Logical certainty and empirical certainty

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So spoke von Weizsäcker.

"Doch uns ist gegeben,
Auf keiner Stätte zu ruhn,
Es schwinden, es fallen
Die leidenden Menschen
Blindlings von einer
Stunde zur andern,
Wie Wasser von Klippe
Zu Klippe geworfen,
Jahrlang ins Ungewisse hinab."

Hölderlin

1. – Introduction

Some years ago a friend of mine sent me a copy of an interesting article by Carl Friedrich von Weizsäcker, entitled "Allgemeinheit und Gewißheit" [*Generality and Certainty*], contained in the volume by various authors *Martin Heidegger zum 70. Geburtstag* [1].

In his essay von Weizsäcker does not dissert on Heidegger's philosophy, a reader who does not know this philosophy could define von Weizsäcker's paper as an article on symbolic logic and physical methodology – and in reality this characterization is absolutely correct. However, the influence of Heidegger's thought is quite present, particularly in those passages in which the Author emphasizes how even at the basis of the *operational* logic (in Lorenzen's sense) there are essentially *metaphysical* ideas. And an analogous assertion holds also for the methodology of physics.

In the present paper, starting from von Weizsäcker's essay, I shall develop some considerations on the concept of *certainty*, both from the logical and the empirical point of view; but some prolegomena are first needed.

2. – Heidegger *contra* Carnap, i.e. metaphysics *versus* analytical philosophy

Sein und Zeit [Being and Time]. From the scientific standpoint the verb "to be" can have three meanings: *i*) predicative and relational, e.g.: "this rose is red" – "Philip was the father of Alexander"; *ii*) attributive of an identity (*essentia*), e.g.: "*homo est animal rationale*"; *iii*) existential, e.g.: "the world is". – From the physical point of view the general concept of time is perfectly characterized as a parameter for the description of the motions (with respect to a given observer). And the venerable problem of the *time arrow* has been definitively solved by Bohr and Rosenfeld in the following way: we associate a given temporal direction with the *observational processes*: every physical observation requires the reception of a *signal*, which comes from the external world and is propagated with a ***finite*** speed: accordingly, we can *define* the positive direction of time by assuming that the reception instant of the signal is *posterior* to its emission instant [2].

We see that the scientific discourse is quite unambiguous and transparent. However, from the philosophical point of view matters stand otherwise. In the past century this was particularly emphasized by Martin Heidegger. The aim of his *Sein und Zeit* [3] was a renewing *ab imis fundamentis* of classic metaphysics, starting from the concept of being characterized by *existentia*-*essentia*; in reality the work remained half-way (indeed, *Sein und Zeit* has the subtitle *Erste Hälfte* [First Half]), since it discusses only the so-called existential analytics of *Dasein*. In the ordinary language, *Dasein* means simply "existence", but Heidegger employs this word with the meaning of "living human". (The Italian philosophers have translated *Dasein* with "Esserci" – literally and queerly). *Dasein*'s analytics is a kind of anthropological metaphysics, which develops some suggestive psychological considerations. So far as the concept of time is concerned, Heidegger judged philosophically inadequate the physical notion of time as a parameter: he opted for a "primordial time" and for the esoteric and Pauline idea of *kairós* ("just time", "propitious moment", "circumstances", *etc*.).

The study of *Dasein* had been meant as propaedeutic to the study of S*ein* (Being) in the most general sense, but this investigation was never done by Heidegger, because "the language failed" him! Starting from the half of the Thirties of past century, Heidegger's writings speak of S*ein* according to more and more vague and indefinite significations, as e.g. "the reality of anything that exists". I think that after S*ein und Zeit* Heidegger realized that classic metaphysics does not allow any renewing. In 1958 he wrote that in our time "the dissolution of philosophy is manifest, since it is converted into symbolic logic, psychology, and sociology" [4]. However, after the death of philosophy (in the conventional sense), according to Heidegger we have *das Denken* [the thought], in particular *das dichtende Denken* [the poetizing thought]: see Heidegger's writings on Hölderlin's poems, for instance.

