To the Relation between Religion and Science at the Dawn of the 21st Century

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Abstract

(1) The twentieth century can be characterized by unprecedented progress in natural sciences, especially in the field of lifeless nature. This circumstance influenced substantially also our point of view on the Universe, on its properties, structure as well as its evolution. Many new questions could be formulated and answered in the field of micro- as well as macro-worlds. However, even if several problems could be formulated more appropriately than before, their complete solution is in large deal still missing. There are also cases where the correct answer or solution should be looked for beyond the natural sciences. Generally speaking, current cosmology represents a well established branch of science, i.e. it already does not belong to a pure speculative area of the human activity.

(2) The data, presently available, allow us to conclude that our Universe is evolving. Its evolution started from a hot state of matter. It originated as whole, i.e. there is no scientific support in favor of the idea that the universe - as we know it today – might have arisen (let us say, gradually, in a stepwise way) by gluing together several hitherto individual and independently evolved universes. Our contemporary level of knowledge allows concluding that the existence of the Universe will be finished in the distant future. Moreover, there is no serious evidence of the existence of an oscillating universe.

(3) During recent years, the Standard Cosmological Model has been introduced into cosmology. By and large, it is based on the following principles, or axioms: (i) seen from the global point of view, the Universe reveals its homogeneity and isotropy, (ii) fundamental properties of the gravitation fields are described in terms of Einstein's theory of general relativity, and (iii) matter moves in the Universe obeying the laws of relativistic flow of fluid.

It is usually said that application of the Standard Cosmological Model allows us to explain chiefly the following three fundamental observations, namely: (a) the Hubble red shift of galaxies and their clusters (sometimes called "expansion of the Universe"), (b) the presence of the cosmic microwave background (relic) electromagnetic radiation at the temperature T = 2.735 Kelvin (with small but very important fluctuations), and (c) the primordial abundance of light atomic elements (especially of the deuterium, two helium isotopes and lithium).

(4) Our complex present day knowledge allows to conclude that (i) the relic electromagnetic radiation acquired the properties observed today, when the age of the universe was about several hundred thousand years (recent results lead to the value 340 thousands years), (ii) the primordial abundance of the light atomic elements appeared when the age of the universe was about ten seconds up to several minutes, and (iii) the Hubble expansion (i.e. the increase of the distance between galaxies and their clusters) observed today is primarily caused by the inflation (an enormously large expansion of the Universe in a span of an extremely short period of time); a relatively popular scenario places the appearance of this phenomenon to the period when the universe was t_1 seconds old (where t_1 is equal about 10^{-35}sec) and the duration of the inflation was about 10^{-33}sec. (Let us say that the existence of the inflation cannot be verified nor falsified.)

(5) The three observations mentioned above bring an important portion of knowledge about evolution of the Universe. On the other hand, they do not say anything about processes that

took place before the time t_1, nor do they require existence of the Big Bang. Some theoretical models allow extrapolation from the time t_1 up to the time t_0 (where t_0 means time zero or the starting point of existence of the Universe). This means that the singularity in the temperature or the density of the matter at the time t_0 comes in due to a special and very attractive extrapolation of the properties characterizing the Universe during the time interval between t = t_1 and t = t_0.

Now, it is seen that if there was an "agreement" achieved on the existence of the Big Bang, one should introduce - in addition to the three observations mentioned above, in the foregoing section - a fourth statement, too, namely, that (iv) the Big Bang truly took place (i.e. this addition is introduced by our hands, not by the nature). Introduction of this addition into the Standard Cosmological Model may lead to what can be called an Extended Standard Cosmological Model.

(6) The Hubble expansion requires some comment. Namely, according to our present ideas the Universe is filled with a material environment represented by ("heavy") matter and radiation; the rest mass of the radiation quanta vanishes so that their speed is equal to the speed of the light in vacuum. The Hubble expansion (or more aptly, the increase of the distance among galaxies and their clusters) is ascribed, today, mainly to the inflation and therefore it is not a simple task to deduce (without additional assumptions) the age of the Universe from the time dependence of the increasing distance just mentioned. But the question "What was there yesterday where the Universe is expanding today?" is still interesting and hardly answerable in field of the general relativity.

(7) Let us admit (for the moment being) that all the matter started to exist by Big Bang. This is to say that before the Big Bang there existed no matter at all (i.e. no heavy matter together with any kind of radiation). In that case, natural science (or any other science, such as philosophy or metaphysics) is neither able nor competent to answer the question: "What was there before the Big Bang?" The answer represents a matter of belief: the transition from "nothing" to "something" is not a physical event. Physics and the natural sciences in general are always dealing with some environment whose properties are specified by quantities adherent to the matter. A scientific approach (including for instance also the notion of causality) fits to the material world, not to the spiritual one. Religion is in a special way intimately related to such a "world", which cannot be described in terms adherent to the "material world".

