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Unity is Consistency, Coherence, and Solidarity of Parts

One of our main concerns at this conference is the unity of science. This is an urgent problem caused by the extreme specialisation of the contemporary studies. Necessary communication is thereby hampered, the weakly connected efforts do not essentially contribute to a meaningful understanding of life, common goals get lost of sight. Thus we are, unfortunately, not in the position to simply state the unity of science; we rather feel the desideratum, urging us to postulate it as a necessary task. But is this necessity met by a correspondig possibility? Reliable sciences are and will always be very complicated fields of inquiry simply because of the vast complexity of their respective objects. So what can we have in mind by postulating the unity of this manifoldness, collectively called science? My answer to this questions states: Unity is consistence, coherence, and solidarity of parts. Let us now shortly discuss these three characters, one after another.

1. Consistency, the logical aspect of the unity concept.

All the diverse elements of any branch of science have to be mutually consistent for the reason that contractions were logically destructive. This maxim, demanding the exclusion of antinomies, may sound like a truism not worth mentioning. Yet it is nowadays challenged by an influential doctrine, called dialectic method, which claims and boasts to be able to comprise logical contradictions. Some strong motivations behind this mode of thought are easy to understand: This our world contains many antagonisms of force and expression. We very often encounter diverse tendencies and conceptions which oppose and deny each other, and sometimes even we scientists find ourselves involved in one or the other of these factions. There are repulsions, astronomical or societal revolutions, struggles, quarrels, wars; one man works and talks against his neighbour, one group combats and insults the other; there is no position without some opposition, no impressive thesis without some momentous antithesis. So there are, indeed, contradictions in the real world. But this fact does not justify contradiction within an intellectual system. 'Every kingdom divided against itself goes to ruin, and no town, no household that is divided

against itself can stand.' This remark applies to a spiritual or intellectual household no less than to a political or economical one. In case of mutually adverse arguments, one camp at least is wrong so far as contradicting some valid point of its opponent. One party can never be, of course, in the possession of the total truth; and there can be also no verity in the idea of a truth inherent to a selfcontradicting concertual whole. Allowing for inconsistence within a living body of thought is bound to permit all arbitrary falsehood .

This is an important consequence of the well known theorem, called ex falso quodlibet, which says that any implication $A \to B$ whose premise A happens to be false, is a logically true statement whatever B. (By stating $A \to B$, I commit myself to propose B in case A is true, and in this case only; so otherwise there is no commitment at all and the implication is true by definition.) Thus by admitting any one false proposition A we could be forced to approve of each wilfully, even perversely, chosen conclusion B. The only way out is either to withdraw, or to stop clear thinking. The second route is, of course, not in accordance with the scientific spirit, and it is likely to motivate unthoughtful, violent activities which are of no good. The total result may be an example for self-fulfilling prophecy with all its vanity.

It is the task of mathematics to explore sharp ideas possible by being clearly self-consistent. This intellectual exercise is quite indispensable for each genuine science, and is more than some means only: A system is scientific insofar as of mathematical shape. This qualification was and is appreciated by most erudite men since ancient times until now, and all over the world; and the most practical men frequently agree. The combination of mathematical theory with unbiased observation has created the by far most efficient means of mankind in its hard (and so often futile) labours for worthwile, truthful knowledge. The origin and growth of mathematics is closely connected with the empirical sciences, yet its interior truth is self-contained and cannot be affected by physical or social experiences. There is thus a strange beauty in mathematics somehow analogous to that of music yet with less emotional impetus in favour of more intellectual organization. Mathematics has, as a fine art of high sophistication, great dignity of its own and is, as an

honest art of strong solidity, extremely useful too. What is the nature or the reason of this proverbial certainty?

