sole energy throughput potential was the absorption of solar radiation. As carbides in the form of iron and other metals erupted to the surface and were acted upon by the superheated aqueous vapor of the oxygen-less and ammonia-containing atmosphere of that epoch, ultraviolet sparks or lightning catalyzed the formation of hydrocarbons (e.g., methane):

> As the temperature of the Earth had cooled off sufficiently to permit the formation of droplets of liquid water torrents of boiling water must have poured down upon the earth's surface and flooded it, thus forming the primitive ebullient oceans. The O2 and N2 derivatives of hydrocarbons already present in the atmosphere were carried down by these torrential rains and the oceans and sea, at the moment of their first formation, contained therefore, the simplest organic compounds in solution. The interactions between hydrocarbon derivatives and their further transformations did not, however, cease in this new aqueous medium. On the contrary, alcohols, aldehydes, acids, amines, amides, etc. continued to react with each other as well as with the elements of the aqueous environment, giving rise to a prodigious number of all sorts, and even much more complex, organic compounds.

Oparin, drawing on existing knowledge of biochemical processes, goes on to trace the development of proteins from these organic compound building blocks, detailing the evolution of organic material in the "primordial sea" to higher and higher grades of organization and therefore energy throughput potential. Through processes of *coazervation* these compounds continually move toward concentration of structure, until the moment when it is meaningful to speak of the *differentiation* between the organic substance and its aqueous environment. (see Figure 4) At this point, different compounds could pursue different courses and we are in Volume V of heterotrophic metabolism.

And so Oparin's fascinating story continues through to the end of Volume VI and the first major "resource" crisis of the environment. This "conjunctural crisis" had two aspects: first, a total heterotrophic

Figure 4



Through the process of *coazervation* organic matter first became "delimited" from its aqueous surroundings. The evolution of organic substance previously could only be seen as an undifferentiated totality, so long as it was randomly dissolved in the planet's original sea. Here, organic substances are becoming spatially separated and concentrated into "droplets" of semi-liquid gels. As a definite border develops between them and the surrounding environment, true individuality is possible for the first time on the earth. From this moment forward, different coazervate droplets could then follow different lines of development.

Figure 5

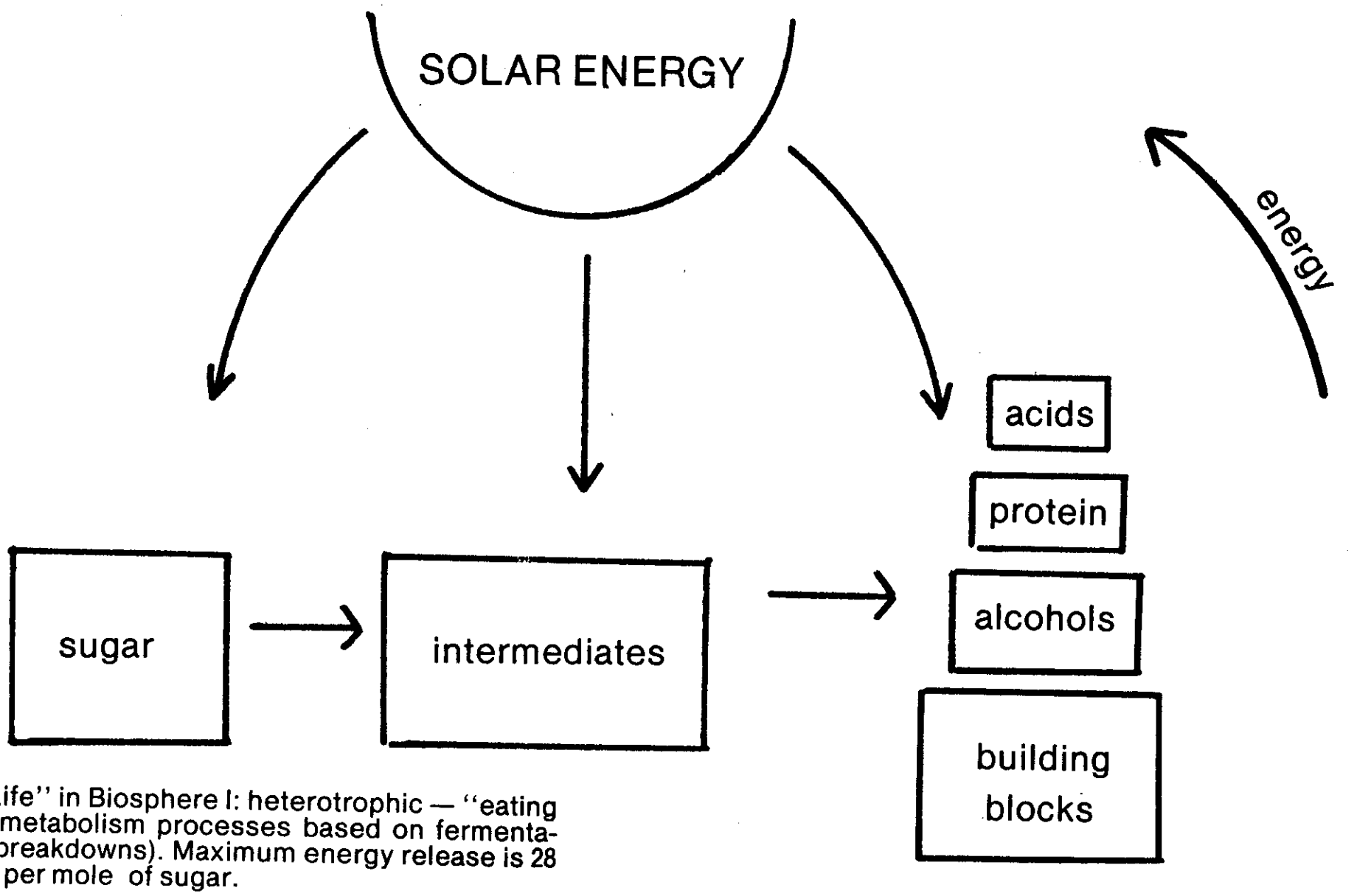


Figure 5: "Life" in Biosphere I: heterotrophic — "eating others" — metabolism processes based on fermentation (sugar breakdowns). Maximum energy release is 28 kilocalories per mole of sugar.

Figure 6: Life in Biosphere II (the modern biosphere): heterotrophic respiration and interrelated autotrophic photosynthesis. Maximum energy release is 674 kilocalories per mole. Note exponentially increased energy throughput levels.

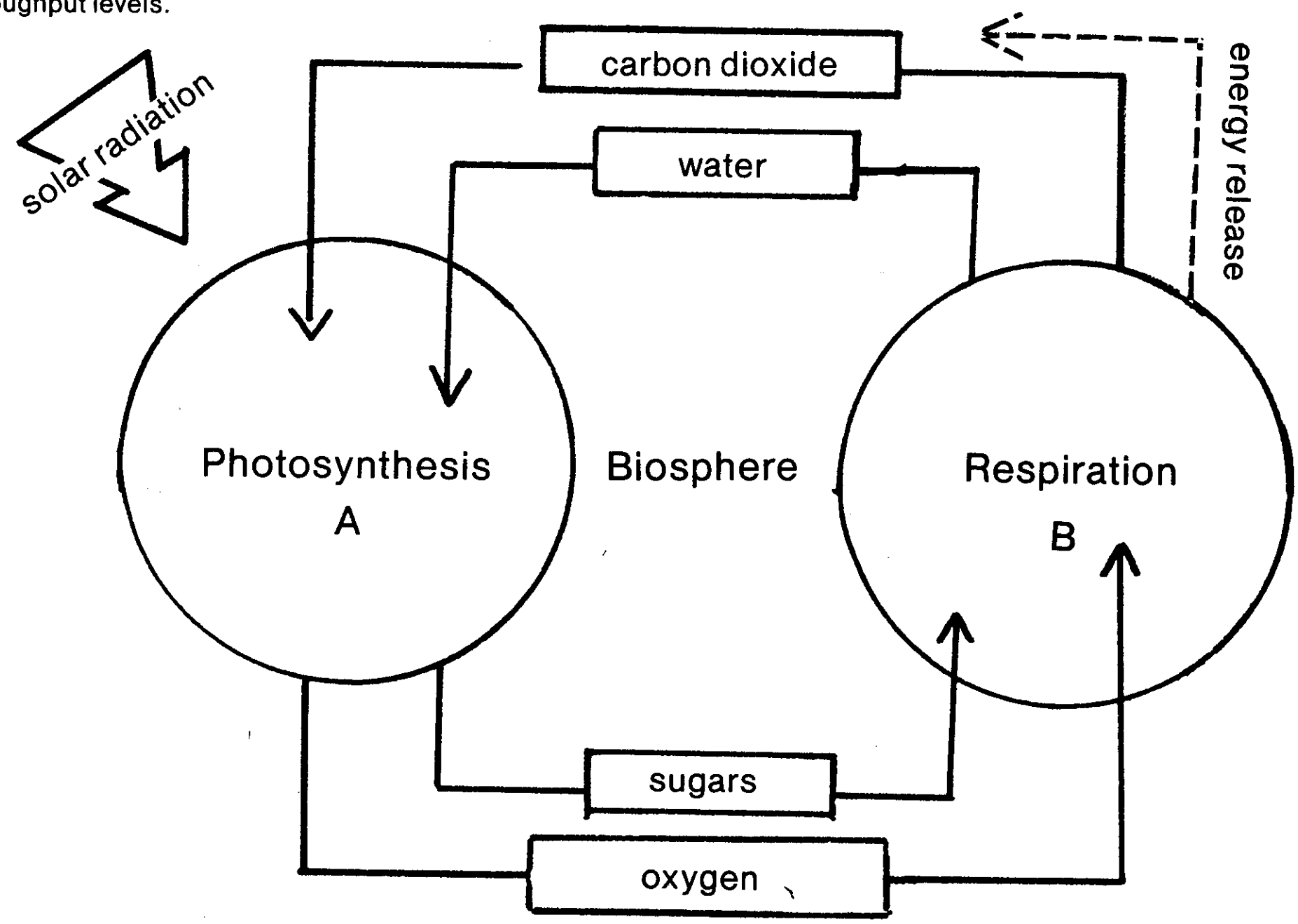


Figure 6

metabolism necessarily led to a point of extreme nutrient shortage in the primordial sea, and second, fermentation processes had depleted a major portion of the atmosphere's carbon dioxide supply. *Both* the metabolic process and the medium for free energy creation were threatened. The entire biosphere, "life without oxygen" as Pasteur brilliantly defined the phase of fermentation metabolism, was coming to an end.

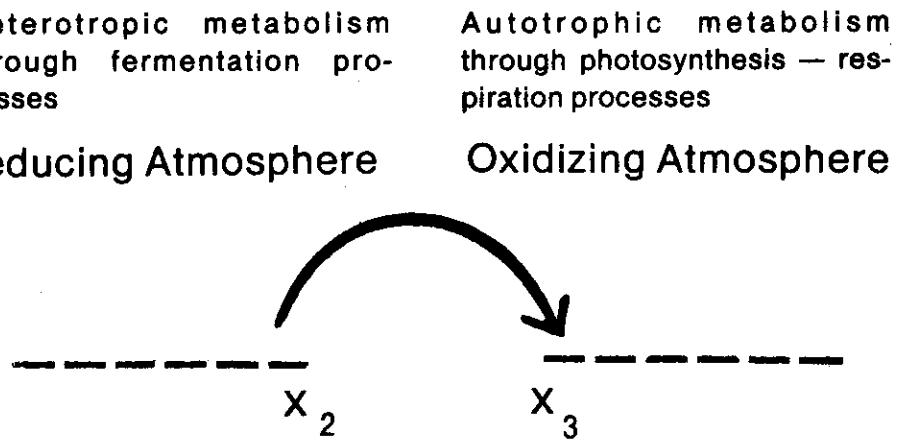
From the Biosphere I of fermentative metabolism there was a transformation to Biosphere II of photosynthesis/respiration (maximum energy release increase from 28 kilocalories/mole to 674 kilocalories/mole of substance). (see Figures 5 and 6) The origin of photosynthesis/respiration allowed the accumulation of oxygen "along with the amount of organic substances which could be drawn into the cycle of energy metabolism" to increase without limit. The acute shortage of organic nutrient and carbon dioxide supply had been overcome. Metabolism, in the self-reflexive sense of a process which throws itself beyond itself, had moved from heterotrophic fermentation to autotrophic photosynthesis.

Oparin's work was coherent with the Labor Committees' conception of negentropy. In terms of Figure 7, note that Oparin, standing at point and looking back "down the evolutionary line" of hylozoic development, could give a brilliant empirical demonstration of the negentropic leaps across singularity, from $\times_1$ to $\times_2$ to $\times_3$ to higher and higher levels of energy throughput for the biosphere as a whole, from the sterile planet to Biosphere I to Biosphere II. However, despite the advanced conceptual character of his work, Oparin himself was ignorant of the significance of what he had done and referred to the "motor force" along the *world line* as Darwinian "natural selection"!

Oparin likewise explains the "variation" at major transformation points in the continuum of world development which generate "free energy" as adaptations caused by "natural selection." Yet despite the embarrassment of Oparin's clinging to Darwin when he, Oparin, had actually proved "negentropic development," despite the fact that he did not actually understand what he did, Oparin's work is solid. He actually demonstrates, through his discussion of increased bonding energy capacity and ever higher energy throughput capacities in higher organisms, the relentless development of the "world line," toward higher and higher energy throughput levels for the biosphere as a whole.

Nevertheless, Oparin's approach to explaining his work has the classic *chicken-egg problem* built into it. For instance, suppose we isolate the development from fermentative to photosynthetic metabolism. (see Figure 8)

Figure 8



While life on the oxygen-less biosphere as a whole "adapted" to the fermentation resource crisis, according to Oparin, there is "natural selection variation" to photosynthetic-respiratory reactions. Then *which came first*? Was it the oxygen in the new atmosphere, i.e., a new biospheric medium? Or, was it the variation toward photosynthetic capacity, i.e., the metabolic process necessary? Oparin has no way to resolve this problem.

We can see the same chicken-egg absurdity in the way in which "origin of life" experimenters and other biochemists reacted to the Watson-Crick discovery of double-helix structure for DNA in the early 1950s. In the 1940s and 1950s a number of experimenters, most notably Fischer and Miller, actually reproduced in their laboratories the key reactions discussed by Oparin. S. Miller applied silent electrical discharges as energy source to methane ammonia, hydrogen, and water mixtures and was able to produce amino acids, the building blocks of proteins in vitro. Fischer and Tropsch synthesized hydrocarbons from hydrogen and carbon monoxide. Other biochemists concentrated on replicating reactions occurring later along on the evolutionary "line." Within the laboratory *all* of the metabolic reactions which occur in the primitive cells were reproduced — the only difference being that they occurred at a much slower rate. Enzymes, within living cells, increase the rate of reaction several millionfold.

After the discovery of RNA-DNA replication in the early 1950s the entire "origin of life" world was thrown into a tizzy. (see Figure 9) For nearly 20 years, biochemists have been lost in a silly "chicken-egg" de-

Figure 9

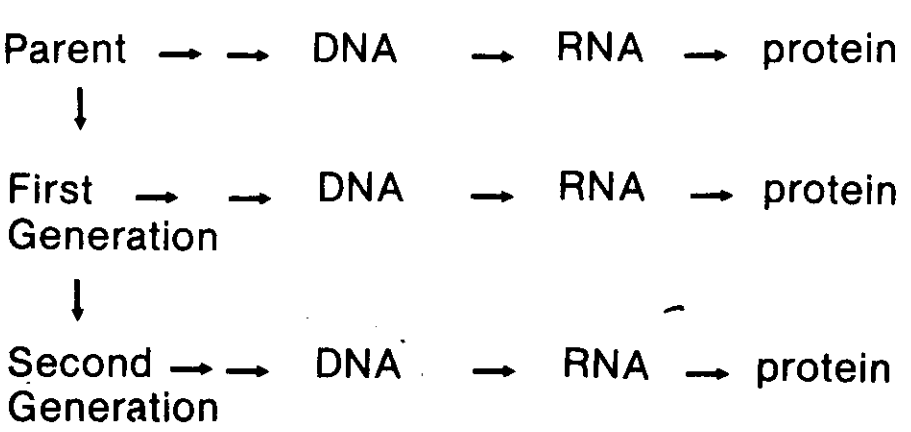


Figure 7

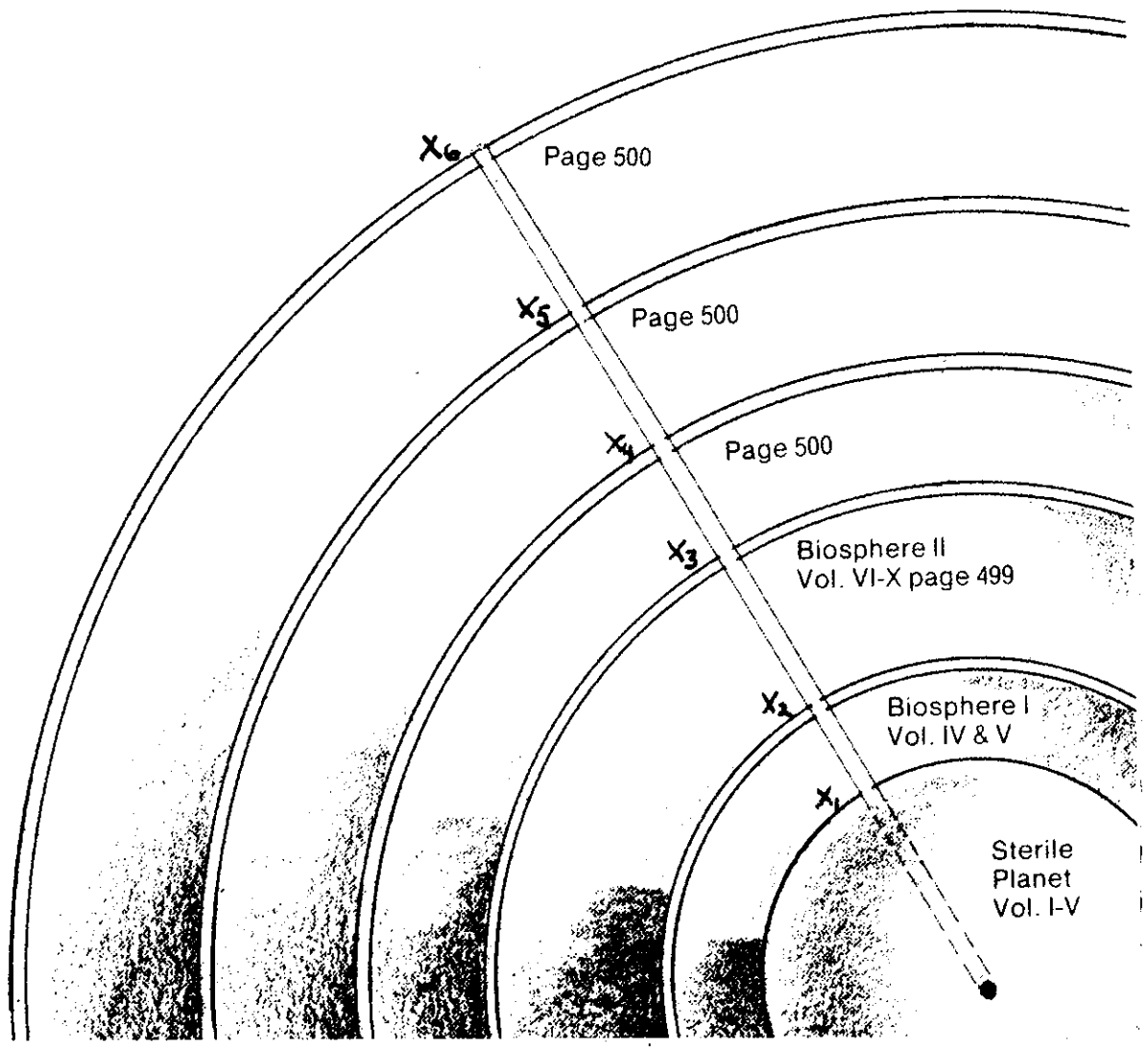


Figure 7: Lyn Marcus' representation of negentropic development of the universe as a whole, adapted here to suggest the five billion year hylozoic development of the planet Earth into the modern biosphere. Note that the majority of concentric spheres would be needed to represent the last 10,000 years of the biosphere since the Neolithic Revolution. The human species is currently situated at × 1 Unless the next singularity is "leaped" to a worldwide fusion-powered socialist economy, the biosphere will collapse into ecological holocaust within the next 15 years.

bate: Which came first? Nucleic acid, protein, or the cell?

In 1961 Oparin published a reevaluation of his work in the 1920s, entitled *Life, Its Origin and Development*, in which he attempts to expand his views in the context of their fundamental significance to man's philosophic-scientific tradition. He makes a rather hopeless mess. First he polemicizes that Descartes' science "represents" the mechanist tradition. He quotes Engels and Darwin, whom he credits with the discovery of the "brilliant" laws of the dialectics of nature and adaptation, reflecting the most banal notions of Soviet "dialectical materialism": idealist vs. materialist world view, the whole world in flux, etc. What is most disheartening is Oparin's support of Schroedinger's formulation, that inorganic matter is entropic while organic matter has negative entropy direction, disregarding his own 1920s work proving the hylozoic unity of inorganic and organic development.