The scientific community did not ignore the works of Heidegger. In particular, neo-positivists and logicians declared against him; in 1932 Rudolf Carnap in an article on *Erkenntnis* [5], entitled "Überwindung der Metaphysik durch logische Analyse der Sprache" ["Overcoming Metaphysics through Logical Analysis of Language"] chose the very Heideggerian essay of Heidegger "Was ist Metaphysik?" ["What is Metaphysics?"] [6], and demolished it with the catapults of symbolic logic. In reality, the thing was not too difficult; here I limit myself to emphasize Carnap's refutation of the following typical Heidegger's sentence: "Das Nichts selbst nichtet" ["Nothingness itself nothings"]; *nichtet* [nothings] is present indicative of the verb *nichten* [to nothing], a neologism coined by Heidegger. With this cryptic statement our philosopher desired to affirm the thesis, quite opposite to common sense, that the negation – the "*non*" – is generated by a hypostasized Nothingness, which is, in the last analysis, a creation of the existential *Angst* [Anxiety].

Carnap remarked simply that, from the standpoint of logic, the notion of *Nichts* is only founded on the notions of existential (in the logical, not in the Heideggerian, meaning!) quantification and of logical negation. However, Heidegger confirmed that "Nothingness is the origin of negation, not *vice versa*. But if the power of the intellect in the field of questions concerning Nothingness and

Being is thus broken, then the fate of the lordship of 'logic' within philosophy is also decided therewith. The idea of 'logic' itself dissolves in the vortex of a more original questioning”. (English translation by the present writer).

Everyone of the two authors, Carnap and Heidegger, had perfectly understood the theses of the other, but their intellectual interests were quite distinct: Carnap’s interests were logic and epistemology, Heidegger’s interests were metaphysics and − after the famous *Kehre* −the *Denken*. In Heidegger’s conception, there exists no bridge that leads from science to *Denken*, the only possible passage is a “jump”. With this jump we arrive at the other side of the “abyss”, a completely different region. We have here a kind of revisited *gnosis*.

3. − Hilbert, Weyl, and the intuitive presuppositions of symbolic logic

In an important article of 1926 [7] Hilbert wrote (this English translation is due to Michael Friedman): ”As a condition for the use of logical inferences and the performance of logical operations, something must be already given to our faculty of representation, certain extralogical concrete objects that are intuitively present as immediate experience prior to all thought. If logical inference is to be reliable, it must be possible to survey these objects completely in all their parts, and the fact that they occur, that they differ from one another, and that they follow one another, or are concatenated, is immediately given intuitively, together with the objects, as something that neither can be reduced to anything else nor requires reduction”.

This Hilbertian conception is essentially accepted by Weyl [8]. At p.235 of [8] we read: “A truly realistic mathematics should be conceived, in line with physics, as a branch of the theoretical construction of the one real world, and should adopt the same sober and cautious attitude toward hypothetic extensions of its foundations as is exhibited by physics”. And at pp. 61-62: “… it is a function of mathematics to be at the service of the natural sciences. The propositions of theoretical physics, however, certainly lack that feature which Brouwer demands of the propositions of mathematics, namely, that each should carry within itself its own intuitively comprehensible meaning. Rather, what is tested by confronting theoretical physics with experience is the system as a whole. It seems that we have to differentiate carefully between phenomenal knowledge or insight − such as is expressed in the statement: 'This leaf (given to me in a present act of perception) has this green color (given to me in that same perception)' − and theoretical construction. Knowledge furnishes truth, its organ is 'seeing' in the widest sense. Though subject to error, it is essentially definitive and unalterable. Theoretical construction seems to be bound only to one strictly formulable rational principle, that of concordance (compare Section *17*, p.121), which in mathematics, where the domains of sense data remains untouched, reduces to consistency; its organ is creative imagination. In connection with physics we shall have to discuss in greater detail the question what its determining factors, besides concordance, are. Intuitive truth, though not the ultimate criterion, will certainly not be irrelevant here”.

In reality, Weyl goes beyond Hilbert’s conception. The unpleasant fact that the consistency of set theory (basis of mathematics) cannot be proved is exorcized by him with the significant remark that logic, mathematics and theoretical physics are the components of a *corpus unicum* of doctrines, which is validated, in the last analysis, by *experimental* physics. Obviously, empirical certainty is not absolute certainty, but it is largely adequate to the ideal and practical aims of the human beings.