Theoretical mathematics is a derivative of logic proper, which treats the compositions of sentences with regard to their truth preserving qualities; connecting links are the logic of equality, the logic of attributes leading to the basic theory of sets, and the logic of relations leading to the basic theory of functions. The contemporary concept of mathematics is no longer confined to its ancient topics with their curious diversity: numbers and figures, followed by stars and harmonics. Mathematics is now, rather, an utmost comprehensive and lucidly unifying science. We know of and esteem many mathematical structures which are neither of an arithmetical or geometrical nor of an astronomical or musical nature. A famous example, important for physics and chemistry too, is the concept of an algebraic group, closely related with the exact idea of symmetry. We may try to extend the four traditional fields so as to comprise all of our algebra and topology, or mathematical physics and fine arts, respectively. There remain structures, though, which do not fit properly, an important example being the order relation which gives rise to transfinite induction, analysis of the continuum, lattice theory. Mathmatics is the science of exactly defined forms and structures established by a corporation of unambiguous propositions that do not contain interior nor mutual contradictions. A statement system of that kind is what constitutes mathematical possibility. Mathematically necessary is therefore a connection if and only if its contradictory negation would imply some self-contradiction.

Thus we see that theoretical mathematics is not an axiomatic science, if the concept of axiom is taken traditionally to mean a logical or ontological principle: a statement so evident and so elementary that proving it is neither necessary nor possible. What contemporary mathematicians call an 'axiom' is nothing but a particle of some basic definition, called 'axiom system'; and this is not an assertive affirmation, but an appelative convention. In mathematics proper we are not concerned with the truth of the premise A nor of the conclusion B, but with that of the implication $A \rightarrow B$. We may call $A \rightarrow B$ a 'relative' reformulation of the 'absolute' statment B by explicitly relating it to the 'absolute' hypothesis A; and

then we can say that mathematics studies the proofs for relative statements only. This kind of truth is, in case of an entirely explicit formulation, independent of the validity of assertive axioms, and in this sense it is 'absolute' indeed.

In the more complex cases, scientists will try to erect a deductive system in order to maintain close intellectual control. This excellent method has been invented by mathematicians and logicians like Euclid and Aristotle. The logical stringency of each step in a deduction is nothing else than its mathematical necessity which we have shortly envisaged. Several deductive systems may be interconnected, and thus formally unified, simply by conjuction of their basic as well as subsequent definitions and logical consequences.

Such an additive integration is , to be sure, not enough. We need knowledge and understanding of the more intimate relations between the branches of science. But when trying to conceive a unified universe we should not forget the crucial lesson which logic and mathematics has taught us by Russell's antinomy: The 'set of all sets' comprises the selfcontradicting set of all those sets which do not contain themselves, because this set could neither contain nor not contain itself. If sets (or attributes or properties) are accepted as elements of reality as they should, we have thus to admit the irreality of the 'absolute universe' of all objects. The concept of universe is not easy, that of a 'total universe' probably an impossible one. Cosmology in the strictly universal sense of this term seems to be a doubtful part of metaphysics more than a reliable science.

2. Coherence, the ontological aspect of the unity concept.

A substantial unification of science is achieved to that degree in which we succeed to realize the relations between the diverse parts of the universe and the different aspects of reality. All mankind has frequently experienced interconnections of various kinds between related and apparently unrelated phenomena. People have always tended to believe in more or less hidden influences and more or less obvious analogies. There have been various conjectures to make sense of the fragmentary letters, written in a

foreign language, which we call men, things, events, r laws. Some of these guesses can now be proven, others are more or less likely or fitting, many can be refuted. A typical example of the latter kind, a misleading presumption, is astrology; another example is materialism, the contemporary mental drug for isolated and uniformed populations. Both are able to trigger and do damp actions by inducing some kind of thinking, but this is based on scientific claims of no authenticity. We have to resist the seducing music of simplistic explanations which are so quick in spelling out the enigmae of this magnificent and cruel and strange world.

On the other hand, there are such studies and teachings which are truly called scientific. Their veracity stems from their readiness to look closely at the real facts regardless of any interests. A great example has been given by the observing astronomer Tycho Brahe together with the theoretical astronomer Johannes Kepler, who cooperated in that remarkable city of Prague about 365 years ago, thereby achieving a revolutionary, extremely important and valid result.