VII. Vernadski's Dilemma

Vernadski, as we have indicated earlier, approached the problem of space-time developing over time much more directly on a conceptual level:

> Prior to our century, in scientifically studied phenomena, one reckoned only with Euclidian geometry of three dimensions. In the new scientific-philosophical conceptions which follow from Einstein's work one deals with a space of four dimensions, and that space, in the opinion of some, corresponds to the space not of Euclid's but of Riemann's geometry. Theoretical physical thought rightly seeks here new paths, but it does not conclude its analysis by logic....
>
> Space for us, is inseparable from time. This concept is not a conclusion from Einstein's theoretical theses and has been arrived at independently of them and much earlier....We are now living in an extremely important epoch of the development of science. Time, which for centuries had been outside the range of science, is now subject to investigation, and thus it becomes clear that time is a complex manifestation of reality. For science there is no space without energy and matter, and in the same sense without time.
>
> *Problems of Biogeochemistry*

What conclusions does Vernadski draw? "With the changing of the Newtonian concept of time, with the new notation of space-time, *it seems to me that our conception of entropy must change also.*" (*4*)

For all further investigations in biology and other sciences, Vernadski poses the necessity of solving the problems of *geometric dissymmetry,* which he himself developed from his brilliant reading of the significance of Louis Pasteur's work. Pasteur's work developed the unique exception to the symmetrical-lattice property of crystals. In enantiomorphous crystals, as a result of the influence of living matter, either the left or right-handed isomer is obtained, but not both! He called this phenomenon dissymmetry. (see Figure 10)

Vernadski points out that the discovery of molecular dissymmetry by Pasteur, completely analogous to the dissymmetry of crystal polyhedra, meant to Pasteur "the possibility of different states of cosmic space,

and explained thus the manifestation of the dissymmetry discovered by him in living matter. Essentially, we must see in a state of space the basic geometric substratum of all its material, temporal and energetic manifestations." P. Curie generalized Pasteur's concept of dissymmetry and applied it to basic physical phenomena, electric, and magnetic fields, etc. Just before his death, Curie generalized the principle of dissymmetry into the concept of different states of space, corresponding to the conception of Riemann's higher ordered-geometries.

> We will start with the working scientific hypothesis that the space inside living matter is different from that inside the inert natural bodies of the biosphere. The state of the former space is not confined within the limits of Euclidian geometry. Time may be expressed in this space by a polar vector. The existence of rightness and leftness and their physico-chemical inequality points to a geometry different from Euclid's, a special geometry of space inside living matter....It is possible that this would be one of the geometries of Riemann's type, perhaps one of the geometries indicated but not worked out by Cartan. This geometry would reduce all space to a point supplied by an infinitesimal vector.
>
> *Problems of Biogeochemistry*

Vernadski goes no further! He appeals to modern theoretical mathematicians and physicists to take the lead in the development of all further work in the biological and other key sciences, based on the assumption that the advanced conceptions of 19th century mathematical physics had to be assimilated as the guide for the next level of scientific breakthrough. In a tentative way, Vernadski implicitly maintains that this must at least be so for the study of all organic matter. A new theory to explain energy throughput from the standpoint of Riemann and Einstein is needed, but, like Oparin, Vernadski adopts the formulation from the standpoint of the *distinction* between inorganic and organic matter with respect to geometry and energy concept.

The Two Approaches

Proceeding along two totally different pathways, Oparin and Vernadski end up in the same blind alley. We feel a sympathy for Oparin, who had essentially worked the problem out at the very beginning of his career, but did not have the knowledge to take it further. At the same time, we feel both sympathy and awesome respect for Vernadski, who had all the correct elements to synthesize the conception of negentropic development, but pulled back from rigorously developing his vague conceptions. Taking both moments together, we are confronted with a sense of bitter tragedy at the *ideologizing of science*, a process we have seen developing continuously at each moment of historic conjuncture over the past four centuries. The irony of the Vernadski/Oparin problem is that they each knew of the other's work. Confined within the boundaries of "Soviet science" in a world dominated by capitalism, any possibility that they had to synthesize the gestalt of negentropic development could only be realized if they rose above that controlled environment.

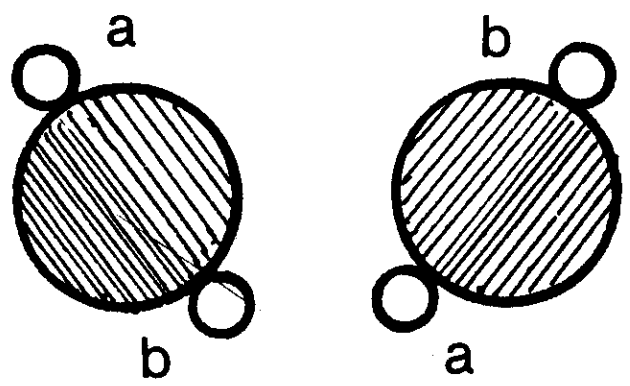
Such a creative breakthrough, of world historic importance, had to result from the same process which was developing the necessary concept of negentropy as an absolute coherent prerequisite for transforming the world's economy. The same process which is entailed in the individual psychology of the creative person — the fundamental aspects of human mentation — are the fundamental laws of the universe as a whole.

For the first time in human history, the leadership of the human species stands before a singularity self-consciously determined to make the necessary creative leap to the next mode. Were we not to make that leap, as scientists infected with "zero growth" notions counsel, the human species as we know it would end.

If mankind is actually to continue self-developing his ecology to higher and higher qualitative advances *for mankind* as a whole, if the biosphere is not to break down in the short future, then man must transform the social-productive organization of the biosphere beyond itself.

Vernadski identified the fundamental flaw by which previous scientists (outside of a self-conscious relation to the humanist tradition) made when they approached the very concept of living matter. The

Figure 10



Many organic forms can exist in either of two similar forms, with the same molecular composition of the atoms but different arrangements in space.
The best example of this is the arrangement of fingers on the left and right hands. Chemical reactions in the laboratory always produce an equal number of the left and right hand antipodes. Yet in living organisms the accumulation of one particular antipode regularly occurs, exciting Pasteur to conclude that "this property may be the only sharp difference between the chemistry of dead and living matter which can be made at present." Pasteur thought that the earth's magnetic field had actually been the force producing asymmetric synthesis. He attempted asymmetric synthesis in the field of a powerful magnet but failed because the magnetic field and rotation of the earth are both symmetrical forces. Experimenters later succeeded in producing asymmetry under conditions of polarized light. It is significant to note that Oparin included this discussion of the problem of Pasterur's assymmetry in the 1934 version of *The Origin of LIfe*, in which he attributes the importance of the problem to the work of Vernadski.

empirical scientists conceive of the "natural world" as merely a sum of discrete objects which can affect another, but which are not fundamentally coherent with a larger conception. When others approached the problem from a simplistic "holist" direction, the single living organism receded from view and living matter as a totality was held up as that which was important. However, not only are certain species dominant at all times since the primordial sea of protein in "hot, dilute soup," but with homo sapiens the individuality of single organisms is crucial. In the case of modern man, as Vernadski's *Problems of Biogeochemistry* puts it, "a single personality sometimes clearly manifests itself in large-scale phenomena of planetary character, by changing and accelerating certain geological processes of immense importance."

The Scientist as Universal

It is the self-conscious scientist himself who embodies in sensuous terms Hegel's conception of the "concrete universal." When he wrote the words above Vernadski was living in a world which had already seen fascism consolidated in Germany and Italy, within a society which was fearfully corrupt with respect to the humanist tradition. With the potentiality of death, disease and decay all around him — in a world not too different than Descartes' in the qualitative sense — Vernadski could leap conceptually and focus on the *future* with a certainty that man's creative input would ensure the survival of the human race on a higher level:

> We live in an unprecedented, geologically significant epoch. Man by his work, and his conscious attitude toward life, is remaking a terrestrial envelope,the geological domain of life, the biosphere. He is transforming it into a new geological state, the noosphere. He creates within the biosphere new biogeochemical processes that did not exist before. A planetary phenomenon, the biogeochemical history of the chemical elements is becoming notably changed. For example, previously non-existent free metals such as aluminum, magnesium and calcium, and their alloys, are now created in enormous quantities. Vegetable and animal life is radically modified and disturbed, new races and species being created. The face of the planet is being deeply changed. A process of turbulent blossoming is now going on in the biospheral envelope of the earth, and the subsequent development of this process may be expected to assume tremendous proportions.
>
> *Problems of Biogeochemistry*

Only a world-historical individual, not a "national being," could have developed such a notion. There can be no such thing as "science within a single country."

Vernadski was fond of referring to the fact that if the world had grasped the philosophic/scientific implications of Rene Descartes' 17th century works, there would have been no need for science to have been constrained within the Newtonian world view for four centuries. Descartes' notion of the *tourbillons* of the universe immediately makes clear the impossibility of Newton's fixed universe of absolute time and absolute space — unchangeable, harmonious, stable and empirically calculable.

Vernadski traced the roots of our modern conception of space-time back to the science of the Greeks in the 6th century B.C., where two fundamental aspects of the modern conception of the universe exist in germ form: the representation of time physically and mathematically as a measure for movement, and the notion of the infinity of time. In the 16th century Giordano Bruno also viewed time as a measure of movement and was the first to introduce time as an integral part of his conception of the universe.

The development over the last four centuries of this idea, that the metric for the infinity of space-time is the human creative process itself, is humanist science. For the human species to develop into the future, that entire tradition must now be mobilized and concentrated for the self-conscious leap of the biosphere as a whole beyond the Rockefeller menace.

If there are to be any significant scientific breakthroughs in that understanding, they will occur as a result of transforming the world working class into a universal species of humanist scientists. To reach that standpoint, we must all learn to cry for the sins committed in the name of science in the primitive past.

FOOTNOTES

1. For a detailed discussion of the concept of negentropic development, see "Rockefeller's 'Fascism With a Democratic Face'" in *Campaigner*, Nov.-Dec. 1974.
2. *Beyond Psychoanalysis*, by L. Marcus, *Campaigner* reprint, published 1973.
3. We quote this passage at length and will proceed to develop Vernadski's concepts in depth because of the general inaccessibility of his writings in Western Europe and North America. The above passage appeared in *Problems of Biogeochemistry* (1935 in Russian and 1944 in English). A partial listing of Vernadski's other key works follows: *Foundations of Chrystallography* (1904 in Russian); *Essays and Addresses* (1922 in Russian); *La Geochemie* (1924 in French); *The Biosphere* (1926 in Russian and 1929 in French); *Works of the Biogeochemical Laboratory* (1930 in Russian); *The Problems of the Biogeochemical Laboratory* (1930 in Russian); *Biogeochemical Essays* (1940 in Russian); "On the Geological Envelopes of the Earth As A Planet" (1942 in Russian); and "On the Limits of the Biosphere" (1937 in Russian).
   We hope that merely the discussion of Vernadski's conceptual approximation to key ideas developed independently by Lyn Marcus will have as one of its consequences the issuance by the Soviet Academy of Sciences or others of the works of Vernadski to Western science. Happily, we can report that initial indications that this is indeed occurring can be seen in the November 1974 edition of *Kommunist*, theoretical and political journal of the Central Committee of the CPSU in an article entitled "Goethe and Modern Science." See text for commentary.
4. V.I. Vernadski, *The Problem of Time in Contemporary Science*, 1932.

The Laws of the Universe

by Carol White

The following is an edited transcript of a presentation by Carol White to the National Caucus of Labor Committees' Strategy for Socialism conference on December 29, 1974.

Lyn Marcus has asserted that we, the Labor Committees, have achieved a higher conceptual level than Albert Einstein, and that it is this, our power of conceptualization, which guarantees that we will win. When we hear about the Nazi concentration camps and reflect upon Rockefeller's plans to use Reesian brainwashing techniques to introduce even more vicious slave-labor camps, and when we meet workers who are unemployed, who are demoralized and disoriented, whose only hope is ourselves, the notion that we have a higher conceptual level than that reached by Einstein can seem uncomfortably abstract.

"Does Marcus mean me? Am I really that smart?" Or for those who refuse to assimilate the challenge which Marcus has thrown out, the response may be not uneasiness or fear but the dangerous one of posturing: "Hey yeah, that's right. I always thought that relativity stuff was bullshit. It's so damn confusing and hard to figure out. Despite their technical know-how scientists are really boobs who see the universe as a bunch of particles bumping into each other, while I know that the universe is a self-developing whole; so obviously I know more than they do, and after the revolution when we have to solve some of these fundamental problems of physics, well, I mean, I'll just go into a laboratory and sort it out."

And that isn't too much of an exaggeration of the kind of trap we have to watch out for in our thinking. It's a manic response to an understandable nervousness which we feel when we face the immensity of the real demands on our conceptual ability. What is demanded of us is that we measure ourselves in practice by the achievement of a standard of conceptualization which is in reality higher than Einstein's.

At the moment, for most of us this higher level is implicit in the concepts which we use rather than in our own thought processes as such. We have a social political theory which is grounded on the fundamental premise of negentropy, of expanded social reproduction. We know that there are no fixed laws of the

universe, because we have established that our own development as the human species has been necessarily based upon our ability to change these laws, to expand the technological basis of our existence by developing a new, higher form of energy, the creative power of the human mind. We know that to survive we must create a fusion power economy which can support an increasing population, an increasingly potent population. We must be able to provide the means for this population not only to subsist physically, but to have laboratories, museums, music and so forth at their immediate disposal, a consumption level which is not now available to any of us.

None of us has the ability to walk into a laboratory and see for ourselves how things work, to study as we wish, to be creative to the level of our capacity. In that we are tremendously impoverished. And of course we cannot really conceive of what will seem to be necessary consumption demands to the generation that will follow us. It will seem to them that we lived in a dark age, and they will have tremendous sympathy for us, compassion as well as love for our struggle and for what we achieved.

When we speak of having a higher conceptual level than Einstein, we locate it in two ways. We are the most creative human beings who have yet lived because our achievement will be the establishment of a society in which the exercise of the powers of human creative mentation will not be a rare, fortuitous occurrence but the expected result of social activity. And right now we have established and we live by the standard of social valuation appropriate to the achievement of this future reality. We properly locate all creativity, all technological innovation, all social relationships accordingly, as they contribute to increasing the expanding rate of surplus value. This is the fundamental notion of the law of value which we premise our political and our personal existence, that higher order of understanding which means that we see ourselves as part of a class, not as monads or swinish individuals fighting each other in Rockefeller's controlled environment.

Now it might seem an awesome task to have to take the conception $S'/C+V$, the expanding law of value, and say that we will be able to transpose it into the world of physics, not in some banal, superficial way, but by encompassing the work of Einstein in terms of the problems which he himself recognized and by going beyond him. At least we can point the way which physicists must take in order to go beyond. But if we reflect, we know that it is not strange at all, and is in fact the very premise upon which our lives are based: that is, that we are part of a universe which is expanding.

There is no such thing as a sociological law of value, relevant to political economy but irrelevant to the problems of physical science. Because if the physical universe is not negentropic, how then do we account for our own existence? How do we explain ourselves, our history, our evolution? How do we explain the fact that our survival can only be guaranteed if we relate our social practice to realizing constantly higher levels of energy by creating a new form of energy, by being the emergent form of the highest form of energy known to us in the universe? How else can we account for the physical universe, except as it is appropriate to what we know of ourselves, just as we judge the appropriateness of human mental processes by the increasing ability of our species to control the biosphere.

Knowing this of ourselves sociologically, knowing that it is the principle of our survival, we know that the human race could not have survived and grown and achieved as we have — to become the universe aware of itself, of its negentropic tendency — if this were not also the necessary tendency of our mental activity. This necessary tendency of our mental activity is the creative process, the development of the cognitive powers expressed emotionally as love; it is not some empty abstraction. The emotion of love for our class, for humanity, is what makes us revolutionaries rather than beasts. It is from this standpoint that we recognize that our human existence can and must define the coherence of the universe as a whole in terms of the negentropic tendency of its development.

Einstein's Failure

When we look at Einstein, his scientific achievements as well as his limitations, it is not ironic that despite his genius and his tremendous contribution to mathematical physics (which we will go into later), he was an impotent person. A sad, disheartened Social Democrat who lived through fascism and two world wars, Einstein saw his highest achievements perverted to serve cold war aims, but could do nothing to intervene effectively. The man who formulated in precise mathematical terms the fundamental conceptions which make the development of nuclear power possible could never realize his creative intellect socially. He could not control the uses to which the products of his genius were being put.

Imagine the bitter misery! Imagine being a person who could feel truly responsible for a unique creative act, a creative moment in history: the application of Riemann's work in geometry to an approximation of a unified view of matter/energy — the theories of special and general relativity. Put yourself in the place of such a person, able to conceptualize in a precise way ideas which had been socially current but not previously made coherent, only to see those ideas being used to develop the potential to destroy the

world. It is tragic but not ironic because Einstein's limitations as a scientist were exactly coequal with his limitations as a Social Democrat.

He failed to locate himself either as a political person or as a scientist in the necessary ruthless struggle for human freedom. He could not formulate a program for expanded reproduction which would have provided a basis for struggle against the cold war/H-bomb ideology he opposed. He failed to develop the cosmological notions which are the obvious extension of his work, or even an approximation of them such as Friedman's formulation of a spatially expanding universe — which Einstein later accepted as do astronomers today. While such a notion does not in itself demand an understanding of negentropy, Einstein's initial adherence to the notion of a fixed universe merely underlines the neurotic block which caused him to postulate in amended form the "law" of conservation of energy: zero growth ideology. It is this fundamental fallacy in his work that locates our conceptual superiority to him.

This is not at all to denigrate Einstein's moral integrity. A high level of morality was the necessary basis for his scientific achievements. The driving force behind his conceptual breakthroughs was his search for coherence in the universe. In this he is firmly adhered to the tradition of Kepler, that human freedom, man's understanding of "God," is located in man's progressive understanding of the universe, which must be coherent to man's mental processes and his ability to formulate unified mathematical expressions of physical processes.

Einstein rejected the discontinuities in Lorentz's solution to the surprising fact that the velocity of light appears constant in any inertial system; Lorentz's solution was to suggest that clocks slow down and physical bodies shrink in the direction of motion of a system moving with constant velocity. He accepted the empirical foundations of Lorentz's work, the dilation of measurements, just as Kepler before him based himself on the minute astronomical observations of Tycho Brahe, but Einstein located this change in measurement not in the properties of things-in-themselves, of clocks and rods as such, but in the lawful relationship of man to the physical universe.

It is not the case that rods shrink but rather that our measurements depend upon our notion of space and time. He demonstrated that there is no such thing as space-in-itself or time-in-itself, but that our measurement of any event takes place in a space-time frame of reference which is determined by our relationship to light, specifically the ratio of velocity of our system of reference to that of light. He went on from here to formulate mathematically the notion which Hegel before him had understood, that mass as such is an ideological misconception. Reality is located in matter-in-motion, momentum. Matter and energy are interconnected; the famous equation $E=mc^2$!

Einstein reflected upon the anomaly that we seem unable to detect the speed of our world when we try to measure by an expected increase in the apparent velocity of light, and he conceptualized the fact which Marx had understood very well before him. He said that space and time obviously are not separate measures, are not things-in-themselves; that we do not have a frame of reference for our universe in which we can view the measure of space and the measure of time as disconnected. The frame of reference depends upon the observer — not in some wistful, whimsical sense (like the rotten claims of the cultural relativists) — but in the sense that the observer's position and criteria for measurement are determinate parts of the field which he is measuring. In fact these are determined not merely by his velocity as an observer, but by the historical evolution of his society to the point where measurement of the electromagnetic field by electromagnetic waves became feasible. Einstein did not discuss the historical implications of the development of measurement, but he did go beyond the development of space-time as interconnected categories rather than separate, a priori constructs as Kant had presumed.

Einstein went beyond this to discuss how these systems, these frames of reference, were related to each other. In this way he sought to encompass the notion of electromagnetism and the force of gravity. He was searching for a field theory which would describe how matter determined the form of its own measurement, the form of its own determination of length and curvature. He built on the notions that were developed mathematically by Riemann in 1850. This was an enormous step forward. He extended Riemann's notion of intrinsic measurement, that there is no unit of measure outside our universe; he extended Riemann's work by describing the gravitational field, matter determining itself, in terms of space-time events. He went on to formulate the problem of a unified field theory in which the self-determination of matter from out of the electromagnetic field would be described. This remained problematic for him because he rejected a negentropic standpoint, instead counterposing as an axiom of his system the conservation of matter-energy.