4. Heidegger, von Weizsäcker, and the ontological bases of symbolic logic

α) In summer semester of 1928 Heidegger delivered a course on the theme "Metaphysische Anfangsgründe der Logik" ["Metaphysical Principles of Logic"] [9]. The course concerned classic logic according to Leibnizian formulation; modern symbolic logic was only touched upon *en passant*. However, Heidegger developed many considerations that are valid quite *generally*, for *any* formulation of the principles of logic: the second part of sect.*7*, concerning the relations between logic and ontology, is particularly interesting from this point of view. The substance of the argumentation can be summarized as follows: logic is not a quiddity suspended in mid-air, a fully self-referential doctrine; indeed, its formulation requires: *i*) a set of preliminary, basic "thought rules"; *ii*) the recourse to some objects and facts of the immediate experience – i.e. to an elementary *ontology* (cf. Hilbert's considerations of sect.**3**).

This is true, in the last analysis, for *any* conception of logic, even for the *operational* version of modern logic, which was developed in a very strict way by Lorenzen in the Fifties of past century.

Von Weizsäcker wrote [1]: "If one wishes to develop from the formal standpoint an axiomatic science, as e.g. the geometry, without the consideration of the meaning of the axioms, it is necessary to determine uniquely the consequential nexus between propositions, the meaning of which is not considered. To this end logic has developed a *calculus*, in which – according to quite formal prescriptions – series of signs are framed with other series of signs. The basis for the choice of given signs and prescriptions lies then in the interpretation of calculus; however, "reckoning" with the rules of calculus does not need the recourse to this basis". (This English translation is due to the present writer).

Lorenzen considered the following *Spielkalkül* [play-calculus] K_1, which does not receive any interpretation; it gives only an illustration of the structure of the logical calculi; scheme of K_1:

$$\begin{aligned}&\text{Axiom } \mathrm{A}_1: +\\&\text{Rule } \mathrm{R}_1: a \to ao\\&\text{Rule } \mathrm{R}_2: a \to +a+\end{aligned}$$

where: o, + are "atoms" (i.e. basic "numerical" symbols); a is a "variable". With ordinary words:

1. The forms o and + are named *atoms*;
2. All the horizontal sequences of atoms are named *expressions*;
3. All expressions made with the following prescriptions are named *formulae*:

(A_1) $+$ is a formula;
(R_1) if a is a formula, then also ao is a formula;
(R_2) if a is a formula, then also $+a+$ is a formula.

Examples of formulae:

$+$	$+o$	$+++$	$+oo$	....
$+o$	$+oo$	$+++o$	$+ooo$	...
$+++$	$++o+$	$+++++$	$++oo+$	......

the rule of construction is evident.
The above prescriptions are composed of propositions which *define* the concepts "atom", "expression", "formula". The theory investigates the objects which are described by these concepts.

In a calculus we are interested in those expressions which are *formulae*, *deducible according to the fixed rules*. E.g., in K_1 we have only *two* formulae composed of *three* atoms: $+oo$ and $+++$; the expression *ooo*, e.g., is not a (deducible) formula, because it does not comprise a cross (+), and every formula begins with a +. Arguments of this kind *prove* that in K_1 there are precisely two formulae composed of three atoms. This proof is *not* a deduction *in* our calculus: it is a "contentual" observation *on* deductions in K_1.

In K_1 we distinguish three kinds of "signs":

1. The atoms of calculus: + and *o*;
2. The signs $\rightarrow$ and *a* of the "metalanguage of calculus", by means of which we *explain* the rules of calculus;
3. The letters and the graphic symbols of the written language, which we use for *explaining* the characteristic properties of calculus.

If the calculus is not interpreted, the "expressions" do not signify. The arrow and the variable *a* are signs of the metalanguage of K_1, which can be developed into a metacalculus MK_1 of K_1. The metacalculus has an interpretation: it communicates the rules of K_1, and gives formal maps of the contentual proofs. Of course, the rules of MK_1 can be explained with a new metalanguage, which gives a meta-metacalculus $\mathrm{M}^2\mathrm{K}_1$, *etc*. In a sense, at every stage we make the "same" thing.

Remark that we can specify some set of general rules, which hold in all calculi, metacalculi, *etc*.; for instance: if $A \rightarrow B$ and $B \rightarrow C$ are admitted rules, then also $A \rightarrow C$ is an admitted rule. These *general* rules can be written down by means of a suitable *calculus*, the "logical calculus" L. The rules of L, written down with the formal symbols of L, are also valid formulae of L. Calculus L generates valid sentences *on* all calculi.