Nevertheless, let us say that some kind of primordial matter (either in its vacuum or some excited state) existed before the time t_0 as well. In such a kind of matter there existed different fluctuations and one such energetic and very rich fluctuation might decay, leading to the birth of our Universe. In that case, the temperature at the origin of our Universe might have been extremely high but it could not have been necessarily infinitely high. Of course, such a possibility does not solve the problem of the origin of the matter. This model shifts it only one step further into the past.

(8)The questions related with the origin (or eternity) of the matter are answered within the framework of religion. Let us point out that it still might be that the volume of the Universe filled by (heavy) matter need not be the same as the volume filled by (some kind of primordial) radiation. On the other hand, quite often the answers to such questions come from various speculations and they do not represent the results of a serious scientific approach.

Perhaps it is interesting to notice that not all questions formulated in a field of serious science will adequately meet their serious (scientific) answers.

(9) In the present contribution the distinction between facts and hypotheses is stressed. There are mentioned also some points of view on the interpretation of observations of the Universe. Mutual complementarity between religion and sciences is briefly sketched, too.

Biography

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The twentieth century can be characterized by unprecedented progress in natural sciences, especially in the field of inanimate nature. This circumstance has influenced substantially also our point of view on the Universe, on its properties, structure as well as its evolution. Many new questions could be formulated and answered in the field of micro- as well as macro-worlds. However, even if several problems could be formulated more appropriately than before, their complete solution is in large deal still missing. There are also cases where the correct answer or solution should be looked up beyond natural sciences. Generally speaking, the current cosmology, as it is known at the dawn of the 21st century represents a well-established branch of science, i.e. it does not belong to a pure speculative area of the human activity any longer.

I. Evolution of the Universe

(1) The data, presently available, allow to conclude that our Universe is evolving. Its evolution started from a hot state of the matter. It originated as a whole, i.e. there is no scientific support in favor of the idea that the Universe - as we know it today – might have arisen (let us say, gradually, in a stepwise way) by gluing together several hitherto individual and independently evolved universes. Our actual level of knowledge allows to conclude that the existence of the Universe will finish in the distant future. Moreover, there is no serious evidence of existence of an oscillating universe. (According to the recent observations of the Wilkinson Microwave Anisotropy Probe the age of the universe is 13,7 billion years, with 1% uncertainty.)

(2) During recent years, the Standard Cosmological Model has been introduced into the cosmology. By and large, it is based mainly on the following principles, or axioms: (i) seen from the global point of view, the Universe reveals its homogeneity and isotropy, (ii) fundamental properties of the gravitation fields are described in terms of the Einstein theory of general relativity, and (iii) the matter moves in the Universe obeying the laws of the relativistic flow of fluid.

It is usually quoted that application of the Standard Cosmological Model allows to explain chiefly the following three fundamental observations, namely: (a) the Hubble's red shift of galaxies and their clusters (sometimes called "expansion of the Universe"), (b) the presence of the cosmic microwave background (relic) electromagnetic radiation

at the temperature T = 2.735 Kelvin (with small but very important fluctuations), and (c) the primordial abundance of light atomic elements (especially of the deuterium, two helium isotopes and lithium).

(3) Our present day complex knowledge allows to conclude that (i) the relic electromagnetic radiation acquired the properties observed today when the age of the Universe was about several hundred thousand years (recent results lead to the value of 380 thousands years), (ii) the primordial abundance of the light atomic elements appeared when the age of the Universe was about ten seconds up to several minutes, and (iii) the Hubble's expansion (i.e. the increase of the distance between galaxies and their clusters) observed today is primarily caused by the inflation (an enormously large expansion of the Universe in a span of an extremely short period of time); a relatively popular scenario places the appearance of this phenomenon to the period when the Universe was t_1 seconds old (where t_1 is equal about 10^{-35} sec) and the duration of the inflation was about 10^{-33} sec, [1]. (Let us utter that existence of the inflation cannot be verified nor falsified.)

II. Approach involving the Big Bang

(1) The three observations mentioned above bring an important portion of knowledge about evolution of the Universe. On the other hand, they do not say anything about processes that took place before the time t_1, nor they require existence of the Big Bang. Some theoretical models allow extrapolation from the time t_1 up to the time t_0 (where t_0 means time zero or the starting point of existence of the Universe). This means that the singularity in the temperature or the density of the matter at the time t_0 comes in due to a special and very attractive extrapolation of the properties characterizing the Universe during the time interval between $t = t_1$ and $t = t_0$.