The Law of Value

Constrast what Einstein did to what Marx did. Marx enunciated the law of value (a "law" which every social system must approximately adhere to on

Carol White speaking at the pre-conference cadre school.

penalty of crisis); that S'/C+V, the rate of surplus value, must increase at an exponential rate. Marx also located the social metric, value, in terms of ratio, connecting the two parameters, socially necessary labor time and the valuation of dead capital. But Marx took the dichotomy between the evaluation of capital from a past period and the shrinkage in its real social value as the productivity of society increases in succeeding periods, the two opposing "tensors" of the social value of capital on the one hand and the capitalist profit-standard of measure (fictitious capital) on the other, and recognized in capitalism's flouting of the negentropic tendency of the universe, the basis for social crises such as the present depression.

Marx never used the word "negentropy," but it is Marx's conception which has been made more precise by Marcus: that every social system must develop on higher levels of energy throughput, must devalue its fictious capital in order to survive, and must therefore free a greater and greater portion of the labor force to spend its time in scientific research, artistic creation, technological innovation, in the production of new forms of production; that we, the negentropic tendency of the universe become aware of itself, know our human freedom as the negentropic necessity for us to encompass and control more and more of the universe of which we are a part.

It is not accidental that we measure ourselves, in each of the time periods through which we have evolved, by the way in which we have been able to capture and utilize previously uncaptured radiant energy — wind power, coal power, oil power, the use of electricity, the fact that we eat meat — just as we measure space and time by the ratio of the velocity of our frame of reference to that of light. It is not an irony, but the perfectly lawful and coherent extension of the simple notion that we cannot even measure space and time in a way unconnected to our relationship to the energy of the sun and the relationship of the electromagnetic biosphere of which we are a part to the sun. Yet such measures are merely linear approximations of reality, as Einstein himself makes clear in the general theory of relativity.

These linear approximations, these abstractions from reality, are not simply mathematical conveniences. Our ability to use such linear methods, the locally entropic tendencies of the universe, are a necessary precondition for our emergence as the human species. If it were not for this we could not consider socialist planning. It would be nonsense to develop a five year plan even as a first approximation, if the universe was evolving at such an accelerated rate that we could not consider its laws as invariant within small neighborhoods of space and time.

We have only evolved as a species here on earth because the earth approximates an inertial system, a system which moves at a constant velocity. Otherwise we would face constant turmoil. It was a necessary precondition of our evolution that the earth's velocity not be high in proportion to that of the sun's light (18 miles per second, as contrasted to 180,000 miles per second) in order that the electro-magnetic rather than the gravitational field predominate so that we can measure by the approximately straight line direction of light's motion.

In the same way it is an irony but nevertheless true that there is no shortage of energy. We are not living in a universe which is impoverished of energy — to the contrary! We can exist only because we are shielded from energy, because the ionosphere gives us a shield from the energy of solar radiation, and the radiation that might come to us from other stars. It is only this which has allowed life to survive. Furthermore, if we

were not governed locally by a limited principle of entropy (that is the dissipation of workable energy), if inefficient transfer of energy flows were not the rule, again we would not have survived. If every forest fire were eventually to turn into a self-generating nuclear-type explosion — and it would not take too long at that — the whole earth would have been consumed and we would not be here. Thus the fact that the law of conservation of energy and the second law of thermodynamics (entropy) hold true as approximations within given limits is a necessary precondition for the negentropic development of the universe — our evolution.

Einstein did not wish to locate himself in a static notion of the universe. He sought to explain the emergence of the particle from the field rather than locate the particle as an inexplicable singularity within the field. But Einstein did not know how to go beyond quantum mechanics. As a necessary axiom upon which his work was premised, he asserted the conservation of energy in the (in this connection) inconsequentially amended form of the zero divergence of the energy tensor of matter. Furthermore, he premised his development of the curvature tensor of the gravitational field on the insignificance of the rate of change of that field over time. This was not merely an approximation but a fundamental fallacy, as demonstrated in his failure to himself discover Friedman's formulation of a spatially expanding universe (one which would necessarily have changing gravitational interrelationships).

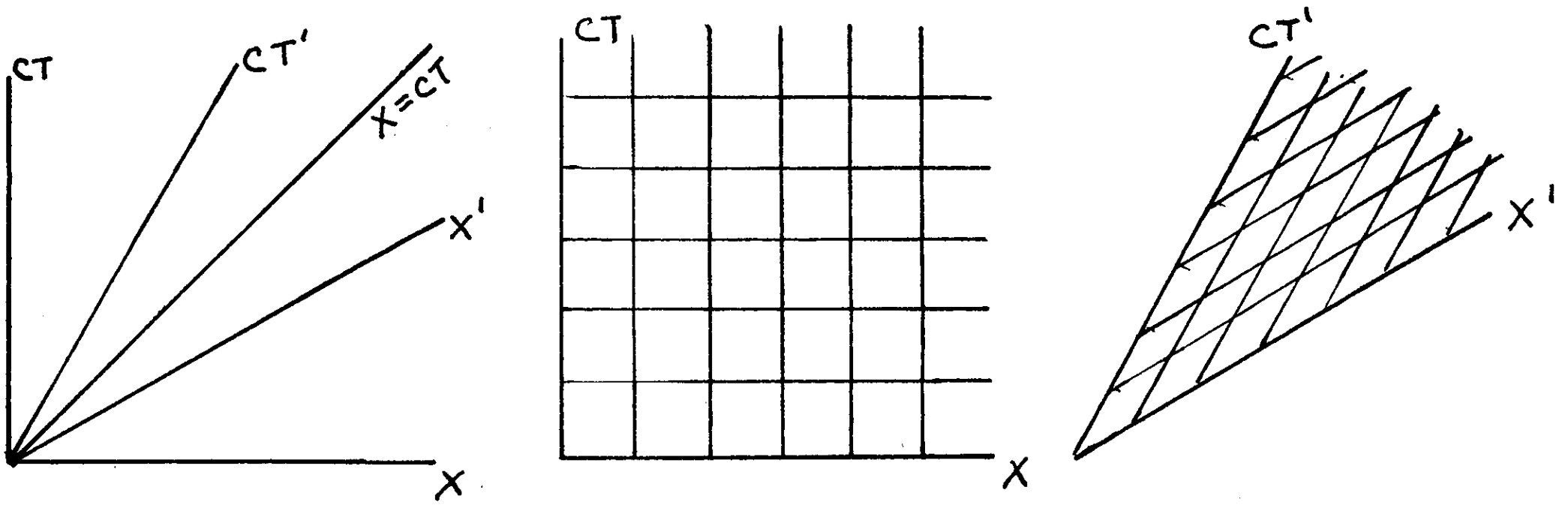
Einstein was able to describe the motion of matter in our part of the universe in a way which was not done previously: the equations which relate the curvature tensor of the gravitational field to the energy matter tensor. In this way he accounted for the interaction between the gravitational and electro-magnetic fields, i.e., the fact that an object moving through a gravitational field experiences a transfer of energy, thus locating the gravitational field as itself another form of energy. But Einstein neurotically blocked when it came to accounting for this gravitational field. By equating the curvature tensor to the matter energy tensor he made the enormous step forward of locating the gravitational field, not as some outside force implanted on the universe by God, but the product of the relationship of matter-energy to itself. Yet he then failed to follow through with the obvious conclusion — that this self-relationship implied the creation of a new form of energy, and the principle of negentropy.

Einstein was driven to search for coherence in the universe, to discover a unified conception of inertia and gravity; but he neurotically balked at giving up mother's fixed universe. His quest for a unified field theory was doomed from the start. He could account for the interaction between the gravitational and electro-magnetic fields, between matter and energy, but not for their occurrence. Matter perforce remained a singularity in the field.

Creativity

Because he refused to consider the emergence of new forms of energy, Einstein sought to explain matter as the product of asymmetries in the field. While at first sight this appears to be a groping effort

Minkowski's two-dimensional representation of Einstein's time-space axis.



In the charts above ct is the time axis and x is the space axis. The line x=ct is the speed of light. They show the change of the geometries of two different coordinate systems relative to the speed of light.

toward a negentropic explanation, it is actually a sophisticated form of reductionism. It denies the emergence of a new lawfulness, the laws by which matter reproduces itself and thus redetermines the field. We can understand this better if we examine our understanding of creativity, which is fundamental to our knowledge that we will win against Rockefeller.

Our existence, which is historically determinate, determines future history accordingly as we realize our creative potential as revolutionaries. There is no field in which we can go out cheerfully confident, picking daisies, and knowing that we will win as long as we have looked up the right route first. There is no road map with preassigned routes, no preordained world line. We change the geography as we go along. We are governed by necessity — the field — but our ability to change that field depends upon our own socially evolved, socially appropriate, but not mechanistically determined, ability to act as self-conscious members of the human species. The lawful development by the human species of creative mentation evolved out of the sociological development of the species, as the form of thought appropriate to that development, but it cannot be described simply in terms of social processes.

We need to make breakthroughs in fusion power technology. When we come to power we will establish the appropriate conditions for scientists to maximize their creative potential to do this. But in the final analysis we will also depend upon finding a sufficient pool of scientists of the moral and intellectual character of Einstein. The laws of psychology and sociology are coherent but not identical.

We can point the way, but contemporary science has still to go beyond the basic dichotomy between matter and energy, has still to supersede Einstein's achievement in establishing the matter-energy relationship $E=mc^2$, the gravity-energy tensor field relationships.

Friedman's theory of an expanding universe, though an improvement on Einstein's first steady state theory, was in no way an advance toward the concept of negentropy. It is a theory of evolution of the universe that is in many ways analogous to Darwin's Malthusian evolutionary theory, which might better be called devolutionary.

In the same way modern cosmological theory is predicated upon catastrophe. One "possibility" is that the world was created at some time in the past (the first estimate was five billion years ago). A singularity, a moment of incoherence: God spoke, and the universe has been constantly expanding ever since, to arrive eventually at an entropic thin broth of homogenously diffused matter energy, which will prevent us from utilizing the difference in energy potential to do work. In other words — disaster! Or we face catastrophe from an opposing process. A continually expanding universe is based on the notion of the dissipation of energy. If entropy is not a universally determining principle, according to *this* theory, if we have negative entropy because of the effect of electro-magnetic fields trapped within plasma which serve to concentrate energy levels, then, whoops! The universe, after expanding to a certain point, will begin to contract.

This supposedly inevitable dissipation of our resources is in fact depression psychology, mother's world in which there's only so much money and we have to watch very carefully how we divvy it up. That is the ideological application of the otherwise limited thermodynamical principle of entropy. If in fact we are escaping entropy, if the universe collects energy so that it maintains negative entropy as would be suggested by the actual observations of astronomy — the clusters of stars, the radiation, the fact that new stars are born, the presence of electro-magnetic fields throughout space—then we run into a problem: the universe is going to come to an end in two billion years! It's going to expand only so long and then it will begin to contract. So there's going to be a crisis, and out of that crisis maybe God will have another creative moment and a new universe will be started — recycling!

It is on the basis of Einstein's original work that modern cosmological theory has developed. Einstein was not able, either philosophically or mathematically, to go beyond this kind of obvious banality to understand what is clear to us: that the continuing process of development of new, higher forms of energy takes the problem out of the dichotomy in which either existing sources of energy are merely reshuffled (negative entropy) or dissipated and made unworkable (entropy). The "law" of the universe is that the laws are continually changing, with new degrees of freedom emerging. A socialist society, which will base itself initially on nuclear fusion power, will begin to be able to control the energy relationships of the universe. Man will be able to control his future, intervening beyond the biosphere into the energy processes which dominate the universe. The people who follow after us will be able to control the electromagnetic fields upon which our relationship to energy, to the sun is now predicated. The scientific human species will be able to control, rather than simply utilize, energy. This is speculative now, but it is obviously the kind of problem that will preoccupy future scientists. We will begin to know the energy relationships which mediate our existence to the sun, know them in our own vital processes as well, and begin to control them. We will begin to be able to control the ionosphere as well, to create our own relationships of shielding, and we will go beyond our particular solar system. Out of this we will change

totally anything that might seem to be existing laws of the universe. We will come to dominate the astronomical universe just as we have taken control over the biosphere. In this process the energy relationships of which we are a part, as we now perceive them, will seem true only as the guiding necessities of a past historical epoch.

The Fallacy of Limits

Einstein did not have this notion of the universe, yet he was a determinist with the same moral commitment to human progress which led Kepler to be a determinist. He fought against the notion that there is a natural limit (the uncertainty principle) to man's ability to understand the physical universe. This is expressed in the Heisenberg theory that nature is fundamentally unlawful from man's vantage point because he can only know it in a one-sided way (the principle of complementarity). Einstein devoted most of his scientific life to fighting the ideologues of quantum mechanics, but without an understanding of negentropy his struggle was impotent. A determinist in the way that Kepler and the Calvinists were determinists, Einstein knew that the universe was coherent and believed in man's reason, but this remained for him a religious belief rather than a firmly grounded scientific conviction. He could not locate man's reason as his socially determined species nature, subsuming all lower forms of energy out of which it emerged.

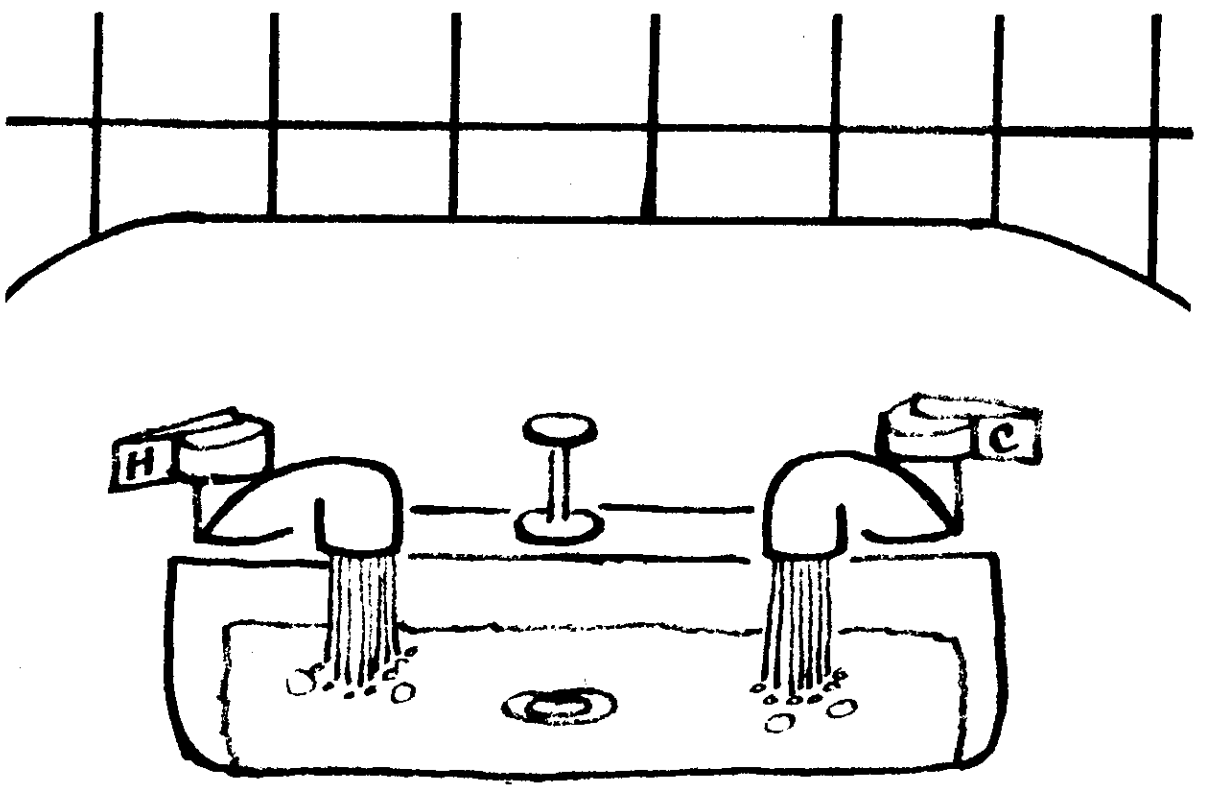
The same fallacious reasoning pervades all forms of Darwinian evolutionary theory. It is *not* the most vicious aspect of Darwinianism that political theorists have used his work (which of course borrowed its premises from Malthus) to justify the most bestial controlled-environment notions of man — dog-eat-dog, "Nature, red in tooth and claw," survival of the fittest — concentration camp notions of humanity and the world. But that is not the fundamental flaw, because one can reinterpret Darwinianism to ground the study of ecology on a study of species reproduction. The struggle for survival then becomes not a series of predatory battles within or among given species, but a struggle by each species to utilize its environment to increase its rate of reproduction. The dominant species, then, are those which can maximally increase their rate of reproduction without destroying the ecology upon which that reproduction is based. Those species which succeed will establish an ecological balance (zero growth). This denies that at every historical period, there is a higher form of energy which subsumes all of the relations of the universe which fall under its purview, i.e., which are within its neighborhood. (We have not yet, to our knowledge, affected other solar systems by our development on earth as a life form.)

The logical extension of Darwinianism is exemplified by a book on gorillas written by an ecologist named Schaller. He bemoans the fact that as Britain lost control of its former colonies in Africa the states failed to police their native populations sufficiently, so that in periods of famine they would hunt gorillas and other apes. True; we too would like to see ape populations protected so that we can study their development and also preserve a living record of our own prehistory. But look at the viciousness of a scientists who sees men starving and is enraged at them because they eat apes. This is the zero growth ideology which says that man, by developing a high-energy industrial society, has polluted the "natural" habitat of other species.

The *fundamental* flaw of Darwinian ecological "science" is that it locates the evolution of species as linear development. It looks for a linear progression to explain the existence of, for example, the horse population today in terms of qualities inherited from its ancestor eohippus, rather than the exigencies of the race-track mentality and the barbarous fact that horse-power is still used for farming.

This again only poses the problem which Einstein struggled with in his efforts to explain the evolution of the particle out of the field. It is necessary to explain how in each epoch a higher form of energy emerges and becomes the determining force for future evolution. We have been able to do this precisely only in the realm of sociology, in political economy. We have laid the basis for a scientific psychology and we are beginning to do the same in the physical sciences. In every case our scientific work has been grounded in practical necessity; the pressing need for man to take conscious, deliberate control of the evolution of his species now, or see the destruction of that species in any form which we identify as human. We cannot afford to squat outside the universe, to see the necessary emergence of a new degree of freedom — a higher form of energy — as a mathematical singularity in the field of existing relations. The leap forward is the historic responsibility which rests upon our shoulders.

We do not yet have a way of explaining this development with mathematical precision, but we can know the process and we can have absolute scientific certainty as we see it unfold within ourselves. We know the negentropic tendency of the universe in those moments when we experience that creative expansion within ourselves, when our internal universe expands. That feeling of joy, of love, which we experience as we understand how we are changing the world by the growth of our conceptual power and by our ability to convey this knowledge to those around us, whom we are organizing to help them realize their own conceptual development; that love is the lawful



The Second Law of Thermodynamics: the flow of energy between different energy states (here, hot and cold) diminishes towards zero as energy levels become homogeneous, at which point work is no longer possible.

subjective basis for our scientific advances.

It is comparatively easy to look backward and account for everything. We can expect to look backward and formulate mathematical laws which will explain the chemical evolution of the universe and its physical evolution; we can describe the events which have brought us to this point. But there are no mathematical laws yet which can describe the revolutionary period which we are going through. There are no laws to describe the constant revolutionary periods which will be the normal existence of self-conscious human beings who are at a faster and faster rate able to assimilate change in their universe, to deliberately will it without being overwhelmed — in fear and agony — by chaos and confusion.

Only as we begin to locate that force of mind in ourselves, initially by the creative act of understanding the achievements and limitations of someone like Einstein and all the creative artists and scientists who fathered us, only then are we in a position to realize the progress from one energy level to the next. A negentropic view of the universe, as opposed to the simple notion of throughput of a fixed quantity of energy (a bad infinity notion of negative entropy as energy which is rearranged in more and more complex ways but remains fundamentally the same), is predicated on our realization that the tendency of the universe has been to evolve qualitatively, transfinite changes of energy. It is predicated on our knowledge of what we are as members of the Labor Committees. Each of us is a necessary creative part of the universal working class; the particular ability of each of us to act is absolutely essential to the continued negentropic tendency of the universe. It is conceivable for us to fail if we do not do this. It is up to us. We are the singularity in the field.

The necessity that we locate in ourselves that realization of our own creative power is the actualization of the negentropic tendency, not only its expression. To do this, we must become musicians who at least can appreciate and live in the world of Beethoven; people who can rescue workers from brainwashing rock culture. We must take the notions of Einstein, and not banalize or trivialize them, but understand that he went one hell of a long way—just not far enough. We must be compassionate toward him and realize that the revolutionary movement failed him: that Lenin's failure to develop a viable communist international based upon a program for expanded reproduction was a betrayal of Einstein and his whole generation of scientists, as well as of the rest of the working class.

With our program we are now recruiting physicists and other scientists, and creating the kind of social environment in which they will not be immersed in the *ideological* notions of matter and field, conservation of energy, entropy, but will go beyond them socially. These scientists will therefore naturally begin to think about the physical universe in ways that are appropriate. As we ourselves move to the frontiers of existing culture and beyond, then the implicit superiority of our conceptual ability, our grounding in a program for expanded social reproduction, will become explicit in our everyday thought processes: then we will have developed the appropriate intrinsic measure of ourselves against the artists and scientists who expressed the potential for human creativity before us.