The ***certainty*** of its sentences (*Aussagen*) does *not* follow – as it is clear – from the fact that they are *deducible* within L, but from their ***contentual*** (***inhaltlich***) meaning. A formula of the *Logikkalkül* is ***certain*** only in the extent of our reliance on its yielding (uniquely) a contentually evident insight about the *working* with the calculi.

β) The previous considerations on symbolic logic are due almost literally to von Weizsäcker [1]. I wish now to mention a simple and significant example of *Logikkalkül*: the *classic prepositional calculus* Π. *Its variable signs are prepositional variables: p*, *q*, *r*, *etc.*; its constant signs are the parentheses and the signs which denote respectively: "non", "vel" (i.e. the inclusive "or"); "if … then" (the so-called "material implication"); "et" (i.e., "and").

The fundamental transformation rule is the *modus ponens*: from two formulae of the kind "S_1" and "If S_1 then S_2", it is always possible to deduce the formula "S_2". Finally, we have the *axioms* of the calculus, i.e. a small number (e.g., four) of *basic* formulae.

The calculus Π is particularly interesting because it is possible to prove that it is *consistent* and *complete*. In Π the "*tertium non datur*" ("*p* vel non-*p*") is always

valid. Now, there are logical calculi in which the "*tertium non datur*" does *not* hold: von Weizsäcker remarks that this is due, in the last analysis, to the fact that in them the notion of *truth* has been substituted by the more limited notion of deducibility, which allows however an *operational* decision.
The instance of the "*tertium non datur*" illustrates how much the *expressiveness* of a calculus depends on its contentual interpretation.

5. Eddington and the ideal structure of a physical theory

At p.106 of his very original treatise on Relativity [10] Eddington says: "In the last century [i.e. in the 19th century] the ideal explanation of the phenomena of nature consisted in the construction of a mechanical model, which would act in the way observed. Whatever may be the practical helpfulness of a model, it is no longer recognized as contributing in any way to an ultimate explanation. A little later, the standpoint was reached that on carrying the analysis as far as possible we must ultimately come to a set of differential equations of which further explanation is impossible. We can then trace the *modus operandi*, but as regards ultimate causes we have to confess that "things happen so, because the world was made that way". But in the kinetic theory of gases and in thermodynamics we have laws which can be explained much more satisfactorily. The principal laws of gases hold not because a gas is made "that way", but because it is made "just anyhow". This is perhaps not to be taken quite literally; but if we could see that there was the same inevitability in Maxwell's laws and in the law of gravitation that there is in the laws of gases, we should have reached an explanation far more complete that an ultimate arbitrary differential equation. This suggests striving for an ideal – to show, not that the laws of nature come from a special construction of the ultimate basis of everything, but that the same laws of nature would prevail for the widest possible variety of structure of that basis. The complete ideal is probably unattainable and certainly unattained; nevertheless […] it appears that considerable progress in this direction is possible [cf. Einstein's theories]".

The opposite conception, suggested by a very naïve philosophical realism, is nowadays vindicated by the community of the particle physicists. Here is a quotation from the second edition (1989) of the *Physics Vademecum* (H.L. Anderson, Editor in Chief, A.I.P., New York); at p.171 we read that there is the possibility that "quarks [the constituents of the hadrons] and leptons are themselves composite and that some substructure will be revealed in higher energy experiments. A more fashionable idea at present is that elementary "particles" are not particles at all, but rather the lowest vibrational modes of tiny strings with an extension of the order of the [so-called] Planck length, about 10^{-33} cm. When supersymmetry [which relates fermions to bosons] is included, this "superstring" theory provides the only known possibility for a consistent quantum theory of gravity. It suggests that space-time is actually ten-dimensional, but with six dimensions curled up with a radius comparable to the Planck length. In the context of superstring theory, many new exotic particles (in addition to the superpartners of ordinary particles) are predicted". These statements represent a conglomerate of bad metaphysics, science fiction, and nonsense – the phrase "quantum gravity" is a physical oxymoron, because quantum theory is actually incompatible with *general* relativity. We have here an instance of "science pompière", physical analogue to the "art pompier", a well-known artless and magniloquent manner of painting (France, 19th century).

6. Mathematics and logic

α) Weyl wrote ([8], p.66): "Mathematics is the *science of the infinite*", and Hilbert [7]: "… the infinite is also, more than any other concept, in need of clarification" [Helmer's translation, see [8], p.66].

The set of the parts of a countably infinite set (as, e.g., the set of the natural numbers) is a continuum (as, e.g., the uncountable set of the real numbers).