Now, it is seen that if there should be achieved an "agreement" on the existence of the Big Bang, one must introduce - in addition to the three observations mentioned above, in the foregoing subsection - a fourth statement, too, namely, that (iv) the Big Bang truly took place (i.e. this addition is introduced by our hands, not by the nature).

Introduction of this addition into the Standard Cosmological Model may lead to what can be called the Extended Standard Cosmological Model.

(2) The Hubble's expansion requires a comment. Namely, according to our present ideas the Universe is filled up with material environment represented by matter and radiation; the rest mass of the radiation quanta vanishes so that their speed is equal to the speed of the light in vacuum. The Hubble's expansion (or rather the increase of the distance among galaxies and their clusters) is to be ascribed, today, mainly to the inflation and therefore it is not a simple task to deduce (without additional assumptions) the age of the Universe from the time dependence of the increasing distance just mentioned. But the question "What was there yesterday where the Universe is expanding today?" is still interesting and hardly answerable in field of the general relativity (compare also [2] and [3]).

(3) Let us admit (for the moment being) that all the matter started to exist in the moment of Big Bang. This is to say that before the Big Bang there existed no matter at all. In that case, the natural science (or any other science, such as philosophy or metaphysics) is neither able nor competent to answer the question: "What was there before the Big Bang?" The answer represents a matter of belief: the transition from "nothing" to "something" is not a physical event. Physics and natural sciences in general are always dealing with some environment whose properties are specified by quantities adherent to the matter. A scientific approach (including for instance also the notion of causality) fits to the material world, not to the spiritual one. The religion is in a special way intimately related to such a "world", which cannot be sufficiently described in terms adherent to the "material world".

Nevertheless, let us say that some kind of the primordial matter (either in its vacuum or some excited state) existed before the time t_0 as well. In such a kind of matter there existed different fluctuations and, at a certain point, such an energetically very rich fluctuation might decay which led to the birth of our Universe. In that case, the temperature at the origin of our Universe might have been extremely high but it could

not have been necessarily infinitely high. Of course, such a possibility does not solve the problem of the origin of the matter. This model shifts that problem only one step further into the past.

III. Pre-Big-Bang theory

(1) In some studies the assumption is adopted that a special (primordial) matter (sometimes it is called “dilaton”) field existed and exhibited fluctuations in its vacuum state. And, eventually, one of the fluctuations, very rich in energy, arose and decayed. Briefly saying, after that decay, there appeared all periods of the evolution of our Universe known today, [4].

In this case it is sufficient to expect that only a finite amount of the energy-matter at very high but finite temperature and density participated in the decay. The corresponding approach represents a non-singular pre-big-bang cosmology; it might be called e.g. the *extended dilaton cosmological model.* However, the question concerning the origin of this pre-big-bang energy-matter is not answered there, it is only shifted again one step further into the past. Of course, this field might be present also in those regions where our today’s universe expands. The question whether the volume (in our usual three dimensional space) filled by that matter is finite, remains unanswered as well. On the other hand that approach predicts some phenomena that might be observed in the next decade. And they differ from the big-bang predictions, so that the experimental evidence might play a decisive role in favor of the Big Bang or of the pre-big-bang scenario.

Especially, the approach involving dilatons predicts existence of the relic gravitation field which - when compared with such a field predicted in frame of the standard cosmological model – should exhibit increased intensity in the region of high frequencies.

(2) A quasi-steady state cosmological model [5] involves also a scalar field with the aim to realize the pair production (considered as creation of the matter from the already existing electromagnetic field) which takes place in “little” big bangs distributed over all space and time, the Universe itself being without a beginning. Some other cosmologies are shortly mentioned e.g. in [6]. Looking on those

approaches it is advised to take into account the well-known rule, *non sunt multiplicanda entia sine necessitate* (do not enlarge the number of fundamentals if it is not necessary).

(3) Questions related with the origin (or eternity) of the matter in general are answered within the framework of the religion. Let us point out that it might still happen that the volume of the Universe filled by the (heavy) matter need not be the same as the volume filled by (some kind of primordial) radiation. On the other hand, quite often the answers to such questions come from various speculations and they do not represent the results of a serious scientific approach. Perhaps it is interesting to notice that not all questions formulated in the field of a serious science must meet their adequately serious (scientific) answers.