It is this sense of our own power properly located, this knowledge of ourselves and what we represent, of our place in the negentropically expanding universe, that will guarantee that we have the conviction, the firmness, and the ruthlessness to triumph over the bestiality of the Reeses and the Himmlers, the Goerings and the Rockefellers. And it is only this.

The Neurotic Problem

A number of questions followed the presentation, each trying to "adjust" the concept of negentropy to fit the law of conservation of energy. The first question, quoted in full below, is symptomatic of the neurotic problems involved. The answer given here is a condensation and amalgamation of those which actually followed a series of such attempts to milk a he-goat with a sieve.

Q. I found your presentation very, very fine, very moving, but at one point you kept using certain phrases that really disturbed me. You talked about the evolution of energy, the higher forms of energy. Yet from all I know, we have no evidence to say that energy has been increasing. What we have evidence of is an increase in negentropy, an increase in the ratio of S/C+V, an increase in the evolution of intelligence, of life, an increase in that capacity in the potential to change the relationships between matter and energy. Isn't that the focus of evolution? It's not an increase in energy—it's not an increase in matter.

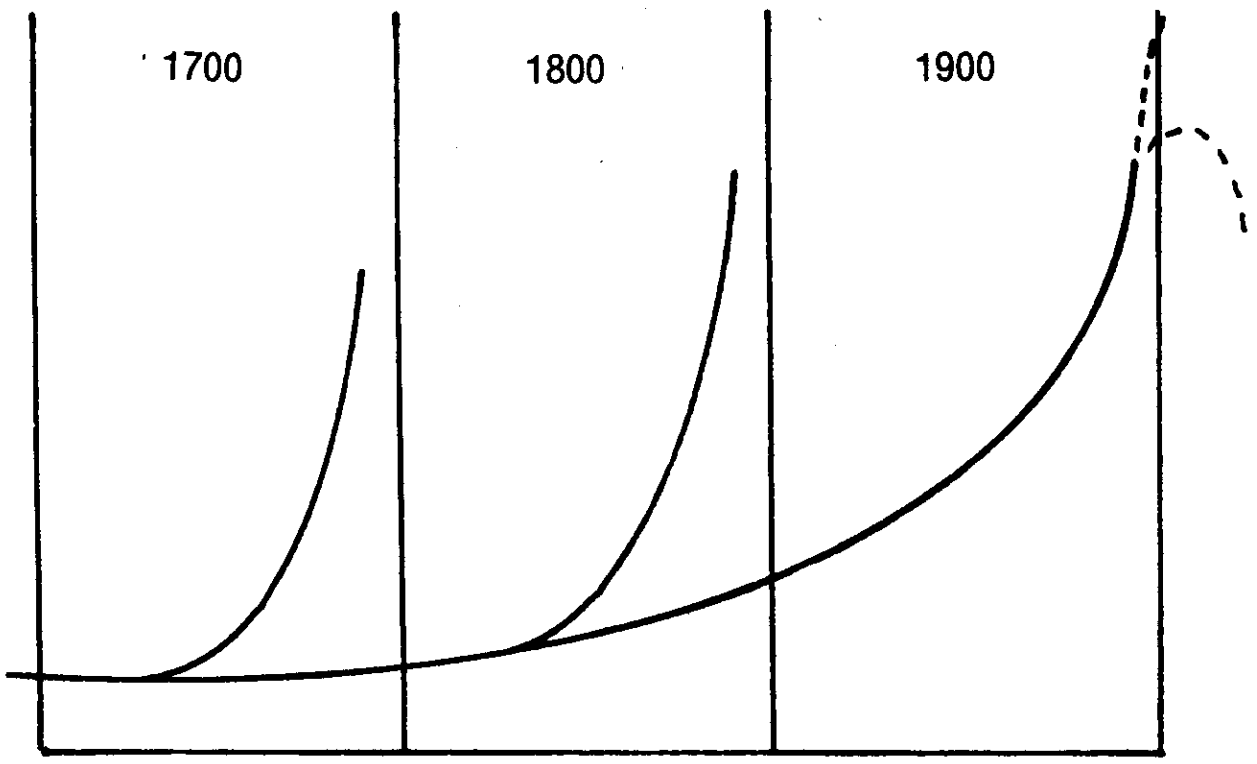
A. If you think you can locate security in some fundamental particles, you're in for an unhappy surprise. Not only are you left with a dichotomy between matter and energy, the particle and its laws of motion, but scientists have just discovered some new "fundamental" particles this past week. If you seek to locate reality in the subdivision of the whole, to make the subdivisions (particles) fundamental, then you are left with Zeno's paradox unresolved.

We can illustrate this in a humorous way by considering the gestalt psychologist Koehler's famous experiments with a chimpanzee and a banana. One chimp, Sultan, was able to conceptualize the process necessary to allow her to pull down a banana located above her reach. She learned to drag a stool to the appropriate place and climb up so that she could reach the banana. Some chimps who watched learned to imitate Sultan successfully. Others simply caricatured her motions, pushing the stool every which way, never managing to get the fruit. Success demanded that the animal conceptualize the process as a whole first.

The experiment was part of a polemic against vicious reductionist notions of learning theory being peddled by behaviorists like Skinner, which claimed that human thought processes were simply more complex versions of the mental activity of rats learning to run through a maze.

We can take the experiment a bit farther in our imagination. Suppose that the banana had been just slightly above Sultan's reach so that she could get it after making a number of tiring jumps. Suppose that the stool was also located in the room. Would Sultan jump or would she bring over the stool? We can't know, since to my knowledge the experiment was never performed in that way. But we can be fairly positive that Sultan would not have conceptualized using the stool in the first instance if she could have fed herself by the hard but familiar work of jumping.

Now take a man and put him in that same situation He will immediately look for the easiest way to get his banana. He will intuitively think in terms of net energy. To carry the analogy still further: We can measure the caloric count of a banana, but if we are planning a meal from the point of view of maximizing our energy, it makes a tremendous difference if we can buy it at the A&P or we have to go to Africa first in order to pick it off a branch—even if we have a stool.



From any given linear perspective there will always be an ecological crisis — an unbridgeable singularity. But reality is not linear, and new degrees of freedom — creative social/technological breakthroughs — can change the laws of the universe. Which way the future? It's up to you.

The questioner clearly understands negentropy and then he immediately neurotically blocks. Any serious society is going to define energy on the basis of net throughput, and this can only be defined in terms of S'/C+V. How else do you explain the development of industrial society after the use of electricity became widespread? If we measure energy in terms of reductionist notions of transfer of energy, we find that we dissipate 38 per cent of effective energy when we convert the steam power which runs most dynamos to the form of electrical energy. You can only explain the deliberate social decision to utilize electrical energy on a wide scale, to the fact that electrical energy is in fact a qualitatively higher energy source when it is organized by man to run factories and provide superior lighting, than is steam power. And the mental power which understood this and made the social use of energy practicable is a still higher form of energy.

Maxwell, the scientist who developed the mathematical equations to express Faraday's discovery of the electromagnetic field, thus making possible our ability to control electrical energy, defined energy as the capacity to do work. Yet he also accepted the axiom of the conservation of energy. Maxwell had the correct social definition of energy but lacked an understanding of work; saw it as a continual cycle of simple reproduction. He did not understand that with the kind of leaps in productivity which he himself had made possible, man's labor power increases exponentially, so that in each succeeding period work itself is redefined.

How is energy ever measured? It is measured fundamentally in terms of the ability to do work, by a social form of measurement carried out by human beings who are measuring energy to some purpose and who are defining it accordingly. The law of conservation of energy was socially useful to the limited extent that it accounted for the waste of mental energy by scientists who were attempting to build perpetual motion machines without accounting for energy transformed into heat by friction. The second law of thermodynamics, the principle of entropy, is useful because it is a measure of the inefficiency of energy transfer systems. These laws are useful *within these explicit limits.* It is when they are extended to serve as supports to zero growth ideology that they become vicious.

Einstein himself redefined conservation of energy even though he remained trapped within its ideological form. First he extended the law to conservation of matter-energy, then, with the general theory of relativity, he included gravitational energy within the bounds of conservation because work is done against gravity. So we find that not only are fundamental particles continually being discovered, but the fixed "law" of conservation of energy has also been redefined twice in the 20th century.

The Political Question

If you locate energy as a fixed quantity you cannot escape the antinomies of quantum mechanics. In the final analysis you are forced to side either with Heisenberg or with Schroedinger. Heisenberg says that since you cannot measure both the velocity and position of a fundamental particle, because sufficiently precise measurement will affect either the one or the other, physical reality is therefore basically indeterminate. He found this vagrant quality in social reality as well, calling it free will, and on this basis found it quite comfortable to remain a practicing physicist in Nazi Germany.

Schroedinger denied this right-anarchist, fascist notion of free will. He was the first to apply the term negative entropy to biological process. He also worked with Einstein to develop a unified field theory, but he was left on the other side of the paradox. He argued that the particle had no independent reality, it was merely a singularity thrown up by the field, and he extended this to his notion of the individual. In order to attack Heisenberg's fascist ideology he could only fall back on poor old Plekhanov — if Napoleon had died a new general would have arisen to take his place. In other words, when Lenin died Trotsky was there to replace him! If Marcus hadn't lived someone else would have done just as well! Schroedinger denied the unique importance of the individual (the higher energy form represented by matter-energy as opposed to an energy field in which matter does not have determinate existence). In a philosophical passage from his book *What is Life* Schroedinger poses it this way: What is I? It's ephemeral. Just as the quantum is only a momentary singularity produced by the field, so I have no permanence; I am constantly recreated from the field. It is the field, not the individual, which has continuity. Schroedinger, like Einstein, intended to be a humanist, but he had a mechanistic, non-humanist understanding of determinism, of negentropy. He could not locate his own human creativity.

If we do not premise our notion of negentropy and the development of transfinitely higher levels of energy on our own process of human self-development, on the conscious realization of ourselves as the socially appropriate form of mass-energy which knows itself and the laws of its own development; if we do not locate ourselves in those terms, then there are *no* reasonable terms which do not leave us in the world of Heisenberg or the world of Schroedinger. And that is a political question.

Certainty and Uncertainty: The Incoherence of the Physicists

by Dr. Morris Levitt

> It is probably justified in requiring a transformation of the image of the real world as it has been constructed in the last 300 years, since the re-awakening of physics, based on the discovery of Galileo and Newton that bodies determine each other's *accelerations*. That was taken into account in that we interpreted the velocity as well as the position as instantaneous properties of anything real. That worked for a while. And now it seems to work no longer. One must therefore go back 300 years and reflect on how one could have proceeded differently at that time, and how the whole subsequent development would then be modified. No wonder that puts us into boundless confusion!
>
> E. Schroedinger
> (to A. Einstein; Nov. 28, 1950)

Our thesis is that, quite aside from material seducements, coercive pressures and other psychological manipulations, *the ultimately decisive factor in severing science from the humanist tradition has been the collapse of rigorously self-conscious evaluation of the coherence of theoretical knowledge*. Nowhere can this be demonstrated for physical science more clearly than in the case of quantum mechanics.

Quantum mechanics and relativity theory have been the two most prominent *reformulations* of physical theory in the 20th century. While they have generally been accorded equal "revolutionary" merit, it is only relativity theory that has been associated with a *reconceptualization* of physical reality that (within certain limits) *coherently subsumes* (since it transcends) earlier descriptions of process in nature. Put as briefly as possible, the central idea of relativity theory is that the totality, or appropriately delimited sub-totality, of process in the physical universe is primary. Therefore, it specifies, paradigmatic language (such as space and time) must be mathematicized in structures and with meanings which are consistent with overall process-reality.

For example, in *special relativity*, the concepts of absolute space and absolute time, absolute simultaneity of events, etc. are replaced by new *invariants*: first, the speed of light as a velocity fixed with respect to any two or more observers — regardless of their relative velocities, and as an absolute limit to speed of propagation of any signal, i.e., information-bearing string of events; and second, the invariance of the so-called "space-time interval" characterizing an event, as measured by any set of

observers in uniform motion with respect to each other. All of this goes through without any modification of the common-sense Euclidean geometrical space of three mutually orthogonal dimensions in terms of specifying "position." Autonomous space and time reference frames are replaced by an indivisible four dimensional space-time complex, or Minkowski frame.

With *general relativity*, the Euclidean character of space as an unvarying "backdrop" for physical process in each inertial reference frame is superseded by the concept that space itself is co-determined with the process-complex of the physical universe as a whole. To the extent that geometry is appropriate to a description of physical reality, Riemannian geometry and even less restricted topological constructs must be employed.

In contrast with relativity theory, quantum mechanics, even in its most successful domains of application, (*1*) is totally ambiguous with respect to the relationship between its conceptual apparatus and physical reality. Since this has been widely recognized for the past half century, there has been much factional struggle over the two related questions: "Is the theory complete?" and "What does it *mean*?" Given these problems, and those peculiar to relativity theory itself, it is obvious that the latter must also be incomplete in some sense. The two theories have been successfully combined in certain limited applications, as in the computation of the basic features of atomic systems. However, it has not been possible to combine them so that there is a unification on the theoretical level of the cosmological and microscopic domains. Having noted the relevancy of the issues raised for the future unification of theoretical physics, we turn now to the peculiarities of the debate over quantum mechanics as a reflection of the collective mind of the physicists.

Bourgeois Science

Quantum mechanics, as a *systematic way* of looking at the world (as opposed to its unobjectionable role as a particular algorithm appropriate to a range of atomic and other phenomena) has been the metaphysic prescribed for a conceptually constipated bourgeois physical science. To those academics and others who would object that there is no such thing as a "capitalist" or a "socialist" science, we reply that "bourgeois" science is scientifically defined as that which is produced in the absence of critical consciousness of both the processes through which scientific concepts are historically formulated and evolved, and of the most advanced unifying conceptualizations of science-in-general and its historically associated philosophical elaborations. (Thus, a physicist ignorant of, say, biology and Hegel is a bourgeois physicist.) As Einstein put it:

> If one wants to consider the quantum theory as final (in principle), then one must believe that a more complete description would be useless because there would be no laws for it. If that were so then physics could only claim the interest of shopkeepers and engineers; the whole thing would be a wretched bungle. (*2*)

In this essay we will trace the origins of quantum mechanics in the ideological and scientific breakdown of the mechanical-progressive world-view characterizing the expansive period of capitalism as it entered its period of utmost stagnation and degeneration. This should not be taken for the vulgar conclusion that social conditions and thought directly determined the form of the quantum mechanics (QM); physics should receive the "credit" it is due. However, the vast confusion which QM engendered is quite another story.

We will show that most of its fervent apologists, as well as its hostile critics, have completely in common the fetishization of micro-entities "in themselves." That both sides of historical disputes should act to merely divide the terrain of incoherence according to their respective fixations (i.e., varieties of reductionism or bastardized holism) should be nothing new to those familiar with the history of bourgeois thought and its self-styled Marxist critics.

In the case of quantum mechanics we can roughly identify three aberrant poles: first, Heisenberg's Absolute Indeterminism, elevating the Uncertainty Principle per se to a place of primacy in reality; second, Bohr and the Copenhagen School, refining the Complementarity Principle with the subtlety of earlier Jesuitical explorations of the Trinity; and third, the Neo-Mechanistic nostalgias of "Hidden-Variable" and other Absolutely Deterministic theories. These will all be discussed in due course. The first two have by now essentially merged into an orthodoxy which is quickly dispensed to physics students — much as vaccines for exotic diseases are to military draftees — before they are sent into the field to do battle with Mother Nature.

The problem for the non-expert in approaching this subject is that a welter of formal mathematical systems and prescribed fundamental assumptions have by now accumulated in a multitude of highly complex theories. This makes the problem enormously more intimidating at first sight than that of grasping the transition from Ancient to Classical science, or from Newtonian to Relativistic physics. In order to judge the coherence or lack of it in the interrelated mathematical and physical ideas of QM one must have a more general and advanced standpoint, even if it is not as yet fully formulated as physical theory. That is how the present article has been

motivated, but we will also later be able to discuss current work in progress in physics that shares the general view of physical reality which has been central to the Labor Committees' political and intellectual work.

I. A Brief Review of Pre-Quantum Ideas

Early societies had an essentially holistic view of the universe, that is, they conceived of it as organically integrated. To those whose thinking does not venture beyond the categories of analysis and synthesis, these societies will seem merely naive. Certainly they did not produce what we would today call self-conscious individuals. But as Durkheim argued on the basis of his anthropological investigations, there is a partially self-reflexive intelligence at work in the concept formation of primitive societies. This is revealed in the correlation between supra-individual social practice and the society's ideas about the world in general:

> Saying that concepts express the manner in which society represents things is also saying that conceptual thought is coeval with humanity itself. We refuse to see in it the product of a more or less retarded culture. A man who did not think with concepts would not be a man, for he would not be a social being. If reduced to having only individual perceptions, he would be indistinguishable from the beasts.
>
> Another reason explains why the constituent elements of the categories should have been taken from social life: it is because the relations which they express could not have been learned except and through society. *(3)*

Like Feuerbach, however, Durkheim did not locate his theory of social (species) consciousness in the process of social reproduction. For a proper situation of the issues raised in this article one needs Marx's corrective in the Second Thesis on Feuerbach:

> The question whether objective truth can be attibuted to human thinking is not a question of theory but a *practical* question. In practice man must prove the truth, that is, the reality and power, the this-sidedness of his thinking. The dispute over the reality or non-reality of thinking which is isolated from practice is a purely *scholastic* question. *(4)*

The early socially determined conceptualizations of the universe were certainly rudimentary in that they closely paralleled the literal aspects of earth-bound life, as in the Egyptian and Babylonian cases. Even here, however, a certain degree of imaginative abstraction from everyday experience was developed in order to account for the extra-terrestrial domain; primitive computational astronomy was developed in Babylonia to quantitatively correlate sequential positions of visible stars and planets.

The tendency toward mathematical abstraction was developed in more sophisticated form in Platonic and Hellenistic Greece. This development was coupled with the idea of the universe as a hierarchical system of fixed qualities and completely determined causes and effects. Pictorially, this took the form of a series of earth-centered spheres ranging through the planets to the outermost sphere of the stars, with the motion of the celestial sphere being transmitted to successive inner spheres by a sort of Greek "fluid drive." The spheres were assumed to forever turn at uniform speed, in contradistinction to the wide variety of motions to be observed on the base earth.

There were many alternative views, of course, but we will restrict our discussion here to a brief examination of how this "mainstream" or hegemonic (for its time) model was modified to account for the apparently erratic (as viewed on earth) motion of the planets.

The five visible planets (planet, from the root for wanderer) posed a major problem for the Greek notion of timeless symmetry in the heavens. They departed radically from the general east to west arc traced by the stars (diurnal motion) to the point of executing loops, and their brightness was also variable to the point of periodic extinction.

The reason we raise this problem is that from the vantage point of historical perspective we can see that it provides a prototypical example of how the universe is theoretically "re-structured" in order to re-integrate "model" as well as "deviant" phenomena. In order to do this and still preserve the psychological role of the hegemonic world view it is necessary to restructure the universe by rearranging relationships among its essential features, while basically preserving the autonomous and primary character of those features.

In Platonic Greece, this was achieved for the case of the planets through the invention of the "homocentric spheres" by two students of Plato's Academy. Maintaining the uniformly moving, earth-centered sphere as the primary construct, it was possible to build up a set of concentric spheres, with axes of rotation of successive spheres offset from each other. (see Figure 1) This model introduced, in principle, an infinite number of variations into planetary motion, but still subject to the restriction that planetary distance from the earth remained invariant. With a sufficient number of nested spheres one could reproduce to a high degree of accuracy the apparent motion of a planet as viewed from the earth. This still left the question of variable brightness as an independent factor to be accounted for.

The simplest way to account for the latter phenomenon was to make the assumption that it was directly related to a changing earth-planet separation. But how could that sort of motion be accommodated within the basic ideas of the hegemonic world view?