Now, the existence of uncountable sets is the main obstacle to a reasonable "reduction" of mathematics to symbolic logic. −

β) In the history of philosophy the so-called *logical paradoxes* have been repeatedly discussed and dissolved, see e.g. the detailed footnotes at pp.220, 228, and 229 of Weyl's book [8]. In particular, I wish to mention here Aristotle's *De Sophisticis Elenchis*, and the remarks contained in the *Geschichte der Logik im Abendlande* by C. Prantl. Quite correctly, in my opinion, the ancient, the mediaeval, and the modern philosophers have regarded the above paradoxes as mere trifles, fully devoid of conceptual significance. On the contrary, the modern logicians have taken them into a serious consideration. Thus Russell devoted much attention to the paradox of the set of all things (in particular, of all sets) that are not members of themselves, i.e. that do not contain themselves, i.e. that do not contain themselves as elements. To prevent the appearance in set theory of this paradox he invented the "theory of types": the first type consists of the primary objects, e.g. the numbers, the second of the properties of numbers, the third of the properties of the properties of numbers, *etc*., *ad infinitum* − and these infinite types have to be kept separate, of course. But in the treatises of symbolic logic lion's share has been taken by another paradox: the paradox of the *pseudomenos* (i.e. of the liar). In the classical formulation of Cicero: "Si te mentiri dicis idque verum dicis, mentiris an verum dicis?". In a modern version: "This sentence which I now make is false". Actually, the logicians choose a more sophisticated version (cf. sect.**4**): "This sentence is not deducible (within the considered formal system)". Clearly, we have here a verbal cheat; however, as we shall see, the fantasy of a modern logician (Gödel) has drawn from the above statement some amazing consequences. −

γ) Loosely speaking, the famous Gödel's incompleteness theorems affirm − in the current opinion − that (see Weyl's book quoted in [8], Appendix A) "… in any formal system M, that is not too narrow, two strange things happen: i) One can point out arithmetical propositions Φ of comparatively elementary nature that are evidently true [contentually true, *inhaltlich wahr*] yet cannot be deduced within the formalism [nor can we deduce *non*-Φ, i.e. Φ is undecidable, *unentscheidbar*]. ii) The formula Ω that expresses the consistency of M is itself not deducible within M. More precisely, a deduction of Φ or Ω within the formalism M would lead straight to a contradiction in M …".

Some years ago I have proved that actually Gödel's results hold only for ***particular*** formal systems [11] − and therefore they do not represent, contrary to a widespread conviction, an irremediable catastrophe in regard to a logical "systematization" of mathematics. −

δ) I shall now discuss, from the standpoint of *classical* logic, the soundness of Gödel's fundamental idea: he justified it with a formal argument quite analogous to the argument which gives the so-called Richard paradox, and also to the argument of liar's paradox. Gödel wrote at p.175 of his celebrated paper [12]: "We have here a proposition which affirms its own unprovability." And in footnote N°15: "Contrary to appearance, such proposition does not contain a vicious circle, since it affirms first of all the unprovability of a well definite formula [(…)], and only supplementally (fortuitously, in a sense) it is made conspicuous that this formula is just the formula through which the proposition itself was expressed."

The following analogical comparison shows the *fallacy* of the above argument.

Let us suppose to represent numerically the words of the ordinary language by means of the following correspondence between letters and natural numbers: a→1, b→2, c→3, *etc.*; then, e.g., the sentence "the universe is" becomes

"20|8|5 21|14|9|22|5|18|19|5 |9|19";

quite similarly, we represent the sentence "this proposition is unprovable":

"20|8|9|19 16|18|15|16|15|19|9|20|9|15|14 |9|19 |21|14|16|18|15|22|1|2|12|5".

If we do not decipher, the two "numerical" sentences seem of the same kind, but in reality, if we consider their *meaning*, we see at once that they belong logically to *different* "types".

I conclude that Gödel's formal edifice rests on rather brittle foundations.

7. Theoretical physics and experience

I do not wish to discuss here the subtle question of the relations between theory and experience (there are *no* "bare" experimental data …) [13].