Today we have a lot of results of similar kind, but many of us and our contemporaries wonder whether enough is known of the sublime harmonies (and the shrill disharmonies) over and above or within these matters. I feel there are now some important insights in view: The objects of science have disclosed many similarities, repetitions, correlations which allowed, ever and again, for partially unifying conceptualizations. There has been a remarkable progress in this respect. It turned out, for example, that all chemical matter in the vast astrophysical universe is composed of the same kinds of molecules, atoms, and their particles, and these interact with the same kinds of force-fields. Acoustics became a part of mechanics, optics and magnetodynamics became parts of electrodynamics, crystallography and chemistry including biochemistry became parts of atomic physics, which is fundamental for astronomy and geonomy too. All these branches of natural science are closely interwoven by five basic systems: relativity theory, quantum theory, particle theory, field theory, and thermodynamics. How these are interrelated is not clear but there seems to be a strong tendency towards a unified physics. This is the science of the most general features or structures of empirical reality so far as it shows up objectively in the framework of space and time. These general structures are usually called 'laws of nature'. They possess fascinating symmetries leading to conservations, most of which are strangely broken to a

higher or lesser degree. The reason of these curiosities is unknown until now.

It is not enough to contemplate these abstract structures only; we cannot overlook the more concrete objects we have to deal with. They are less symmetric and harder to apprehend than the eternal ideas crossing in them, but this difficulty does not deprive them of their own dignity. The concrete beings are at least as important and beautiful as the abstract structures are which constitute the possible essences of their real existences. Those sciences or arts which undertake to tell us the stories of the moving and changing entities, their members and their societies, may be summarized under the general heading of history. There is, or should be, a complex hierarchy and interplay of historical studies according to the order of the many things, events, relations that have to be disclosed and interpreted.

The fundamental distinction between physics and history is not of a regional but of a categorical quality. The same topic may be treated either way: in historical terms as well as in physical ones, and most topics need both. This overlap of perspectives is especially important in the cosmographical fields of knowledge: astronomy, biology, geography, and anthropology. Their respective objects are very different in size or structure, indeed, yet we should not overlook their profound relationships. Most if not all organisms on earth are apparently kinsmen to each other in a rather literal sense: they are members of one great genealogical tree which is rooted in the preorganic field. The present gap between the organic and the inorganic regions of our globe is not one of metaphysical distinction. It is a gradual difference only, which must not be confused with the discrepancy between the sacred and the profane, or the like. Life is a many-leveled notion whose range of application is not, and should not, be confined to organisms. Spontaneous motion of self-stabilizing beings is found in the preorganic domain too. We may distinguish between four main levels of life: dynamical life, represented by currents and shared by all quick bodies; vegetative life, represented by plants and shared by all organisms; sensitive life, represented by prehuman animals and shared by men too; intellectual life represented by humans and shared by their organizations. Typical examples of currents are streams, stars, flames beams. Characteristic for all life is a well-shaped dynamic allowing for internal stability and spontaneous motion; distinctive of organisms is growth programmed by digital information; characteristic

or spiritual in history

for animals is running and feeling; and distinctive of humans is speaking and reasoning. Each level contains those below and attempts transitions to that immediately above. There is, everywhere, a great number and hierachy of wholes which exceed the sums of their respective parts.