Figure 1

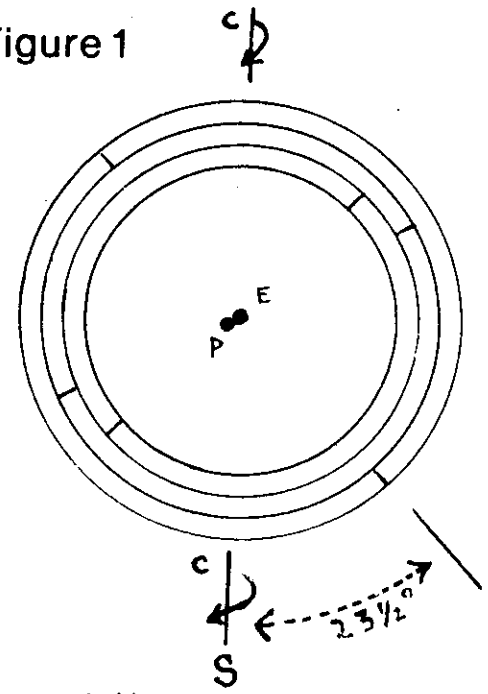


Figure 1. Homocentric Spheres

Figure 2

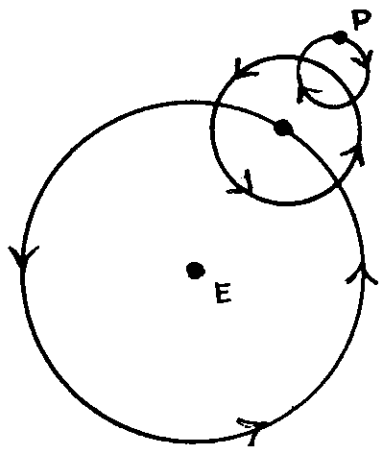


Figure 2.Epicycles in the Ptolemaic system

Figure 3

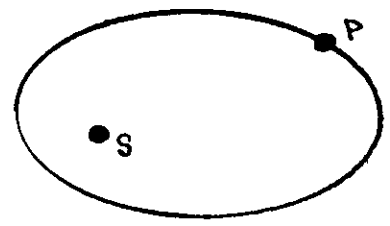


Figure 3. Elliptical orbit in the Newtonian system

The ingenious solution here involved the introduction of the construct known as the epicycle. This was a secondary, or arbitrarily higher order, sphere centered on or near the surface of the primary sphere, and moving at uniform speed with respect to that surface in a perfect circle. (See Figure 2.) Now one had at hand an infinite number of variations in a fully three dimensional geometry, so that, in principle, all the observed manifestations of planetary motion could be accounted for. In the Hellenistic world, in conjunction with detailed astronomical observations and geographic research, such computations reached their highest level of sophistication and accuracy with Ptolemy's *Almagest*, published in the second century, A.D.

Disintegration

Why bother about this epicycle business? Because it provides a clear and relatively simple example of how a purported universal theory, in the course of its elaboration and extension under the pressure of general technological and cultural advance, disintegrated as a coherent world view. Beginning with the organic wholeness defining the absolute space and modes of motion of the Platonic-Aristotelean universe, one ends with a set of inexplicably different constructs for each of the solar bodies. Nor are the differences uniquely determined. By the time of the revival of Ptolemaic astronomy in the middle of the 15th century, even in the partially recovered literature there were numbers of alternative Hellenistic and Arabic computational schemes. Finally, Ptolemy himself knew that the model was contradicted by empirical evidence: an epicycle that he added to account for the motion of the moon would have at some time placed it half way between the earth and the moon's primary orbit. This would have increased the apparent area of the moon by a factor of four, which was not an observed occurrence.

The new structures into which the old primary principles had been incorporated undermined the possibility of those principles retaining their primacy, and indeed their very meaning. We will see shortly how this situation arises in the case of quantum mechanics.

Why then were the old conceptions retained for so long? We must be brief in treating a complex issue so that we can take up the case which immediately concerns us. If we restrict ourselves to those periods of history in which relatively self-conscious interventionary forces are not yet developed, then the willful but only partially self-conscious activity of humanity is captured in Marx's phrase "...mankind always takes up only such problems as it can solve." This will seem tautological only if interpreted as describing some sort of passive or purely mechnical interaction between established and emerging social forces. However, when viewed in the light of willful, but ideologically mediated interventions within concrete historical struggles, Marx's phrase is properly understood as indicating that the conditions under which new concepts have the possibility of becoming hegemonic are also the conditions of ferment under which they are most likely to be developed and elaborated. In the case before us, the conditions for the superseding of the Platonic-Ptolemaic universe were the emergence and acceptance of new concepts for the causal origins of motion and the correlated structure of space.

This leads us directly to the case of Copernicus. We are not concerned here with the details of his biography and work. Jumping immediately to his contribution in his *De Revolutionibus Caelestium Orbium*, published in 1543, we find that he has taken the stationary earth from the center of the universe (now occupied by the sun) and imparted to it three motions; revolution about the sun, rotation about an internal axis, and precession of the axis of rotation. As a result of these shifts, his importance emerges as a transitional figure in forcing the old theory into an even more untenable configuration. That is, he is not the

proverbial pioneer in virgin territory, but rather the one responsible for closing the frontier.

In doing this he drew on the medieval and Renaissance reconstruction of the Ptolemaic system of astronomy, and refinements in the ideas of terrestrial and celestial motion which could be used to dispel doubts and fears about the earth's motion in space:

> Now if one should say that the Earth *moves*, that is as much as to say the motion is natural, not violent; and things which happen according to nature produce the opposite effects to those which occur by violence. Things subjected to any force or impetus, gradual or sudden, must be disintegrated, and cannot long exist. But natural processes being adapted to their purpose work smoothly.
>
> Idle therefore is the fear of Ptolemy that Earth and all thereon would be disintegrated by a natural rotation, a thing far different from an artificial act. (*5*)

The extraordinary feature of the way in which Copernicus structured his work is that he invokes what were eventually to be the bases for revolutionizing astronomy and physics — the relationship between terrestrial and extra-terrestrial motion, and the infinite (but bounded) expanse of the universe — primarily in order to clear the way for what he feels to be a more *natural* reformulation of the Ptolemaic system. This is expressed in his famous cover letter to the Pope: "Mathematics is for the mathematicians." Thus, aside from the novel features accorded the earth, especially precession of the axis of rotation, the overall scheme is still couched in the language of the Aristotelean orthodoxy, including the retention of epicycles upon epicycles for computational accuracy.

Here is the kernel of the relevancy for our investigation into the case of quantum mechanics in the present period. The so-called "Copernican Revolution" did not in itself redefine or restructure the fundamental defining relationships in nature. Rather it combined established and emerging concepts, which were fundamentally *incoherent* with each other, in a historical period (itself a setting for decaying and developing forces) capable of dialectically explosive interaction with such a hybrid theory. That is precisely why the Copernican universe as a system lasted only decades before it was radically reconceptualized in various ways by Kepler, Descartes, Galileo, and Newton and his contemporaries. And that is what we will argue is the present situation in the case of quantum mechanics.

Before passing to that subject, it remains only for us to briefly summarize the emergence and key features of the Newtonian Universe which superseded the short-lived Copernican era.

The essential question provoked for post-Copernicans by the re-shuffling of the orbs was: what was to be the new basis for properly considering the universe as a system — indeed, did it contain systemic principles? This question increasingly came to focus on the similarity or difference between the attraction of the earth for projectiles and the principle of cohesiveness of the solar system. As indicative of the range of opinions operating, consider the following: Kepler was of the opinion that bodies moved only under the action of some propelling force, and in the case of the earth it was provided by the spoke-like *anima motrix* emanating from the sun; Galileo retained the notion that the natural inertial condition for planets was uniform, circular motion; and Descartes argued that planets deviated from natural rectilinear inertial motion as a result of the corpuscular vortices surrounding all bulk material bodies.

It is not clear exactly when Newton developed the mathematics of the Universal Law of Gravitation, but the key associated ideas were written down by Hooke in 1674:

> (At a future date) I shall explain a System of the World differing in many particulars from any yet known, (and) answering in all things to the common rules of mechanical motions. This depends upon three suppositions: first, that all celestial bodies whatsoever have an attraction or gravitating power towards their own centers...
>
> The second supposition is this: that all bodies whatsoever that are put into a direct and simple motion, will so continue to move forward in a straight line, till they are by some other effectual powers deflected and bent into a motion, describing a circle, ellipse, or some other more compounded curve line. The third supposition is: that these attractive powers are so much the more powerful in operating, by how much the nearer the body wrought upon is to their own centers. (*6*)

It was on the basis of this program (devised independently) that Newton derived the form for the rate of fall of planets toward the sun, the centripetal force, which he combined with Kepler's Third Law of Planetary Motion to deduce the famous inverse square law of universal gravitational attraction.

The essential features of this theory were that it conceived of physical reality as being an aggregate of various sorts of corpuscles possessing *innate* properties which were manifested in pairwise interactions with other corpuscles having some range of similar innate properties. The pairwise reciprocal interaction became the definition of *force*, which in earlier systems had been assigned to prime movers, angels, and other such potent creatures. With the additional *intrinsic* corpuscular property of *mass*, and the advent of the calculus, the universe could be described in terms of how the instantaneous accelerations of all particles altered their positions and velocities. This is how Newton summarized this *mechanical* universe in his *Opticks*:

QM combines established + emerging concepts which are fundamentally incoherent

> All these things being consider'd, it seems probable to me that God in the Beginning form'd Matter in solid, massy, hard, impenetrable, moveable Particles, of such Sizes and Figures, and with such other Properties, and in such Proportion to Space, as most conduced to the End for which he form'd them....And therefore, that Nature may be lasting, the Changes of corporeal Things are to be placed only in the various Separations and new Associations and Motions of these permanent Particles....It seems to me farther, that these Particles have not only an inertial Force, accompanied with such passive Laws of Motion as naturally result from that Force, but also that they are moved by certain active principles, such as is that of Gravity, and that which causes Fermentation, and the Cohesion of Bodies. *(7)*

Contrary to fairy tales today, this system was far from universally accepted as the logical reformulation of the Copernican system, *even by Newton himself. For it was not self-consistent as a corpuscular theory.* A *pure* corpuscular theory, such as was constructed by Descartes in his treatise, *Principles of Philosophy*, involves only dynamical properties of corpuscles, and aims to derive all other properties as secondary. Thus the "action-at-a-distance"/innate property characteristics of Newton's theory in many ways smacked of the a priorism of the Aristolean universe. Newton admitted as much, but took refuge in the tangible results of this method:

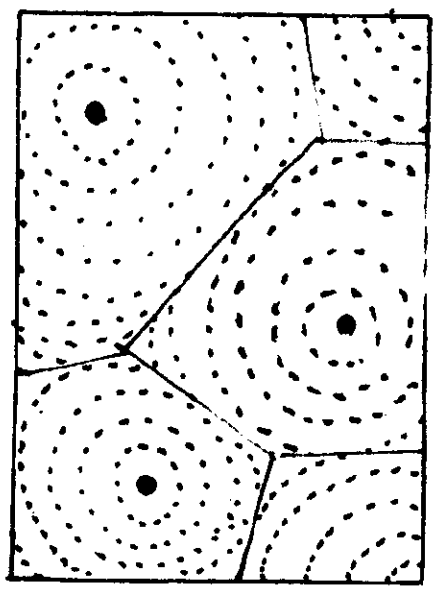
> To tell us that every species of things is endowed with an occult specific quality by which it acts and produces manifest effects is to tell us nothing....But to derive two or three general principles of motion from phenomena, and afterwards to tell us how the properties and actions of all corporeal things follow from these manifest principles, would be a very great step in philosophy, though the causes of those principles were not yet discovered: and therefore I scruple not to propose the principles of motion above mentioned, they being of very general extent, and leave their causes to be found out. *(8)*

His uneasiness with this state of affairs is revealed by the fact that in his *Opticks* he did attempt to find a "deeper" cause for gravity in the existence of a stationary, elastic ethereal medium permeating all of space. When this work led him to the conclusion that, through friction, the universe would eventually run down, he sought a "higher" unifying principle;

> The Deity endures for ever and is everywhere present, and by existing always and everywhere, He constitutes duration and space....Who, being in all places is more able by His will to move the bodies within His boundless uniform sensorium, and thereby to form and reform the parts of the Universe, then we are by our will to move the parts of our body? *(9)*

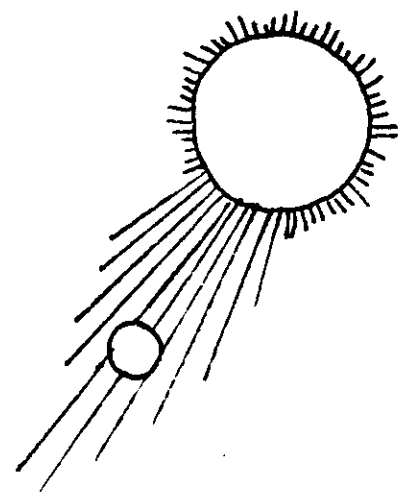
This is not simply a pious mechanist speaking. The spirit of the remarks is Spinozan, and Newton is clearly self-conscious about the limitations of his work. Nonetheless, what has subsequently been presented as the Newtonian Universe is purged of all but its purely reductionist features:

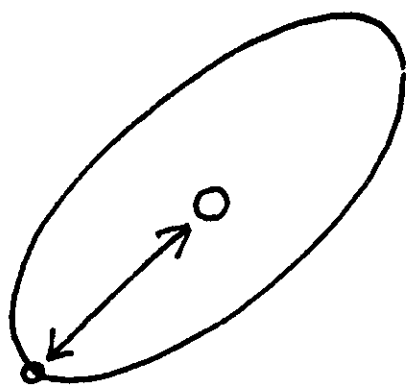
An absolute Euclidean space and independent absolute time as the stage on which at each instant "causes," in the form of pairwise interactions (producing instantaneous accelerations) of corpuscles (or



Descartes' planets were pulled out of natural inertial motion by corpuscular vortices surrounding all bodies.

Kepler's earth moved because of the *anima motrix* emanating from the sun.





Newton's universe moved on the basis of gravitational attraction.

aggregates, which are merely subuniverses) with fixed mass and certain innate properties, precisely predetermine "effects," in the form of altered corpuscular positions and velocities (and, hence, new instantaneous accelerations). The future phenomena of this universe, as described in its appropriate language, are completely determined by any past configuration, and can in principle be measured at any time to within whatever accuracy is desired.

To this classical mechanics must be added the purely wave-like properties associated with the development of 19th century electromagnetic theory. This enlarges the conceptual language, but still preserves the basic feature of deterministic cause-effect chains in space and time.

A far broader significance could have been attached to the field concept derived from electromagnetic phenomena, but Riemann's work in this direction was not internalized in physics. Rather, the mechanical paradigms of fluids — particles, oscillations, and waves — were predominant. The basic difference from earlier classical theories, however, was that instead of instantaneous action at a distance (as in gravity), the electromagnetic effects are propagated in a "retarded" manner and at a finite velocity (speed of light). The distinction is summarized by Einstein and Infeld: "(Maxwell's equations) allow us to increase our knowledge of the field by small steps....In Newton's theory, on the contrary, only big steps connecting distant events are permissible." *(10)*

This then is the view of reality — Classical Physics — that prevailed until the end of the 19th century, when a sharp wave of crises sent it crashing down. Out of the wreckage emerged relativity and quantum mechanics — and the Copernicans and neo-Ptolemies of the 20th century, to whom we now turn our attention.

II. Quantum Theories

> Finite things are;...but the truth of this being is their end.
>
> Hegel, *Science of Logic*

In this section we will briefly summarize the phenomena and associated ideas which led to the development of the various formalized quantum theories, then consider the major interpretive theses, and finally turn to the attempts to construct counter-systems. We will conclude this section with a preliminary critique of these efforts, and then approach them in the next section from the standpoint of the general intellectual and moral climate in Weimar Germany. In the final section, we will take up the question of a unifying perspective.

The usual starting point for the story of quantum mechanics is at the interface of two of the greatest achievements of 19th century classical physics: the correlation of macroscopic thermodynamic properties of bodies with the statistical mechanics of their "underlying" microscopic substrata, and Maxwell's Equations as the mathematical subsumption of all electromagnetic phenomena. These two branches of study had appeared to be all that was necessary in order to construct a viable theory to account for the features of thermal radiation from macroscopic bodies — the so-called "black-body radiation." However, the actualized mathematical theory (the Rayleigh-Jeans Formula) had two crucial, related defects. It predicted practically total energy loss of the radiating body, as such energy was radiated away predominantly at short wavelengths: "the ultraviolet catastrophe." This was, of course, not the case at all experimentally.

The theoretical formulation which brought the predicted radiation spectrum into line with empirical data was provided by Planck in 1900. This was achieved by an alteration of the characteristics of the "phase space" — the momentum vs. position plot representing the classical molecular states of the radiating body — from a continuous space (all allowed values of position and momenta) to a grid with "cells" defined by some "dimension" h, Planck's constant. The physical interpretation which was later developed by Planck was that the idea of continuous exchange of energy had to be abandoned, and replaced by the notion of discrete, indivisible "quanta" of energy, expressed mathematically by $E=h\nu$ where ν is the radiation frequency. In assessing the implications of this, Planck wrote:

> The quantum of action plays a fundamental role in atomic physics, its advent in physical science marks a new epoch, for it contains something unheard of up to that time, something destined radically to transform our physical thinking, which has been based on the concept of continuity of all causal relations since Newton and Leibnitz created the infinitesimal calculus.*(11)*

This quantum hypothesis was successfully utilized by Einstein in 1905 in dealing with another paradoxical (in terms of classical physics) situation: the photoelectric effect. On the basis of the wave theory of electromagnetic radiation it was predicted that the energy of electrons liberated from a metallic surface should be proportional to the intensity of the impinging light, and there should be some small delay between irradiation and electron ejection. This was not the case experimentally. Einstein, however, showed that a corpuscular interpretation of light, i.e., considering it to be "composed" of photons with energy content given by the Planck relation $E=h\nu$ could successfully account for the observed results.

This theory, much more directly than Planck's ear-

Figure 4

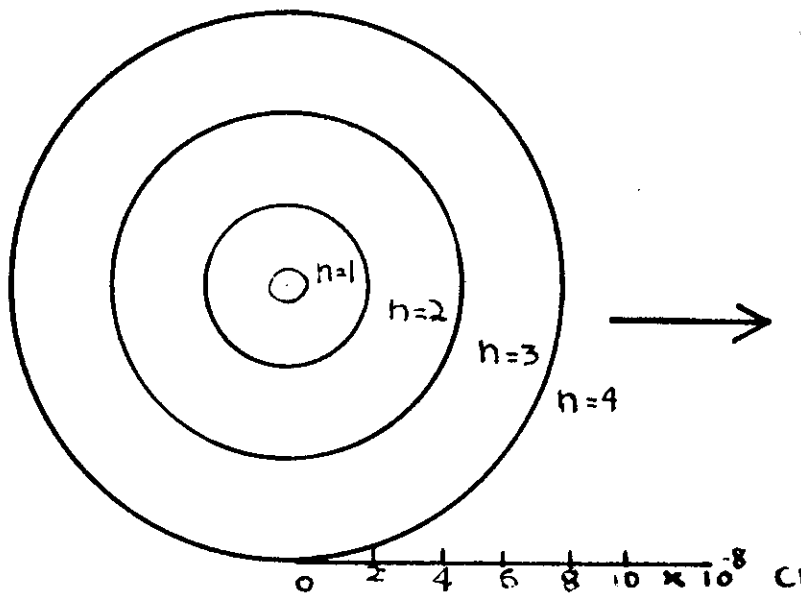


Figure 4. The Bohr Hydrogen atom

Figure 5

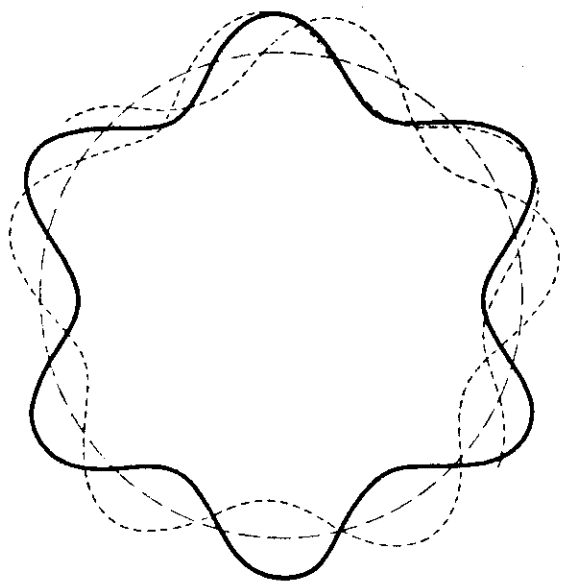


Figure 5. De Broglie Wave for a Circular Electron Orbit

Figure 6

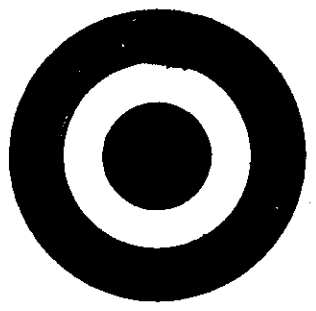


Figure 6. Electron Probability Distribution (Schroedinger) in a Typical Atomic State.

lier work, was not merely novel; it was already *dualistic*. Its form was corpuscular, but its content implied that the corpuscularity was connected to some undulatory or wave-like property since the quantity ν did not merely have units of frequency, but could be made empirically manifest in conjunction with many sorths of "optical" apparatus. In the second decade of the 20th century another phenomenally curious characteristic was established for these photons. Though having zero mass, they could transfer momentum, just like "massy" particles such as the electron. In the case of light, by 1919 its "dual" corpuscular and wave-like properties were well established.