I limit myself to a concise scrutiny of two momentous themes, that have given origin to a series of researches of a fully ***anti-Galilean*** character; the existence and the properties of the black holes and of the gravitational waves. Actually, there are *many* arguments which prove the physical non-existence of the mentioned objects, see my book "On Black Holes and Gravitational Waves" [14]. I shall recall here only a plain refutation of the fanciful notion of black hole and a very easy demonstration of the absence of any "mechanism" whatever for the generation of the gravitational waves. –

α) The solution of the problem of the Einsteinian gravitational field generated by a point mass M at rest is given, in spherical coordinates, by an expression of the spacetime interval which contains an *arbitrary* regular function $f(r)$ of the radial coordinate *r*. If one chooses simply $f(r) \equiv r$, one obtains the so-called *standard* form of solution (improperly named "by Schwarzschild", but due in reality to Hilbert, Droste, and Weyl); it holds, mathematically and physically (and the following is *not* a physical restriction!), only for $r > 2GM/c^2$ – where G is the gravitational constant and c is the speed of light *in vacuo* –, as it was repeatedly emphasized by Einstein and by all the Great Men who developed the general theory of relativity.

Only a fanciful reflection by emulators of the science-fiction authors on the unphysical region $r \leq 2GM/c^2$ gave birth to the fictive notion of black hole. It would not come forth if the treatises of general relativity had expounded, for instance, the ***original*** form of solution due to Schwarzschild [15], which is *regular* for $r > 0$, and is diffeomorphic to the *exterior* part $(r > 2GM/c^2)$ of the standard form.

The most perspicacious among the *observational* astrophysicists have always called in question the notion of black hole: indeed, they know that the *observed* "black holes" have noting to do with the theoretical black holes: they are only large, or enormously large, masses concentrated in relatively small volumes. And general relativity explains all the observed phenomena. –

β) A proof that no motion of masses can generate gravitational waves runs as follows:

i) It is universally known that in any geodesic motion of any mass the emission of gravitational waves cannot happen: indeed, the geodesic motions are "free",

"inertial" motions. (Analogously, in the customary Maxwell-Lorentz electrodynamics the rectilinear and uniform motions of the electric charges cannot generate electromagnetic waves);
ii) Let us consider ideally all the possible geodesic motions of a material particle P in "rigid", "external" gravitational fields;
iii) Let us suppose that in a suitably chosen ***non***-geodesic motion of P, our particle begins to send forth, at a given time t' a gravitational wave. Let us determine the kinematical characteristics of P (velocity, acceleration, time derivative of the acceleration, *etc.*) between t' and $t'+|\mathrm{d}t'|$;
iv) It is obvious that the *same* characteristics will appear also, between – say – t'' and $t''+|\mathrm{d}t''|$, in someone of the geodesic motions of paragraph *ii*);
v) But, see paragraph *i*), in the geodesic motions the emission of gravitational waves is impossible;
vi) Last but not least: those motions of celestial bodies which are *solely* gravitational are *surely* geodesic, and consequently do not generate gravitational waves: consider, in particular, the motions of the bodies of the solar system. (But the proof of paragraphs *i*) ÷ *v*) holds also for ***not*** solely gravitational motions).

I remember finally that Levi-Civita, Einstein, Scheidegger, Infeld and Plebanski, Rosen, *et alii* put forth serious reasons against the existence of the gravitational waves – bibliography in [14].

Of course, nobody has ever detected experimentally a gravitational wave. Only a wishful thinking – and the disregard of realistic explanations – have led to the conviction that the time decrease of the revolution period of the binary radiopulsar PSR1913+16 gives an experimental *indirect* proof of the reality of the gravitational radiation. According to the conventional approach, the two stars of the above binary move *in vacuo* as two point masses: accordingly, they describe *geodesic* lines and cannot emit gravitational waves – although the fallacious application of the perturbative quadrupole formula yields some undulations.

8. "Yet it's not given to us …".

Since Descartes, *certainty* has become a central concept in philosophy and in science; however, the certainty of our intellectual acquisitions must be always conquered and reconquered anew across the stormy vicissitudes of historical life.

Hölderlin's verses that I put in front of the present article delineate poetically the human situation – perhaps too moodily. Let us read them again in an English translation:

"Yet it's not given to us
To rest in any place;
Disappear, fall
The suffering humans
Blindly from an
Hour to another,
As water thrown down
From cliff to cliff
During years into Uncertainty".