This lesson has been dramatically exemplified by the quantum mechanical paradox of Einstein, Podolsky & Rosen. It belongs to the modern version of atomism, called quantum theory, a fundamental kinemato-stochastics, which seems to be strictly valid for the smallest portions of enrgy called (elementary) particles, and probably for all ponderable matter also. Einstein, Podolsky & Rosen demonstrated in 1935 that this state of affairs is consistent with laws of quantum theory: (1.) A composite system $\Sigma = \Sigma_I \cdot \Sigma_{II}$ is in a maximally defined state $\Psi = \sum_\alpha \Psi_I^\alpha \otimes \Psi_{II}^\alpha$. (2.) this state is in every respect stationary; (3.) the constituents Σ_I and Σ_{II} are spatially and dynamically separated; (4.) neither Σ_I nor Σ_{II} is in a maximally defined state. This strange possibility is due to the nonaristotelean ontology of quantum theory: each of the genuine, well-defined properties of a thing is in most cases neither fully actualized nor utterly absent, but partially actual in the manner of a quantitative potentiality or propensity for being. The quantity measuring this strange propensity is a complex number $\Psi = \Phi + i\chi$ called probability amplitude: its absolute square $|\Psi|^2 = \Phi^2 + \chi^2$ is a number between 0 and 1, interpreted as a conditional probability to find this property realized in case of an appropriate measurement. In the paradoxical states of Einstein, Podolsky & Rosen, the properties of one constituent Σ_I are potentially correlated to those of the other constituents Σ_{II} in such a close manner that no property of a single constituent is fully realized. (None of the probabilities has the maximal value 1 denoting certainty.) The physical system Σ is a whole unity which can be divided, by force, into its parts Σ_I and Σ_{II}. But the proprietal state Ψ of Σ is an indivisible unity which cannot be separated intellectually into separate parts 'Ψ_I' and 'Ψ_{II}', in spite of the fact that the physical parts Σ_I and Σ_{II} are spatially and dynamically separated.

This remarkable individuality of atomic phenomena is not restricted to the smallest particles only; it applies also — according to quantum theory — to unities like molecules or organisms in an extremely interesting manner. The dynamical objectivity combined with the informational subjectivity of this basic concept Ψ of a

probability amplitude, is another noteworthy feature of quantum theory which demands a better analysis and interpretation than we are able to give today. Its result will be a radical change in our ways of speaking and thinking. Physics and epistemology will become essentially identical. I feel that the force of a molecule, the entelechy of an organism, the soul of an animal, the spirit of a man do possess collecting qualities somehow related to those we have encountered in quantum theory, which is a profoundly general science indeed. It does not contain any antinomy. But there are startling paradoxes in view of the usual ontology with its strict positiveness regarding the instantaneous properties of physical objects, with its strict separation of matter and mind, of the objective and the subjective. That sharp localization of the kinematical variables of dynamical systems has been disproved by the atomic physics of our century with its fundamental particle-wave dualism; and it has been positively overcome by the systematic quantum theory of Bohr, Heisenberg, Schrödinger, Dirac, von Neumann and others. We know thus of a surprising dualism between the basic discreteness of ponderable matter and the basic continuity of physical reality, whatever these terms may mean. Any clear interpretation of this dualism will yield some holistic unitarism, which Bohr's notion of physical 'complementarity' tries to point at in a somehow vague manner. This atomistic unitarism will be of a truly pluralistic and harmonic nature, thus avoiding the errors of a totalitarian holism with its ultimate monotony.

Another profound unity established by modern physics is that of relativity theory as illustrated by Einstein's twin paradox: A moving body becomes older at a lower pace than a resting one of the same kind. Space and time are thus intimately connected to the point of mutual convertibility at a fixed rate, which is measured by the velocity of light in vacuo. This new unity is one inseparable field called space-time. It is a real object of empirical studies, inspired by the mathematical theory of relativity and gravitation, and leading to the recent developments of astrophysical cosmology. The equivalence of space with time implies that of physical energy with dynamical inertia. (This should not be confused with the notions of 'physical matter' or its hypothetical quantity called 'mass' which has no accurate equivalent in modern physics.)

The close connection between three-dimensional space and one-

dimensional time does not contradict some peculiarities of the temporal dimension, which are called causality and irreversibility. The former means that one body cannot really occupy two different places of space at the same instance of time (though the reverse is quite well possible); and the latter says that time behaves (contrary to space) like a directed flow which never turns, nor returns. This structure reminds us of the historical aspect of reality.