The development of such duality notions for ordinary matter were largely the result of investigations into the problem of atomic structure. The starting point here was the Rutherford model of the atom as a miniature classical solar system, with electrons revolving around the nucleus. Just as in the case of black-body radiation, however, this model plus classical electromagnetism was inconsistent with the fact that atoms only seemed to radiate at a discrete number of frequencies. In fact, classical physics could not explain how an atom could have any stable structure, since it predicted continuous loss of electron energy through radiation.

In the case of the atom, it was Niels Bohr who suggested the necessary restructuring. In 1913 Bohr advanced the first quantum theory of atomic structure in the form of three basic postulates. The first prescribed the allowed atomic electron energies by quantizing the "action," as Planck had done for the classical black-body oscillators. The second and third postulates simply said that the electron does not radiate energy when it is in "allowed" orbits, but does radiate in "jumping" to a lower level. (See Figure 4)

The Bohr atom was subsequently derived from more general principles generated from the standpoint that matter as well as light had dual corpuscular and wave-like properties. This point of view was first forcefully expressed by De Broglie, who succeeded in correlating Bohr's results with the characteristics of matter waves which he had derived. (See Figure 5)

The crowning achievement in this direction came in the late 1920s, with the work of Schroedinger. He was able to extend the optical-mechanical analogues of Hamilton's 19th century formulation of classical mechanics, and incorporate the De Broglie relation, $\lambda = h/p$, to obtain a differential equation for the general wave properties of a micro-entity, the famous Schroedinger equation.

For the purposes of this essay we can ignore later developments (in quantum field theories) and, taking the Schroedinger equation as the seminal formalism of quantum mechanics, restrict ourselves to a discussion of its various interpretations. The basic result is that if one suitably specifies a micro-entity in the usual classical way (e.g., mass, interactions with environment) one derives by solving the differential equation the space and time dependence of an associated complex wave function, ψ ("psi"). Many of the major controversies have focused on the interpretation of this wave function.

Schroedinger's first impulse was to interpret this ψ as something "real," and so he proposed that the amplitude $|\psi^2|$ was just equal to the electronic charge density. However, the solution for a "free" (unconfined) electron led to the charge leaking out into space, which clearly contradicted the localized, fixed charge density of any observed electron. The statistical interpretation, which has since been most widely accepted, was then advanced by Born. He suggested that ψ itself was not a physical variable of a particular system, but rather that it represented the *probability* that some particular system (out of the hypothetical ensemble of all "similarly prepared"

systems) would manifest certain properties (such as position) *if it were experimentally observed*. This implied that there were no longer, as in the case of classical physics, causal relationships uniquely determining the properties of particular micro-entities.

Still, while one might not be able to *predict*, say, the position of a particle, one could still damn well *measure* it at a particular time, with arbitrary accuracy. However, here another essential difference with classical concepts entered. In the latter case one could in principle *simultaneously* measure both particle position and velocity (as vectors) in such a way that the individual or compounded uncertainties in the results were arbitrarily small. The quantum formalism, however, indicated that there were "conjugate" pairs of "observable" properties, such that the product of the respective paired uncertainties could *never* be reduced below about Planck's constant, h. This result has come to be known as the Heisenberg Uncertainty Principle (1927).

Taken together, all of the preceding results, at their appropriate level of explanatory relevance, totally subvert the three main conceptions of classical physics: first, that an isolatable phenomenon has *either* corpuscular or wave-like properties; second, that it is strictly causally determined; and third, that there is continuity in the space-time description of the phenomenon. Let us review why this is so. The first point follows from a multitude of phenomena in which both corpuscular and wave properties must be employed for an adequate description: the photoelectric effect, X-ray-like diffraction patterns of electrons impinging on crystals, Compton scattering of X-rays, etc. The second follows immediately from the Heisenberg Principle, since one can not even specify the earlier and later values of variables which are to be related. The third follows from the statistical interpretation of ψ, since one can in no way "interpolate" between successive observations of a system. This is usually described by saying that the probability distribution associated with a system "collapses" when a measurement is actually made.

That quantum mechanics, *as given*, wrecks classical physics is universally accepted. The mayhem erupts when one asks "what does that mean?" Here, as we indicated at the beginning of the article, several major categories of response may be cited. They are listed, and in turn discussed, below.

1. Quantum mechanics sets the limits on the conceptual coherence with which we can grasp nature. Whether or not new "domains" of phenomena are explored, partially contradictory categories will remain all that is available to describe them.

2. The leading interpretations of quantum mechanics reach unwarranted conclusions which can be rectified by proper reformulation of the interpretations.

3. Quantum mechanics is incomplete. What needs to be done is to more carefully think about the internal structure and external environment of the micro-entity.

The two leading exponents of the first position have been Heisenberg and Bohr. Heisenberg's Principle is essentially subsumed by Bohr's Principle of Complementarity, which has been concisely summarized by one of its critics, Bohm:

> The essential step made by Bohr was then to demonstrate that the laws of the quantum theory permit one consistently to renounce the notion of unique and precisely defined conceptual models in favour of that of complementary pairs of imprecisely defined models. Thus, he was able to prove that the use of complementary pairs of imprecisely defined concepts provides a possible way of discussing the behaviour of matter in the quantum-mechanical domain. But then Bohr's general point of view concerning the principle of complementarity goes further than this. For his assumption that the basic properties of matter can *never* be understood rationally in terms of unique and unambiguous models implies that the use of complementary pairs of imprecisely defined concepts will be necessary for the detailed treatment of every domain that will ever be investigated. Thus, the limitations on our concepts ...are regarded as absolute and final. *(12)*

Bohm has thus registered what is usually the starting point for members of category 3. — the non-justifiability of universalizing the abstracted ideas of the quantum theory. It is precisely such universalization, however, that Heisenberg defends in his book *Physics and Philosophy*:

> Every description of phenomena, of experiments and their results, rests upon language as the only means of communication. The words of this language represent the concepts of daily life, which in the scientific language of physics may be refined to the concepts of classical physics. These concepts are the only tools for an unambiguous communication....
>
> ...It should be noticed at this point that the Copenhagen interpretation of quantum theory is in no way positivistic. For, whereas positivism is based on the sensual perceptions of the observer as the elements of reality, the Copenhagen interpretation regards things and processes which are describable in terms of classical concepts, i.e., the actual, as the foundation of any physical interpretation....any knowledge of the "actual" is ... by its very nature an incomplete knowledge.
>
> ...We realize that the situation of complementarity is not confined to the atomic world alone; we meet it when we reflect about a decision and the motives for our decision or when we have the choice between enjoying music and analyzing its structure. *(13)*

So for Heisenberg we are limited to "the concepts of daily life." Thus, the mental scale on which one would successively place animal intellect, positivism, and dialectics has been slid down a notch, so that ordinary description of the ordinary is the highest state to be attained. In such a world there is an unbridgeable gap between the micro- and macro-domains:

> In the experiments about atomic events we have to do with things and facts, with phenomena that are just as real as any phenomena in daily life. But the atoms or the elementary particles themselves are not as real; they form a world of potentialities or possibilities rather than one of things or facts. *(14)*

But has Herr Heisenberg forgotten that certain commentators had rather more complex views of "daily life"? No, he has heard of them:

> Finally, modern science penetrates into those large areas of our present world in which new doctrines were established only few decades ago as foundations for new and powerful societies. There modern science is confronted both with the content of the doctrines, which go back to European philosophical ideas of the 19th century (Hegel and Marx), and with the phenomenon of uncompromising belief. *(15)*

Now, how does one reply to such rubbish? This brings us directly to grips with the problem posed by the Copenhagen School. *It is a baited trap*. Because it simultaneously embodies, on one hand, the most vulgar *positivist* assumptions about human thought and physical reality despite all disclaimers to the contrary, and, on the other, a devastating "critical experiment" refutation of the Newtonian concept of separate intrinsic and extrinsic properties. The first point is amply made by Herr Heisenberg's babblings. The second has to do with Bohr's crucial insight that

> ...one must regard the measuring apparatus and observed object as a *single indivisible system*, because they are united by an indivisible quantum which connects them during the process of interaction....the combined system consisting of the observing apparatus and the observed system, is, in some sense, a single indivisible entity which cannot correctly be analyzed (even conceptually) into more elementary parts. *(16)*

Before tackling the Copenhagen School, therefore, one has to be clear about its essential features and *all* the possible alternatives. Its theses can be restated as follows:

"Our experience has so far revealed to us two domains, the classical and the quantal. We can encounter phenomena that are more or less confined to one or the other, or which involve coupling between the two. It is only in the purely classical domain that we can formulate a language and an associated model (Newtonian) which coherently relates concept and process. This is, in fact, the only possible language-model construct possible, but it is not appropriate to the quantal domain, which is handled on a case to case basis."

There are two alternatives to this position. The first is that there is some *other* domain which determines the features of the quantum domain and is itself Newtonian. *The second is that there are other modes of cognition and mentation which correspond with relative appropriateness to nature as a whole and which subsume the classical and quantum domains.*

The physicists hostile to the Copenhagen interpretation have almost unanimously pursued only the *first* alternative, and in so doing have overlooked the fact that the Copenhagen doctrine is already fallacious *as it stands* — the Newtonian logic is not at all coherent with process *in general* in the "classical" domain, the "real" world, "everyday" life. For the development of that macro-universe, human society, is demonstrably *negentropic*.

It is the physicists' inability to perceive this that leads them into the quest for yet another "fundamental" sub-stratum and to view fusion power as just another technical option.

It is not important for our purpose here to catalogue all the alternative theoretical approaches which have been pursued. They involve a variety of interpretations of the ψ function and various models for micro-entities in terms of interactions with internal and external structures. And as usual the Soviets, though generally hostile to Copenhagen "positivism," provide no alternative. Consider, for example, the thoughts of a leading Soviet philosopher of science, Svechnikov:

> That part of the cause which lies in the internal nature of a thing constitutes its internal basis. That part of the cause which lies in the external nature of the acting object is the external basis. The task of science is to reveal the inner basis of change of a thing.
>
> ...The problem...of the interaction of an instrument and an atomic particle is an involved epistemological problem. It is apparently impossible to resolve it without an analysis of the actual process of interaction between the instrument and the atomic entity....a complicated philosophical and physical undertaking.
>
> ...But this dependence of the behaviour of a microparticle on its inner properties and external actions is what constitutes the *essence of the dialectico-materialist conception of causality.* (emphasis added) *(17)*

Or the scientists Lifshits and Pyatigorsky:

> The fundamentally important thing is that in quantum mechanics, as in classical mechanics, any change in the state of a system is determined by external actions operating on the system; it is precisely due to these external actions that the system goes into one or another state. *(18)*

Herr Heisenberg need not have worried! — The Soviets are not yet beyond Kant. However, they have grasped one aspect of the "thing-in-itself" problem, which permits a serious criticism of Heisenberg's emphasis on the uncertainty principle:

> Notwithstanding the complementarity principle, Heisenberg identifies a microparticle with the mass point of classical mechanics; in other words, he leaves the stand of complementarity and takes the viewpoint of the interpretation of wave-particle

> duality which regards the corpuscular properties of a particle as something intrinsic to the particle. This indicates a logical inconsistency of the Copenhagen approach to quantum mechanics. *(19)*

Criticisms of this sort have been the basis for most of the counter-theories (which ascribe alternative "underlying" or "interactive" — or both — properties to the "non-classical" particle) advanced in the past four decades. Before we briefly summarize some of the representative types let us touch briefly on the approaches of two of the most consistent critics, Schroedinger and Einstein.

Schroedinger seems to have stuck to the position that the wave character is primary and the corpuscular, secondary. In this view, the real object is the "wave packet" which by its local concentration can approximate corpuscular properties. However, this approach was unable to adequately account for the many instances of discrete valuedness of process parameters. Einstein, about whom more later, strangely insisted on the retention of the idea of corpuscular identity and real trajectory, even within the context of his work on field theory. We will see that this was close to Planck's view and was probably also motivated by the desire to refute Heisenberg on his own ground. This approach was, however, also problematic.

In terms of other alternative formulations we will cite only two types, the *pure field* and the *field-corpuscular*. The former is derived from Einstein and Schroedinger's ideas in its basic construct, the corpuscular aspect as the result of high wave concentration. This was elaborated in De Broglie's theory (developed in the 1950s after early discouragement in the late 1920s) of the "double solution," in which a new wave equation has a "singular" and a "continuum" solution, which account, respectively, for corpuscular and statistical properties. This approach naturally generated the idea of a non-linear (solutions are not additive as in the Schroedinger equation) wave equation to account for the singular (particle-like) solutions.

An early example of the field-corpuscular type was proposed by Bohm. In his model, the corpuscular properties are taken for granted and statistical behavior of the microentity is then accounted for by a combination of interactions with ψ, now assumed to be a real (but unknown) force field, and some underlying subquantum level. This approach and De Broglie's are merged in most of the present theories. Here particulate qualities result from hypothesized field singularities, and quantum effects arise from interactions with sub-microentities existing at "deeper" levels, or with the fluctuations of associated "vacuum" fields.

The plausibility of "hidden" variables arising from the dynamics of subquantum levels has in itself been a major controversy for two decades. The central issue has revolved around a famous proof by Von Neumann in his axiomatization of quantum mechanics that the existence of such hidden variables would contradict the basic quantum mechanical computational apparatus, which had already been empirically demonstrated to be correct at its level of appropriate application. In response, the adherents of determinism pointed out that Von Neumann's argument didn't close the issue since he had assumed the universal validity of quantum mechanical formalism in constructing his proof, which was just the point in question. This set off a round of generalizations of counter theories on both sides which lasted until the present, and dragged the whole problem further into the realm of pure mathematical formalism.

The key point about the various alternative quantum theories is that they differ more in mathematical *formalism* than in *logic* from Newton's theory of gravity in his *Opticks*, i.e., they are essentially Newtonian. Their proliferation has all the features of the compounding of epicycles in the Ptolemaic and Copernican tables. Moreover, most of the theories are transparently artificial ("hidden variables"); this usually takes the form of gross asymmetries in the roles of theoretical concepts — for example, Lande's scheme in which electrons are pure particles and photons are pure waves. Heisenberg has taken great delight in pointing out that just such machinations were undertaken to preserve absolute space in the face of the theory of special relativity. To search for an "improved" theory under such conditions is thus to play the role of a would-be neo-Aristotelean (e.g., Tycho Brahe) in the aftermath of Copernicus.

A Reassessment

To go forward one must stand back and see what comes out of a reassessment of the Copenhagen ideas. In this regard, two of Schroedinger's commentaries are useful. (Both the pioneers Schroedinger and De Broglie were among the earliest to express dissatisfaction with the theory as being final). Schroedinger's differences with the Copenhagen interpretation include the following:

> I fully agree that the uncertainty relation has nothing to do with incomplete knowledge. It does reduce the amount of information attainable about a particle as compared with views held previously. The conclusion is that these views were wrong and we must give them up. We must not believe that the completer description they demanded about what is really going on in the physical world is conceivable, but in practice unobtainable. This would mean clinging to the old view. Still, it does not necessarily follow that we must give up speaking and thinking in terms of what is really going on in the physical world....Physics takes its start from everyday experience, which it continues by more subtle

experimental refutation of uncertainty principle
Mossbauer radiation

> means. It remains akin to it, does not transcend it generically; it cannot enter into another realm. Discoveries in physics cannot in themselves — so I believe —have the authority of forcing us to put an end to the habit of picturing the physical world as a reality. *(20)*

Schroedinger provided one example of the sort of absurdity that could result if one categorically denied the meaning of the existence of objective reality during periods when "one" wasn't actively investigating it. He concocted a "gedanken" (in thought) experiment in which a Geiger counter circuit is hooked up to the detonator circuit of an explosive charge placed on a box in which there is a cat. The passage of a charged particle through the Geiger counter is described by a wave function containing terms associated with the cat both alive and blown to bits. Einstein provided the punch line: "Is the state of the cat to be created only when a physicist investigates the situation at some definite time?"

The problem with arguing about the know-ability of the detailed history of the micro-entity per se is Schroedinger's other point:

> I believe the situation is this. We have taken over from previous theory the idea of a particle and all the technical language concerning it. This idea is inadequate. It constantly drives our mind to ask for information which has obviously no significance. Its imaginative structure exhibits features which are alien to the real particle. An adequate picture must not trouble us with this disquieting urge; it must be incapable of picturing more than there is; it must refuse any further addition....The particle, as we shall see, is not an identifiable individual. It may indeed well be that no individual entity can be conceived which would answer the requirements of the adequate picture stated above. *(21)*

Schroedinger reached this conclusion on the basis of the (Fermi-Dirac) statistics of electron quantum states which were developed in the 1930s. The core of the idea is that the electron is not a thing; it is a set of properties, a state, which depends on some defining totality.

There is a recent experimental result *(22)* which is worth citing in regard to the ideas above. In a series of "coincidence" experiments with ^{57}Fe Mossbauer radiation, two interesting results were noted with respect to the uncertainty product $\Delta E \cdot \Delta t$ of the detected radiation. First, there is strong reason to believe that the uncertainty in radiation energy is due to its measurement time in the apparatus as a whole; second, if the radiation satisfies Einstein's photo-electric effect description of the photon as instantaneously emitted in one place and instantaneously absorbed at the surface, then the uncertainty principle is violated in the Mossbauer case. This indicated that the Mossbauer radiation is continuously emitted and absorbed over a short, but finite, time interval. Both of these results are highly suggestive of the definition of the "photon state" by the process as a whole.

This also coheres with recent re-evaluations, as in "semi-classical" theory, of the question of whether the photon is of the same fundamental structural importance as the particles of quantized mass. See, for example, "The Concept of the Photon," by M. O. Scully and M. Sargent III in *Physics Today*, March 1972. Schroedinger's limitation consists of the unilateral imposition of properties on *all* quanta from the external world, itself composed of quanta!

Schroedinger's comments indicate that the two *essential* characteristics of an alternative approach are that there is an objective character to reality even when someone or something else is more immediately intervening in it (although the coherence can be conceptualized only through such intervention), and that the most localized manifestations of that reality have no definable, continuous self-identity *in themselves*, but in conjunction with the totality of physical reality, and in a wide range of mediating contexts, do manifest important invariance characteristics. This is the *inverse* of Heisenberg's approach, in which the defined particles capriciously evade our scrutiny. So far, so good. But now the problem is how to *realize* these properties with an approach different from the anti-Copenhagen theories just summarized.

This is equivalent to the problem of going beyond the Kantian ontology and the associated predicates, "underlying" and "external". For in seeking to restore an ontological principle the theoretical physicists have assumed that it must be grounded in those predicates. But this view raises the spectre of Zeno's paradox on the scale of the whole universe. Indeed, one of the best known anti-Copenhagen manifestoes admits as much in its conclusions:

> **To know this reality better,... we must continue our scientific researches, with the objective of finding more and more of the things into which matter in the process of becoming can be analysed approximately, of studying in a better and better approximation the relationships between these things and of discovering in greater and greater detail what are the limitations of the applicability of each specific set of concepts and laws. The essential character of scientific research is, then, that it moves towards the absolute by studying the relative, in its inexhaustible multiplicity and diversity. *(23)***

Thus, from the Copenhagen frying pan into the "bad-infinity" fire.

Only one concept remains after these two "alternatives": a unified universe in which ontology and predication are self-reflexively co-determined. In which the "micro" and "macro" domains are mutually reflective, rather than "in interaction." This is the concept which we take up in the concluding section.

First, to further clarify what is at stake, we return to the origins of the quantum theory and re-examine them in the context of the intellectual anarchy of post World War I Europe.

III. Weimar Culture and Quantum Theory

It has been shown that phenomena inexplicable in terms of the Newtonian system led to the rise of a new acausal physics, a physics of Copenhagen antimonies. There can be little doubt that this development was sufficiently determined by the experimental results and the *general* limitations of prevailing thought in physics. But one can not overlook the specific fact that very few individuals were willing, let alone able, to struggle to transcend the situation when it arose.

Quantum mechanics was therefore a theory which not only arrived in the third decade of the 20th century; it was *appropriate* to the period of its inception. It is therefore lawful that the place and time where it was most fervently greeted as ushering in a "new era" was Weimar Germany. From there, the hegemony of the uncertainty principle was to radiate to the world.

How was it that the quantum theory and its featured acausal elements could largely be grown on German soil? It had been Germany that in the second half of the 19th century and through World War I had set the pace in most fields of rigorous scientific investigation, and had actively organized its scientific activity in pioneering industrial laboratories, state supported universities and research institutes, and technical schools. Science and technology had been decisive in developing German industry, such as chemicals, and the scientists had been assigned an important role in war-related research. As late as June 1918, when mathematician Felix Klein and representatives of government and industry met to discuss future funding of science, there seeemed to be no reason to doubt that science would continue to play a highly esteemed role in German society. That was to abruptly change with the total defeat suffered in the fall of that year.

Within a year of the war's disastrous end, strong intellectual currents had developed which were to challenge the form, content, and social role of science. What is of special interest in the development of this tendency is the effect which it had on the German physicists. Since the origins of the quantum theory in systematically formulated terms date to about 1924, one can investigate what influences outside of physics were shaping physicists' thinking in the pre-1924 period.