Appendix: Classical logic and symbolic logic

The essential difference between classical logic and modern symbolic logic has been illustrated in the clearest way by von Weizsäcker [1] with the instance of the "*tertium non datur*": symbolically, "*p* vel non-*p*". Aristotle characterizes this logical law with the *stricter* sentence: "A being (a subject, grammatically) does have or (*aut*!) does not have a given property". There is here a reference to the *meaning* of the sentence, that attributes, or does not attribute, a given predicate to a given subject. The modern propositional conception is more comprehensive: *vel* in lieu of *aut*, and *p*'s more generally structured.

The Aristotelian conception makes evident the ***ontological*** underground: the grammatical subject is necessarily a ***being***. For Aristotle *ontology* is the science which lays the foundation of *logical truth*.

Von Weizsäcker writes [1]: "The generality of the *ontologically* founded sentences of logic depends on the ability of the human being to gain general insights upon what he did not make; the generality of the *operationally* founded sentences of logic depends on his ability to gain general insights upon what he himself made. […]. This distinction does not take into account the dependence of what we can make on what we did not make, and likewise the dependence of our understanding of what we did not make on our understanding of what we can make. These dependences announced themselves in the circularity of knowledge […]. The limited value of the scientific assumption that severs "subject" and "object" appears, from the assumption itself, as a circle of opposite dependences; as the *Midgardschlange*, encompassing the horizon, which bites its tail".

With the mythological and esoteric image of the Cosmogonic Serpent [16], von Weizsäcker concludes his remarkable essay on generality and certainty.

So spoke von Weizsäcker

In July 1968 a meeting on "Quantum Theory and Beyond" was held at Cambridge. I remember it mainly for the presence of Carl Friedrich *Freiherr* von Weizsäcker: he distinguished himself among the participants for the clarity and appropriateness of his speech, for the vastness and depth of his knowlwdge, for his exquisite politeness. The physicists of my generation knew his name because of the electrodynamical approximation method by Weizsäcker-Williams [17], of his formula for the binding energy per nucleon in a nucleus, and of his study of the exothermal nuclear reactions in the stars [18].

In a private conversation he told me that since 1957 he held a chair of philosophy at Hamburg University, and that in the last semester the theme of his lectures had been Aristotle's *Metaphysics* – in the original Greek version, of course: indeed, "it would be not appropriate to discuss such a fundamental work in a translation, German for example; don't you agree?" I opened my arms and said: "Certainly, but I should not be capable of such a performance!"

One night after dinner we had remained at the table to chat a little bit. One of us asked von Weizsäcker what happened to the German physicists at the end of the Second World War, in May 1945. He was eager to answer and he told us that all German physicists who were somehow well known and who lived in the zones occupied by US, UK and French troops had been deported to England to be thoroughly examined. They were allowed to exchange mail with their relatives, but of course they were not permitted to say the name of the place where they were kept. "June 1945 was rather cool, and at nights we lighted the fire. I said this to my wife, and so she understood that I was in England" said von Weizsäcker.

Our conversation did not flag and a physicist asked about von Weizsäcker's father, who had been from 1943 till the end of the war the ambassador of the Third

Reich in Vatican. Formerly he had been *Staatssekretär*, i.e. vice-minister, for Foreign Affairs, both with von Neurath and with Ribbentrop, a faithful Hitler's supporter. "My father confided me" – said von Weizsäcker – "that his professional life had been a complete failure: when Hitler took the power, in 1933, he chose to remain at his place at the Foreign Affairs, thinking he could somehow influence and modify the foreign policy of the dictator. Unfortunately, this proved to be impossible, for Hitler was completely crazy".

Since that dinner long ago back in 1968 I have not been able to see von Weizsäcker again. On June 28th, 2002 he had his 90th birthday. German papers and TV interviewed him, and he answered every question very frankly and very kindly. He is now a radical Christian pacifist, more radical than his brother Richard, eight years younger than him, former President of the Federal Republic of Germany for ten years. In the German world there sure exist people who criticize his political views; some of them, with unfair irony, push their criticism to the point of affirming that he considers himself the critical conscience of the German nation. It's a wrong judgement. In my opinion, von Weizsäcker in his uprightness thinks only that he has to let his fellow citizens know the firm beliefs he has developed during his long life from a culturally and socially very high position.

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[16] The Serpent *Ouroboros* is of Mediterranean origin, but it is also present in Icelandic myths, as its German name declares; "it was dreamt in Iceland" − says Borges in his little poem "Midgarthormr", see J.L. BORGES, *Tutte le opere* (Mondadori, Milano) 1985, vol.II, p.1368.

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