Yes, we know of unity even above physics and history. Some of its elements are: space and time, a causal order of patterns, relative reality of parts within individual complexes, irreversibility, so called evolution, and the essential identity of spiritual mind with ponderable matter. Most of these points have been already mentioned. Now I should like to stress the fundamental continuity or affinity between prehumans and humans, between the intellectual man and the intelligible world. All are fine creatures of the same wise founder. There is nothing like a metaphysical hiatus between 'dead matter' on one side and a 'divine soul' on the other. The notion of massive matter is an empirical approximation to reality but not a basic explanation of reality; and the radical disruption of the epistemological subject from its physical object is an ontological misconception of the 17th century too. More convincing theories are given by modern authors like Whitehead or Russell. There is a number of hints indicating that ponderable matter as comprehended by quantum theory is neither alien to, nor essentially different from spiritual mind. Two of the mediating notions are form and information: All matter is eventually of an algebraic and informative nature, and all mind is intimately joined with the pure forms of energy and momentum as known to us from molecular physics, chemistry, biology, or physiology. Matter is not stuff, and the spiritual is not ghostly. To be sure: mind and matter are not flatly the same, their relation is not a symmetrical one. The former corresponds closer to the intensive, the latter more to the extensive dimensions of the world. We have thus to distinguish, but we must not separate. There will be some basic coherence. As most of it is hidden, until now, in the abysses of our subconscious life, any meaningful attempt to guess or to speculate about its structure and nature has to be a bold undertaking. But private or esoteric inspiration is, though badly needed, no substitute for public reasoning. There is, consequently, much work to be done in future.

One of the strongest arguments for the essential sameness of matter and mind is provided by that grandiose phenomenon which has been called 'evolution'. The theories summarized by this notion are well proven and of extreme importance. But I should like to remark that the traditional word is unfortunately a misleading one. It suggests the idea of some predetermined unfolding of a complex and completely detailed germ. This view, however, is contrary to our biochemical experience in all cases which transcend the mere reproduction of a biological species. What 'evolution' really points at, is a process of involution, an immense gain of integrated complexity that leads to verily new structures and beings. An essential feature of most involutions is fusion or exchange. Its importance is impressively demonstrated by the expensive and complicated efforts invested in sexuality. There are and were involutions within the preorganic domain leading to the realm of organisms and their populations, involutions within this realm leading to the kingdom of animals and their flocks, involutions within this kingdom leading to the republic of men and their hordes, tribes, nations, civilizations, and tending to one global supercivilization (which should not be confused with the barbaric aesthetism dreaming of a 'superman').

An important theorem in this context reminds us of the fact that the notions of continuity and difference are, though somehow contrary to each other, not really contradictory: they are mutually consistent. A continuous change can very well lead into a novel domain, the boundary of which may or may not be sharply localized. There must have been, for example, a continuous chain or network of generations connecting the nonflying reptiles with the full-fledged birds. Similar considerations apply to the gradual origin of conscious mind out of premental life, as it manifests itself in the growth of every human child. The origin of mankind out of the prehuman stock was an analogous process.

Logical problems with qualitative or even categorical changes arise also when the borders of science are to be crossed.

3. Solidarity, the ethical aspect of the unity concept

Unity is not only an issue regarding the branches of science in relation to each other; it is as well an issue regarding science in relation to the other enterprises of mankind. An irresponsible knowledge would fail to be a thorough one. We ask therefore: what can be said about the relation of the sciences to the arts? By this name we summarize such diverse activites as agriculture, therapy, education, law, policy. We are facing now the dichotomy of the theoretical and the practical life of mankind. This dualism is again not one of distinct areas but one of mutually infiltrating orders. There is no science without some art, and no art without some science. Each empirical science as atomic physics for example depends essentially on the art of experimentation and its techniques; and their efficiency depends, in turn, on the technological sciences. The purely theoretic science of mathematics is by itself a fine art, their results being most beautiful edifices rather than matters of fact; and those extremely aesthetic arts like sculpture are by themselves contemplative sciences which try to interpret rather than to improve our world. Interpretation and improvement do not exclude each other, of course; on the contrary: fair interpretation is necessary for any reliable progress, and some real amelioration of the human conditions is basic for better understanding. This complementarity of the knowing with the making wisdom of man implies the pertinence of ethical inquiries to all of science; their obvious impertinence is much to the point.