The general situation has been summarized by a historian of the atomic scientists:

> ...in the aftermath of Germany's defeat the dominant intellectual tendency in the Weimar academic world was a neo-romantic, existentialist "philosophy of life" (*Lebensphilosophie* — M.L.) reveling in crises and characterized by antagonism toward analytical rationality generally and implicitly or explicitly, the scientist was the whipping boy to the incessant exhortations to spiritual renewal, while the concept — or the mere word — "causality" symbolized all that was odious in the scientific enterprise. *(24)*

Certainly a number of leading scientists saw German society as increasingly fostering the irrational. Thus, Planck:

> ...the belief in miracles in the most various forms — occultism, spiritualism, theosophy...penetrates wide circles of the public,...despite the stubborn defensive efforts directed against if from the scientific side. *(25)*

A 1905 cartoon reveals that "naturalism" had already infected German intellectuals.

"*She*: You are a German professor, n'est-ce pas? *He*: Did you recognize this by the manner in which I express myself? *She*: No, by your hunter's shirt."

And Einstein found it "peculiarly ironical that many people believe that in the theory of relativity one may find support for the anti-rationalistic tendency of our days"*(26)*. This threat seemed real enough in social terms to the German mathematicians that in 1920 they formed the *Mathematischer Reichsverband* as a defense organization to protect the place of mathematics in the schools. Their fears were well grounded, since by 1924 the roles of mathematics and science were substantially reduced in secondary schools. In response to the Prussian education ministry's plan of 1924 Felix Klein said bluntly, "This school reform signifies for our educational system the end of a century of science."

What was the emerging ideology which motivated such "reforms" and which was the ultimate threat to the persona of the German scientist? Here we need not cite all the tendencies and anti-rationalist ideas, since there is one work which captures (and in practice, motivated) their spirit as well as many of their themes: Spengler's *Decline of the West*. First published in 1918, it had wide and decisive effect among German intellectuals as an expression of *Lebensphilosophie* in general, and as an attack on the Western tradition in science in particular.

Spengler's work basically combines a "refutation" of the possibility of objective knowledge along with the grossest objectivist illusions about the organismic cycles of human civilizations. Out of this amalgam emerges an extreme relativist position on culture and science:

> There simply are no conceptions other than anthropomorphic conceptions ... so it is certainly with every physical theory.... *(27)*

Nevertheless, Spengler does see a unifying characteristic of Western, or as he calls it, "Faustian" science: the causality principle *(Kausalitaetsprinzip)*. It is this principle, in opposition to the more fundamental principle of *Schicksal* (destiny) that is central to man's fate:

> The one requires us to dismember, the other to create, and therein lies the relation of destiny to life and causality to death. *(28)*

The outcome of the struggle is not in doubt as "weary after its striving, the Western science returns to its spiritual home."

This is the appropriate place to take up what the actual situation in physics was in the early 1920s. Firstly, the effects Spengler probably had in mind when he talked of "crisis" in physics, related to relativity and statistical thermodynamics, had in no way in their formulation contradicted the definitions, coherence, or causality relations of physical theory. There was one prominent scientist, Franz Exner, who had even before 1918 postulated that the appearance of statistical laws in physics would be shown to be related to spontaneous behavior of microentities. But the only phenomena he referred to in his major work were Brownian motion and radioactivity. In fact, the various quantum effects which were described earlier, and which were embodied in the Bohr atom as the "old" quantum theory, did not in themselves provoke widespread discussion of the causality principle. It was not until 1923 that Max Born called for a new conceptual approach to resolve the physical problems.

Nevertheless, by that time a significant number of leading physicists had already drastically (and publicly) shifted their positions on what physics was all about. The case of Wilhelm Wien illustrates the first phase of the transition — redefinition of the motivation and social role of physics. In an early period his views had been conventionally utilitarian, stressing the important mutual stimulation of physics and technology, and denigrating any influences of philosophy. However, by 1920 Wien is able to explain to the Prussian Academy of Sciences that physical research reflects "an inner need of the human spirit." And by 1925 he is prepared to argue that "the results of research are worthless if they are not taken up into the culture."

This justification of science in terms of some life force relentlessly driving on research was in fact almost unanimously adopted by the scientist of the 1920s, and is a clear index of their need to accommodate themselves to the Spenglerian environment. The choice was constantly posed between cold intellect and warm, organismic feeling. Even a formerly hard-boiled logical empiricist, Reichenbach, was moved to explain that when one does physics it is "like the wish to form a community with others."

Capitulation

What is even more striking, however, is the capitulation to the Spengler doctrine within the very content of physics. Here the issue was not vague feelings, but the cutting edge of the causality principle. What was at stake, as noted by the physicists of the time, was not simply a particular (if crucial) feature of physical theory, but its very cogniscibility. As Reichenbach stated in 1920, "if there is cognition of nature, then the principle of causality is valid, for, without this principle, cognition, by its very meaning, is impossible."*(29)* Numbers of physicists were in full agreement with Reichenbach's corollary and yet repudiated causality — without pausing to reconsider whether or not the concept itself needed rethinking.

In surveying the positions of the earliest converts to the acausal doctrine, one can make a basic distinction between two types. While they are both basically Spenglerian, one at least also contains the germ of

some unitary alternative conceptualization. As examples of the "pure" Spenglerian sort, one can note the cases of Von Mises, Schottky, and Nernst. First Von Mises *(30)* :

> August 1920: —We see now in our time, how a new and simply enormous field of phenomena, ... is drawn into the realm of causal explanations.
> *September 1921* — ...other, perfectly definite ... considerations are destined to relieve or to supplement the rigid causal structure of the classical theory.

Evidence: The general statistical results of physical experiments. Change of *evidence* from August 1920 to September 1921: *None*.

Schottky's recantation (1921) was predicated on the fact that the laws of interaction of atoms with radiation were not *yet* known and so "state variables of the field theory ... no longer possess any significance whatsoever for scientific research."*(31)* End of proof.

Nernst, in the same year, bases himself on a similarly flimsy and artificial construct. Arguing that fluctuations at the micro-level might be due to fluctuations in a hypothetical ether, Nerst argues that the old system breaks down because "then we come to an infinitely extended system, in the face of which our laws of thought fail." There are several ironies here. One is that Nernst's model had already been developed, without crisis, in a purely classical form by Boltzmann in the late 1890s. It is also a forerunner of the sort of picture employed by later *anti*-Copenhagen theorists. Clearly there are other forces responsible for failing thought.

The cases of Schroedinger and Weyl are more complex. The former had been a student and colleague of Exner, and so before the war had already been exposed to acausal ideas. In 1922 in his inaugural address at Zurich he acknowledged Exner's role and stressed that causality on the micro level would create an intolerable duality in natural law. He also stressed a theme which we noted in the last section, but which at this time was invested with more provocative imagery: "This duplication of the laws of nature reminds one too much of the animistic duplication of natural *objects* for me to believe in its tenability."*(32)* In any case, his loyalties to coherence ultimately overcame any Spenglerian colorations, as evidenced by his insistence on relating mathematical and physical concepts in his contribution to quantum formalism, and his later criticisms of the status of the theory.

Weyl's ideas in this period are perhaps the most fascinating. As one of the few physicists who had actively engaged Einstein's general field theory, he was uniquely situated to intervene in the developing controversy. However, the best he could muster was a semi-mystical mixture of Riemann field theoretical and Liebnitzian quantum concepts:

> ...finally and above all, it is the essence of the continuum that it cannot be grasped as a rigid existing thing, but only as something which is in the act of an inwardly directed unending process of becoming ... (but) there remains ... room for autonomous decisions, causally absolutely independent of one another, whose locus I consider to be the elementary quanta of matter. *(33)*

So instead of a coherent alternative development based on a unified field theoretical approach, another stream is added to the torrent of existentialism and vitalism.

What was mustered in response to this drift in the early 1920s? Surprisingly, damn little. The two key figures in this regard were Planck and Einstein, but the latter steered clear of public polemics. Thus the main burden fell to Planck, who did not hesitate to assert the most extreme formulation and defense of causality: "For causality is ... transcendental, it is entirely independent of the constitution of the inquiring intellect, indeed it would retain its significance even in the complete absence of a knowing subject." A principled and courageous conservatism for the time, but nonetheless a forecast of the anti-Copenhagen sterility.

Einstein, in contrast, devoted his efforts to developing a deterministic theory based on his earlier work on general relativity. Since the years 1907-09 Einstein's aim had been to develop a "field theory with quantum solutions, not a quantum 'mechanics'." But in 1929 he had to report that "The postulate of general relativity as well as the hypothesis of the unified structure of physical space, or the field, were supposed to serve as guideposts in this search. There the goal stands, unattained. *And there was scarcely a fellow physicist to be found who shared my hope of arriving by this route at a deeper understanding of reality."(34)* (Emphasis added)

By the middle of the 1920s the issues had to be resolved in the face of more or less polished theories, with the development of Heisenberg's matrix mechanics in 1925 and Schroedinger's wave mechanics in 1926. (A brief biographical note on Heisenberg is in order, to cap off the discussion on the role of ideology. When he began the study of theoretical physics at Munich in 1920, Heisenberg had already been a member of one of the radical rightist youth groups devoted to *Lebensphilosophie* for several years. The next two years were divided between intensive study and an intense political activity whose *exact nature* Heisenberg omits in his memoirs.)

With Born's development of the statistical interpretation and Heisenberg's public campaign for the finality of the uncertainty principle in the later 1920s, the way was clear for the final assimilation of the "new" physics into the "avant-garde" of fascist Weimar culture.

The case of Weimar shows that the immediate conditions in Germany gave positive impetus to the idea

The Double-Slit Experiment:

The double slit experiment is often invoked as one of the simplest illustrations of the transition from classical to quantal behavior. A beam of particles, typically electrons, is emitted from a source (such as a hot wire) and after passing through an initial collimating slit is directed toward a plate with two holes in it. Beyond the plate is a screen which contains some sort of particle detector such as a photographic emulsion or an electron multiplier. When the beam energy is large enough so that the De Broglie wavelength is small compared to the slit dimensions, a simple beam "shadow" is obtained (see I).

FIG. A1

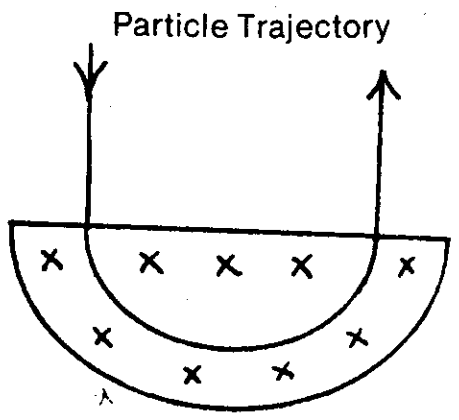
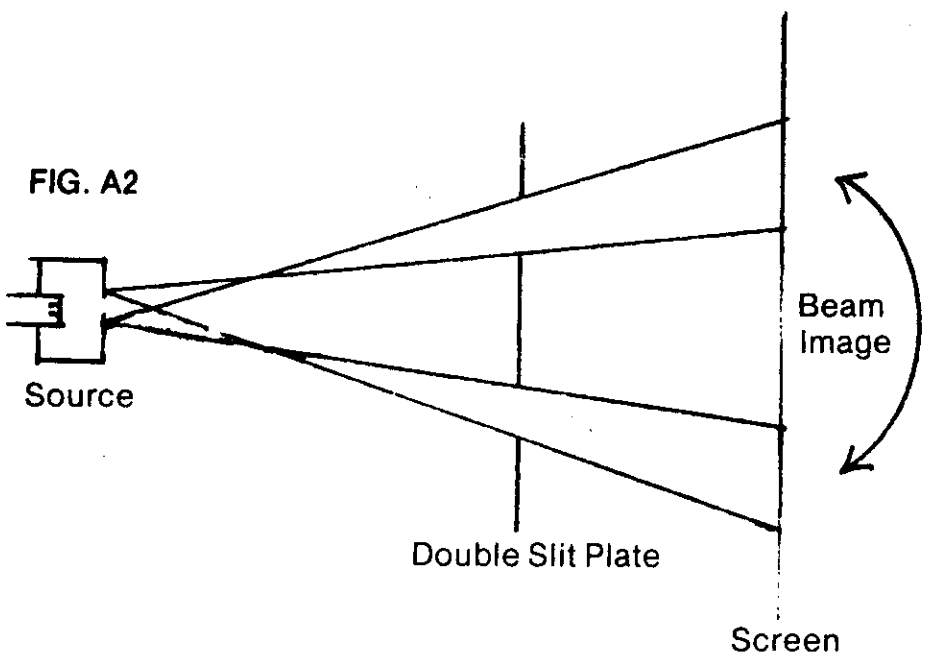


FIG. A2



However, when "wavelength" and slit dimensions are comparable (for example, a "thermal" neutron with energy of about 0.025 volts or a 50 volt electron have wavelengths comparable to the spacing of atoms in a solid or liquid, which is about one Angstrom or 10^{-8} cm.)the signal intensity at the detector shows the spatial variations characteristic of wave interference phenomena, even when only one electron at a time is being detected (see II). Both the classical and quantal aspects of these phenomena can be subsumed, however, by a self-reflexive conception of physical process.

I. *The classical-corpuscular picture.* The essential metaphysical conception is that of *inertia* : the "innately" discrete body moves itself so as to trace out a trajectory which is parallel to the straight lines defined by an absolute Euclidean reference frame which forever characterizes the geometry of the universe. It is assumed that earth based material bodies can be constructed and aligned according to Euclidean prescriptions so as to replicate the contours of the absolute frame.

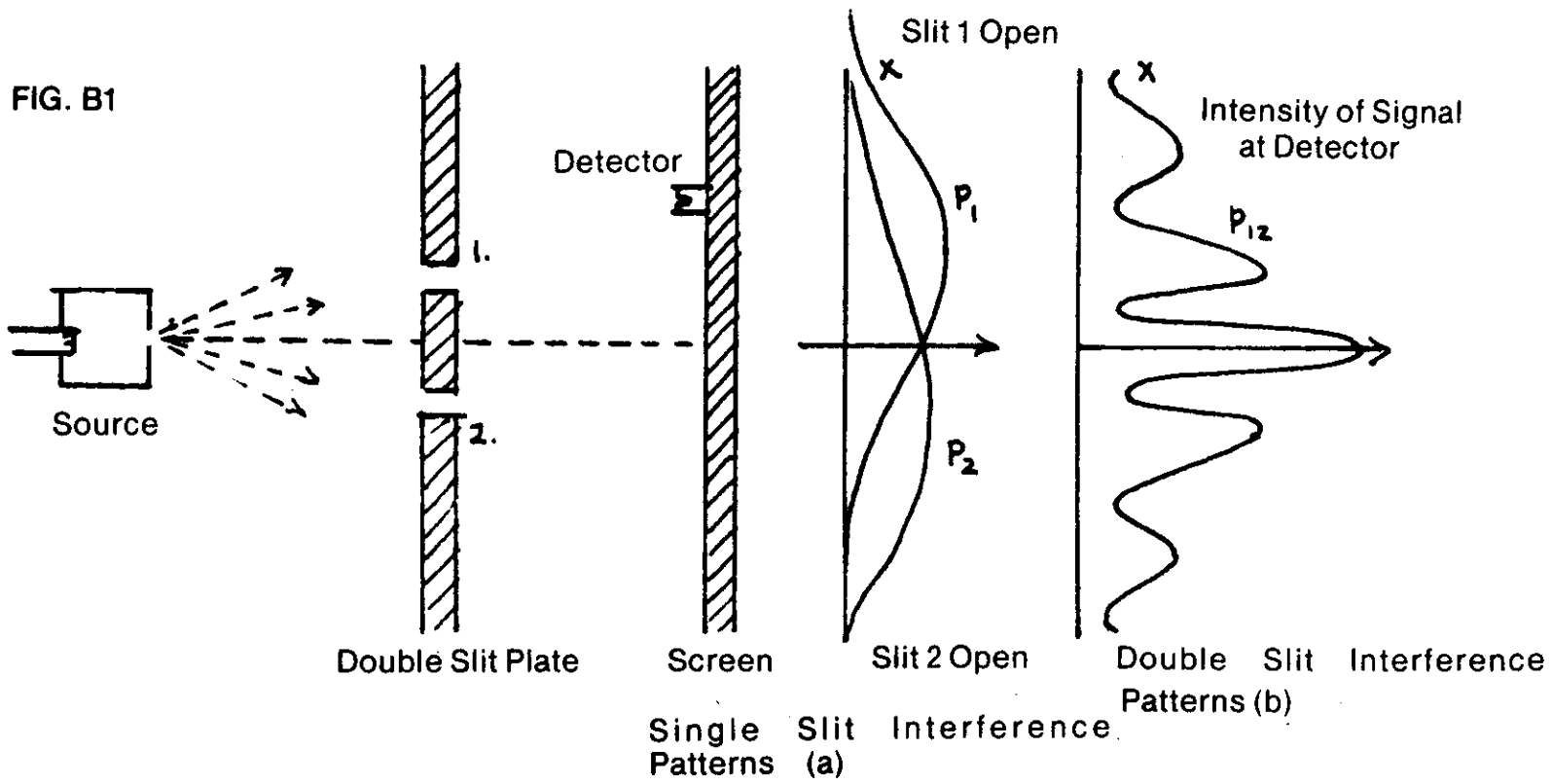
Using such experimental instruments, the inertial trajectory can be demonstrated empirically for a wide range of macro- and micro-entities (of sufficiently high energy) in "free" or in field-permeating space, as in Figure A1. The double slit pattern is in this case the mere projection of non-intercepted corpuscular rays (Figure A2).

II. *The quantum-wave picture.* The essential metaphysical assumption is that there is associated with the micro-entity a "guiding," but otherwise non-physical, wave which interferes with itself; the consequences of such interference are most noticeable when the De Broglie wavelength is comparable to the slit system dimensions. The only observed manifestations of discreteness-localization occur at the "points" of particle emission and at the screen.

It is further assumed that there is no empirical basis for demonstrating the reality of the psi wave or the particle trajectory; one is not even permitted to conceptualize the particle as *physically* passing through the slit system, let alone a particular slit. Sufficient verification of the metaphysics is thought to be provided by the experimental fact that the two slit screen pattern (Figure B1(b)) is not the simple superposition of single slit patterns obtained when one of the slits is covered Figure B1(a).

III. *A proto-unified conception.* The particle is characterized by certain invariances which are defined on a space-time

FIG. B1



The Classical, Quantal, and Proto-Unified Approaches

manifold which it co-determines with matter as a whole. Its localization and trajectory in space-time are thus neither simply "innate" nor externally "determined". Rather, it moves on infinitesimal space-time geodesics (paths) which it participates in defining, which become the basis for subsequent trajectory development.

Over a wide range of particle energies and micro- or macro-environments, however, the intrinsically *non-differentiable* (in the sense of the calculus) trajectory "segments" can merge into the smooth, continuous path of the mythological inertial particle. But conceptually this is now a channel actively carved out in a space-time manifold, which itself is defined by the actual physical process.

Under conditions of more direct mediation or "confinement" (that is, when co-relation of the micro-entity and some micro-environment becomes important) characterized by energy values such that the particle's De Broglie wavelength (now considered to be only a useful scalar reference) is comparable to characteristic "environment" dimensions, the situation is fundamentally altered. In this case, there is a new transfinite structure which still "projects" free electron discreteness properties, but within more complex space-time dynamics. Under such conditions, any "inertial" description becomes meaningless.

Applying these ideas to the double slit experiment, we can roughly divide the process into two domains: the quasi-inertial "free", and the "mediated-transfinite," as depicted in Figure C1. In *both* domains the particle retains its essential quantal properties (or else one is back to Schroedinger's original problem of the electron "leaking" away) but with differences between regions which must be the subject of further theoretical elaboration. Thus, the concept of trajectory must be re-conceptualized (as above), rather than abandoned.

In the region near the slits the situation is not fundamentally different from an atomic state, except that in a bound state the total range of moment to moment structures is generally more limited. In both cases, the key concept is that of self-reflexive process generating meta-invariant moments. A model of such process is schematized (and thus unavoidably abstracted from reality) in Figure C2.

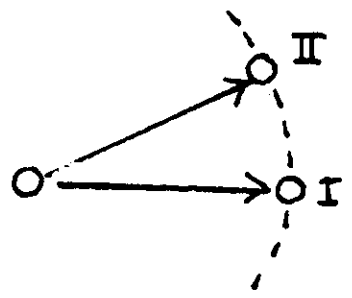
From this standpoint, the double slit pattern would not be expected to be the linear sum of single slit patterns. Obviously, the trajectory itself cannot be "photographed" without introducing a totally new physical situation, but this in no way makes less real the process that takes place in the absence of such operations. (The regions near the source and screen also "interfere" with the trajectory but are less important than the slit effects in determining the overall results due to their non-periodicity.)

A biological analogy to the problem is provided by the organ-typical cell which maintains its essential structural integrity and function even as it is non-deterministically displaced (during its lifetime) as progressive differentiation of organs occurs during embryo-genesis. Its motion provides a paradigm of the complex, but real quantum trajectory.

FIG. C2

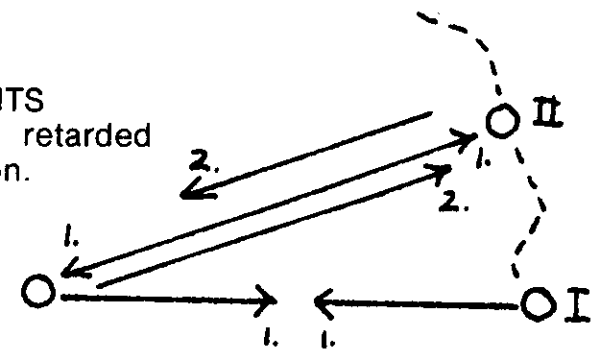
(a)

NEWTON'S MOMENTS
Fixed sources and action at a distance; a mechanical trajectory.



(b)

MAXWELL'S MOMENTS
Fixed sources but retarded fields; a wave equation.



(c)

SELF REFLEXIVE MOMENTS
Field and particle are mutual sources in a unified structure.

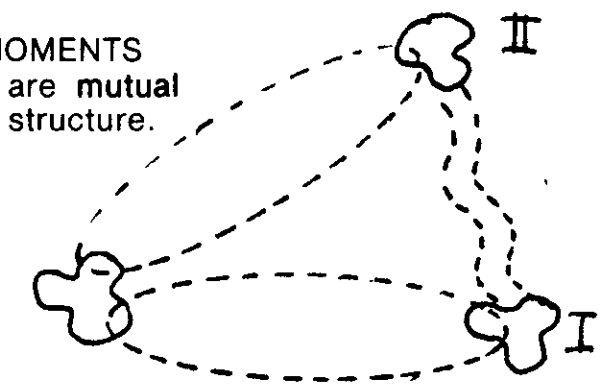
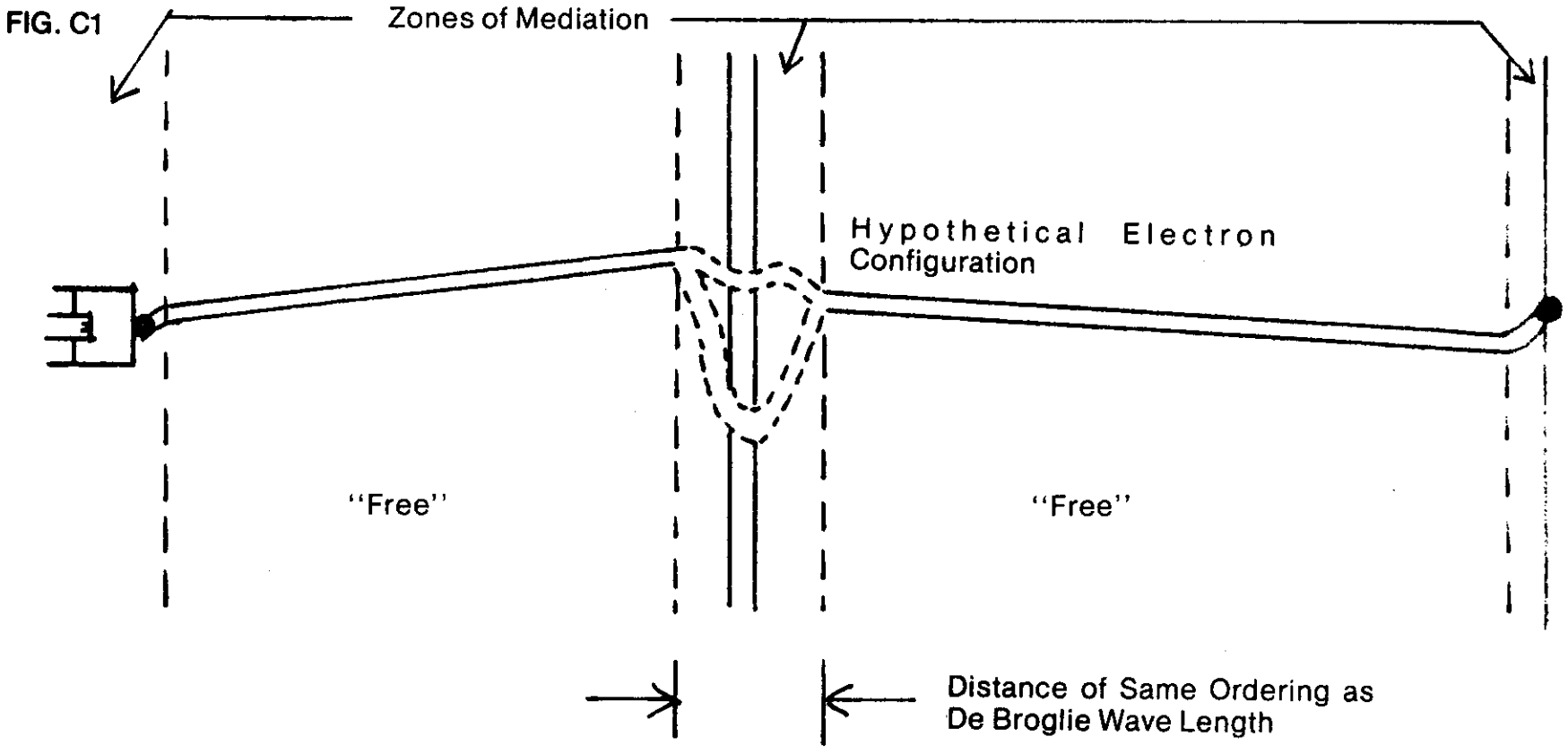


FIG. C1



that most of nature was fundamentally un-knowable, since irrational. However, the severe German pathology should not be interpreted as being "responsible" for quantum mechanics. Rather, it stimulated a more sensitive *anticipation* of the theory in Germany than elsewhere. Elsewhere, the *average* level of neurosis and wretched ignorance of unifying conceptions was quite sufficient to sustain the hegemony of Copenhagen ideas, or largely sterile counter-schemes. That is largely the case today, as minus the "magic" of the 1920s and 1930s, various models are cranked out in physics factories.

The vaunted "revolution in physics" in the 20th century ultimately boils down to the growth of some new functional predicates of nature made possible by the quantum algorithms and associated technologies (e.g., the transistor). Thus, it really is merely the continuation of the original scientific and industrial revolutions into a mystified micro-domain in the era of capitalist degeneration.

Had the conditions been realized for a truly revolutionary and unified conceptualization of nature, there would also have been no Auschwitz. But now, almost five decades later, with Einstein's project still largely ignored, the "quality" of life — rather than its coherence — is again an issue. And once more, the "communitarians" warn of the evils of science, while the Nazi doctors and the astrologists explain the coming death camps at Ivy League graduation ceremonies.

We return now in the concluding section to a reconsideration of quantum theory, and an introduction to theoretical work which grasps the problem.

IV. The Way Forward

> Thus both the Appearing and the Essential World are each the independent whole of Existence. One was to have been only reflected Existence, and the other only immediate Existence; but each continues itself in the other, and consequently in itself is the identity of these two moments.
>
> Hegel, *Science of Logic*

In this concluding section, the basic features of quantum phenomena are resummarized and placed within the context of the phenomenology of matter in general. The basic features suggested are then shown to arise in a natural way within a conceptual scheme which has been proposed recently to eliminate the present contradictions in physical theory.

In the earlier sections on physical theory, the following three new features of the quantum theory (relative to classical physics) were indicated:

> 1. *Indivisibility of the Quantum of Action.* This indivisibility implies that transitions between stationary states are in some sense discrete. Thus, it has no meaning to say that a system passes through a continuous series of intermediate states.
>
> 2. *Wave-Particle Duality of the Properties of Matter.* Under different experimental conditions, matter behaves more like a wave or more like a particle, but always, in certain ways, like both together.
>
> 3. *Properties of Matter as Statistically Revealed Potentialities.* Every physical situation is now characterized by a wave function. This wave function is not directly related to the *actual* properties of an individual object, event, or process. Rather, it has to be thought of as a description of the *potentialities* within the physical situation. ...in quantum theory, it has no meaning to discuss the actual state of a system apart from the whole set of experimental conditions which are essential to *actualize* this state. *(35)*

There is a fourth feature which is important not only as an additional break with classical theory, but because it also violates a basic feature of Einstein's relativistic framework. This is the category of "non-causal" correlations, which is known in the physics literature as the Paradox of Einstein, Podolsky, and Rosen (EPR). Put simply, it is that in a typical quantum phenomenon, correlated events (such as the *simultaneous* determination of the states of widely separated decay particles) occur which *cannot* be explained on the basis of "signals" being propagated, as causal agents, at less than the speed of light. This feature signifies the irrevocable break with all pre-quantum ideas of the relationship of events in nature, and the incompleteness of relativity theory. Thus, one is again presented with the choice of arguing "it can't be," or searching for the system of which it is a logical feature.

Surely we are now on confusing and unfamiliar ground. For what has been left behind are two of the most deeply ingrained ideas of modern human thought: First, that the world is *ultimately* populated with various entities — particles, waves, fields — which, despite even the most violent and abrupt alterations of their features, are still, through some inherent "essence" continuously and forever identical with themselves; and second, that process in nature is ultimately reducible to a complex of strings of events that are serialized in a definite way, whether classically or relativistically.

How can one begin to take leave of such ideas, which have been held by all but a handful of the billions of people who have lived in modern societies? To begin, consider three apparently different situations and see what one can make of them: an electron, a person, a rock. Can one speak of "essence" or "cause and effect" as ultimate realities for any of them?

The electron: It has already been shown on several grounds that "it" cannot be considered identical with itself over time, even as part of a lone hydrogen atom in some cranny of the universe. And should it ever meet up with a positron it can be "converted" to photons — which can be absorbed by some other "particle" — which can lose some part of its energy in a collision, etc., so that "it" ends up effectively and

untraceably dispersed over the whole universe.

The skeptic at this point will say "All right, the electron is weird, but it's a pure quantum entity. But I know who I am, and what causes me to act and think." The skeptic has already betrayed his ignorance of other opinions, such as those of Marx and Hegel, but he is still eligible for the short course. When he says he knows who he is, does he mean his material substrate, his appearance, or his ideas — or all of them? In terms of the substrate, does he mean last year's cells? Sorry, they're gone. Well then, the electrons. Sorry, we just discussed them. All right then, the whole damn thing, the face in the mirror. That's like the rock, which is treated next, so hold on — but in the meantime, note that any organism or sub-level exhibits *systematic* behavior, i.e., it can't be analyzed in terms of substructures. That leaves thought. And only various leaps, mediated through social activity, can account for the passage from new-born baby to what you are now — ask Koehler. (If your thinking is rigid and apparently continuous, it still really has the creative features, but you're mentally ill — i.e., confined to merely endlessly reproducing bourgeois ideology.)

So the whole case, determining the fate of billions, comes down to the rock. Now think of the toughest, most durable rock you've ever taken home as a paper weight. Smoothed down by eons, compact, no powers. Is that not finally the icon for a desperate humanity, the awful "thing-in-itself?"

But what's that it's sitting on? The pedestal? .... The pedestal! Close the cathedral doors, remove the masses, and get the rock strung up with some invisible wire or the whole thing is blown. Otherwise it will be seen that if the rock is in this universe it is co-joined in defining that universe and in non-classical process in a million ways. It's only a relatively more durable mirage (and then only for non-relativistic observers) than any of the others. Then the truth will be out: the universe is one indivisible self-developing process (and it's no blasphemy to send the rock to the fusion torch).

Can this phenomenology be expressed in compact, coherent conceptual terms? And can we get down to doing physics with it? If the answer is yes, this is the way forward. What is wanted is a theoretical apparatus which can account for the *relative* durability (in perception) of certain micro — and macro — "objects", the quantum effects, and the relativistic domain — but which indicates how these concepts mutually limit and de-limit each other, and subsumes them as limiting cases of a fundamentally indivisible universe.

The fundamental aberration of practically all the quantum theorists which has blocked the wanted advance arises from their dismal ignorance of (or hostility to) the centuries long struggle in philosophy, originating in the modern period with Ficino and culminating in Hegel and Marx, to comprehend the *transfinite*. Had they internalized that struggle they would have been able to locate the new 19th and 20th century physical data within the tradition in mathematical physics of Riemann and Cantor.

Then the kernel of the matter would be universally recognized: Discreteness (quantization) is not proof of static, self-sufficient, self-continuing identity — if it were it would then be proof of universal incoherence (viz. Zeno, Kant) and, hence, disproof of the existence of the holder of that view. Discreteness, rather, is the appropriate localized form-expression of a universe which is not a mere continuum, but instead is a self-reflexive multi-continuum.

This latter point is conceptually illuminated by the Cantorian infinitude of transfinite levels and by the limitations of the theory of general relativity. Phenomenologically, the discrete "thing" is itself of transfinite integrity, but as an intersection or intermediation of other transfinite levels. This is most readily seen in the example of the role of individual psychological structures in mediating between social and physiological processes as well as having their own dynamics.

The key concept is thus that of the particular which is both historically determining as well as determined, the expression of and agency for free energy generation. This has been discussed previously on the level of economics and ecology in terms of production and speciation spaces. (See "Human Ecology and the Science of Socialist Planning" by E. Lerner in the Aug.-Sept. 1974 *Campaigner*.)

In this regard there is a striking similarity in one respect between the electron and man. As we find them now, they are embedded within process development in relatively fixed gross structural forms. However, their participation in free energy generation involves higher levels of organization which must *ultimately* alter structure at their level. For example, the process of expanded reproduction at the *social* level is associated with the yet to be understood manifold of physico-chemical correlates of the advancing levels of *individual* mentation. For the electron, there is the yet to be achieved theoretical unification of electromagnetism and gravitation as a historically evolved relationship. The discrete entity is thus both the "fossil" resultant of — as well as the active agency for — expanded auto-differentiation of the totality.

(Another way of putting this is that the discrete micro-entity expresses itself both in 1. differentially metastable states of non-analytical holism, and 2. mediated processes of hyper-geometric evolution. These aspects must be "enfolded" in an appropriate theory.

(For an example of the first (holism) in biology, the reader is referred to the discussion by the biologist Weiss on the non-reductionist relationship between any organism and its sub-systems, with the obvious implications which this must have for eco-systemic dynamics. *(36)* Work on the second has been done by the French mathematician Thom, whose advances in differential topology provide mathematical models for various types of biological discontinuities or branchings.

(In physics one of the most accessible examples is provided by nuclear structure; all extrapolations of component nucleon behavior to composite models break down at some point. Bohm has also recently provided a useful heurism: the hologram represents a whole unto a whole, or all point into each point, non-affine transformation (in this case for a vector field) rather than the point to point (or small area into small area) transformation properties of the lens.*(37)* Clearly, we must think more deeply about the concept of the particle as a "source" compared to how that term is commonly used in classical and quantum field theories.)

That is, the "elementary" particles, whether stable or unstable, must be non-simple topological structures as intersections of complex, unified fields. The particle is the representative discrete expression of matter as a whole during some appropriate parametric (e.g., space-time) interval of that whole, and in turn alters that whole in all its structural concomitants. The physical universe is self-reflexive or it is nothing.

First Step

Thus, there is no contradiction between manifest discrete structure and changing laws of the universe (e.g., changing values of the universal constants). What needs to be specified is how the various particle populations developed in conjunction with primordial field manifolds, which in turn altered the overall structure, including the very conditions for particle stabilization, and expanded process development. Such considerations provide the skeleton for a unification of cosmological and all mediating sub-levels down to the microscopic.

For the case immediately at hand, the first step will *likely* involve the unification of gravitation and electromagnetism in the context of the macro-stability of the electron. An advanced theory (e.g. extended to the proton and neutron) will in turn immediately provide a coherent conception of integrality of higher level structures such as the hydrogen atom, and more importantly, the nucleus. The reflexive structural changes produced in the directly mediated "particle" (even in the H atom there can be only a "projected" electron) will provide the conceptions adequate to subsume the quantum behavior and theory.

In terms of quantum mechanics and micro-physics, then, the "paradoxes" arising from the new restriction of the old energy continuum to discrete values, and the new smearing out of the old discrete particle over some continuum interval, are merely the mischief to be expected when the real world is mapped onto the artificial universe comprised of the unstructured point and the unilinear continuum.

It has been pointed out by Bunge that the vaunted Uncertainty Principle is not where the "uncertainty" basically resides, but in fact indicates how to better specify or narrow the range of uncertainty of some dynamical variable. *(38)* Probabilistic spreads are a feature of the quantum formalism in general, given that the micro-entity is mathematically described by an "interaction" Hamiltonian in the discrete Hilbert space.

Certainty and uncertainty co-exist in this context in the form of the conceptually contradictory theories proposed to account for the properties of the micro-entity. For example, one can obtain the Schroedinger Equation for the electron from models as widely divergent as 1. a purely stochastic dynamic variable approach, *(39)* or 2. well-defined structures derived from relativistic classical fields. One is tempted to argue that they cancel by symmetry.

What is wanted to supercede the uncertainty notions is a more advanced conception of how the co-mingling of levels produces qualitatively different new levels. (For example, the three cases of a "free" proton and electron, a hydrogen atom, and a neutron.) This would also clarify the relative importance or non-importance in various contexts of experimental intervention, and so eliminate the vicious operationalism which pictures the micro-entity as being "conjured up" by the physicist.

Only with a more advanced overall conception can a theory be produced which differentiates itself by suggesting an appropriate "crucial experiment" for testing its validity. This is the objective to which must be applied the combined, sustained efforts of at least general relativity theorists and differential topologists.

The corollary to the discussion above is that the normal concept of energy in terms of Hamiltonians, mass, etc. is a secondary, derivative (though hardly epiphenomenal) aspect of overall physical process. Within a universe of unalterable laws total energy would be fixed by the relationship $E=mc^2$ for mass-ive particles and $E=h\nu$ for mass-less ones, but this is not the case if, say, c and h are variable. For the case of a fixed universe, immortal interactions or forces of various sorts would only cause changes in m or ν

which conserve total energy content as expressed by those interactions. But $E=mc^2$ follows from the special relativistic world — a straightforward four dimensional manifold — without inquiring into internal (or total) structure, and also expresses properties that are unrelated to "deeper" (or higher) structure, since ν is an index for a simple space rotation group which is merely transformed into a similar group even under inelastic scattering.

But it must be just the elaborated micro-structure which is connected to universal order and supra-energetic measures of development of that order. Thus, not only is the Second Law of Thermodynamics invalid in the broadest contexts, but so is the First Law!

The question of "causality", which we have seen as pivotal in the 1920s, must likewise be subsumed under the more advanced general conditions for coherence. Since these cannot ultimately be reduced to any purely formal representation, there can be no *a priori* formulations of the type "if A, then B," since the very materialization of "A" means that there is no longer an "A-like" universe. There can only be particular circumstances under which the meta-invariance of a sub-universe is such that it closely approximates the mere extrapolation of the circumstances of the original world-moment in a simply continuous or approximately self-reproducing way. From this vantage point, the difference between the positions of Heisenberg and Planck on the causality principle is analogous to the difference between Senators Mondale and Goldwater on Rockefeller's fascist programs.

In this respect quantum mechanics is not essentially different from classical mechanics in terms of the predictable correlation of final conditions and initial conditions. (This is where unreformed determinists, such as the Soviets, usually breathe a sigh of relief and stop.) The point, however, is that in either case the internal aspects of the "initial-final" correlation must be epistemologically consistent with the longer term change in the general structure of the universe as a whole and all sub-processes. Or, to paraphrase Hegel, discreteness in general is the crucial manifestation of a universe in which no *particular* form of discreteness is *absolutely* preserved.

When that is understood, the squabbles between the mechanists (whether classical determinists or quantum spontaneists) will give way to the dialectical comprehension of the interplay between freedom and necessity throughout the whole history and expanse of the negentropic universe.

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Footnotes:

1. See, for example, any standard text on atomic structure or solid-state physics.
2. Pribram, page 39.
3. Durkheim, pages 487, 491.
4. *German Ideology*, "Theses on Feuerbach."
5. Kuhn, page 150.
6. Kuhn, page 254.
7. Kuhn, page 260.
8. Mason, page 204.
9. Mason, pages 206, 207.
10. Einstein and Infeld, page 54.
11. Cited in Svechnikov, page 137.
12. Bohm, pages 93-94.
13. Heisenberg, pages 144, 179.
14. Heisenberg, page 186.
15. Heisenberg, page 203.
16. As restated by Bohm, page 89.
17. Svechnikov, pages 166, 170, 209.
18. Svechnikov, page 209.
19. Svechnikov, pages 184-185.
20. Schroedinger, pages 203-204.
21. Schroedinger, pages 204-205.
22. Tefft.
23. Bohm, page 170.
24. Forman, page 4.
25. Forman, page 12.
26. Forman, page 13.
27. Forman, page 32.
28. Forman, page 33.
29. Forman, page 65.
30. Forman, pages 81, 82.
31. Forman, page 83.
32. Forman, page 88.
33. Forman, page 78.
34. Forman, page 95.
35. Bohm (book).
36. Weiss.
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38. Bunge.
39. Nelson.