If we try to concentrate on the questions of principle, we soon encounter the vexatious problem of evil. I do not mean now the 'so called evil' of the ethologist Lorenz (who received the medical Nobel award in these days). Human ethology cannot establish the whole of ethics simply because animal agressivity is, though on the dark side of this world, a quite innocent factor. Not so sin, the inhumanity of humans; our falsehood, arrogance, idleness, violence. This grave evil tends to contaminate all qualities, to corrupt all unions, to pervert all meanings. There can be no anthropodicy: no theoretical nor practical self-vindication of mankind, the family of man, considering its individual and collective wickedness. One of its vain and vitious essays is to transform anthropodicy into some kind of theodicy, an all too manlike vindication of

divine providence in view of actual evil. There is no true explanation for the existence of that impossible possibility (Barth) called nothingness. This evil is in all its metaphysical vanity an obvious ethical reality, yet an irrational one: it cannot be understood nor incorporated into a tenable system. Any attempt to construe a theory for this absurdity will make the evil all the worse. The only way is to reject the temptation of inappropriate reasoning or justification and to profess one's lack of insight. The unreasonable cannot be explained. A wholehearted rebuff of evil implies as its intellectual component a sober refusal of any rationalization. A total concept of an entire universe is not consistent with a whole heart. We have here a base of all contemplative wisdom, as exemplified by men like Socrates or Kant. There may be some help in a principle called hope, if you allow it to transcend the unified, closed universe.

To interpret this monstrous fiction as an ordered whole called cosmos is possible only so long as Kant's radical evil is completely ignored. But this deficient possibility cannot really be maintained: We cannot confine our attention to questions of fact, power, and success only, and disregard the correspondig questions of value, righteousness, and justice. These two categories, fact and value, are not easily related. There is always a logical as well as a real gap between is and ought: between propositions and proposals, between demonstration and vindication, between success and justice. But the necessary coherence of our intellectual and operational life demands some bridge built by an agreement called faith. This is found in personal or religious experiences leading to theological or philosophical considerations.

They tell us after and among other issues that science, being responsible for most important influences and impacts on our life and environment, should be solidary with the other enterprises of mankind within the family of all the fine things in this beautiful yet threatened world. We scientists ought to be ready to communicate and to cooperate with each other and with nonscientists, regardless of ideological boundaries. We are in the lucky possession of unambiguous and mutually convertible languages. So let us use them in order to promote understanding through broader knowledge and deeper insight. Understanding contributes to that strong and tender charity called love, which is the very essence of humanity. My

neighbour is everyone, akin or strange, who has done me a favour. We should not yield to our inherited tendencies of xenophobia. The differentiations and specializations of mankind need not to be deplored so long as we keep talking, dealing, bartering, trading, helping. Let us resist the false spirit of all those unfortunate priests, managers, functionaries, officials who try to suppress spontaneous communication. Free flow of people, information, ideas and utilities is badly needed. Isolation and secrecy are threatening Distrust tends to become dangerous, but there is no trust without transparence and some familiarity with the respective foreigners. Most of the dangers latent in new scientific discoveries are not checked by concealment, but by publication and public control with all its vigorous controversies. There will always be struggles; they are to some extent necessary. Yet there should be no unfairness no deceiving. Man needs truth almost as urgently as food. The profession and institution chiefly responsible for this intellectual health is that of teacher and school. We should not forget that this is the unifying topic and issue of science, the fundamental loyality of us scientists. We serve the people best by searching and teaching, rather than by seclusion or propaganda. We know, at least roughly, what truth means: let us not forget asking for and answering to it.

We know of the one Truth, and of many smaller or greater truths; we meet the one Being, and many smaller and greater beings; we deal with the one Life, and with many smaller and greater lives. There is, accordingly, some truth in monism and some truth in pluralism, too. We find much necessary insight by analysis, but some other we seize only by synthesis. We need both: the fascinating systems as well as the interesting details, the realisitc multiplicity no less than the essential unities.