IV. Deterministic but unpredictable phenomena

(1) Many events appearing in the Universe were "prepared" far under the limits of our detecting possibilities and our abilities to observe them. Such events may be deterministic, but still unpredictable. In this context the attribute "deterministic" indicates a process that is described in a sufficiently accurate way by a set – sometimes quite a simple set – of nonlinear differential equations; in few words, they establish a relation between a process in a given moment and the process in the preceding moment. And, what is essential, for some values of the parameters involved in those equations, their solution is extremely sensitive on the concrete value of the initial conditions. This means, in the case when we are seeking, for instance, the location of a particle, that a very small change of the initial conditions (which is usually out of our control) gives rise to a quite different location. Such a circumstance characterizes a "chaotic" or "unpredictable" behavior of the system.

(2) There are events that once observed allow to deduce a chain of small, separately insignificant disturbances (or "causes") which eventually led to them. However, also in those cases there is still open the problem why they appeared exactly "there" and "then". Let us keep in view the evolution of a system that was influenced by immense numbers of events whose individual appearance was nearly improbable but they

appeared in a “needed” sequence. Let us also bear in mind the events prepared very far under our detection possibilities and abilities. Both cases might be considered as a remainder of the God’s “manuscript” in the Universe. On the other hand, it might be a sign of deep misunderstanding if somebody would make a considerable effort to regard God like a subject of the material research; God cannot be circumscribed by properties adherent to the matter. Nor a scientific research or a rational approach are adequate for study the God’s attributes. Moreover, rational approach usually dealing with causality, and, on the other hand, with implicit assumption about the presence of some signs or rules, indicating more or less pronounced or hidden regularities, leads to the conclusion “where are regularities there are equations”. But God cannot be described in terms of equations.

(3) The evolution of the Universe as well as the mutual behavior of its parts is significantly marked by non-linear interactions. This is the reason why the chaotic phenomena cannot be excluded from the history of the Universe, nor of our solar system. Those phenomena are hardly reversible in time. Therefore the history (or the evolution) of the Universe has, and can have, only one time direction. In this connection it is perhaps worthwhile to recall the words of E. P. Wigner, the Nobel Prize winner for physics in 1963, “the miracle of the appropriateness of the language of mathematics for the formulation of the laws of physics is wonderful gift which we neither understand nor deserve”. Let us add that the considerations mentioned above are related also with problems of the free will, necessity and responsibility.

V. God and rational methods

Some of God’s deeds can be analyzed by means of rational procedures. However, this fact doesn't mean that God himself (or the world of transcendence) is rational. Of course, the fundamental properties of God cannot be characterized by any set of relations or equations. Anybody who would try to perform the analysis of God himself by rational methods or equations would finish his work with something that cannot characterize the God of Abraham, Isaac and Jacob (Ex 3,6) but something quite different.

Let us add that while in the region of transcendence it is more appropriate to look for the “truth” or for the “true answer”, in the region of the science it is much more adequate to speak about the “correctness” and the “correct” answer, of course, in frame of the underlying “philosophy”. Also the notion “proof” is adherent to what we call the scientific or material world.

In this connection we mention also the effort of John Paul II (cf. “Fides et ratio”, 106) to encourage especially the faithful Christians working in the field of philosophy that they try to clarify different spheres of human activity by applying the “ratio”, which becomes more sure and bright once it is supported by belief. And, the fearlessness of the ratio must respond to the sincerity of the belief (ibid., part 48).

VI. Exemplifying the cosmic distances

To get an insight into the cosmic scales let us adopt a model in which everything is miniaturized on a scale of 1:100,000,000,000 (= 1 : 100 billion). Given such a drastic reduction, one centimeter in the model corresponds to one million kilometers in reality. Accordingly, the 1.392 million-kilometer diameter of the Sun shrinks to 1.4 centimeters, about the size of a cherry. A small grain of sand -the Earth- revolves around the cherry at a distance of a meter and a half. Almost 8 meters from the Sun there is Jupiter, 1.4 millimeters in diameter; and 59 meters from the Sun there is Pluto, 0.05 millimeters in size. If we imagine the sun-cherry located in New York City, then the star that is our closest neighbor, Alpha Centauri, is 410 kilometers away in Rochester. We would find the next closest star (Barnard's Star) 560 kilometers away in Toronto. But the Andromeda galaxy, which in reality is 2.3 million light-years away, now shatters our attempt to construct the Universe on an earthly scale, for in our model it would be one and half times as far away as in reality the Earth is from the Sun. The farthest perceivable distance in our universe – from here to Quasar Q1208011, 12.4 billion light years away – produces in our model a distance corresponding to 7800 times the actual distance between the Earth and the Sun. And so our attempt to model actual distances itself collapses under the weight of the incomprehensible magnitude of the Universe [8].

VII. An interesting lesson from the history

On April 26, 1920 Harlow Shapley and Heber Curtis came together in Washington to discuss the state of the Universe. The question was this: What were the spiral-shaped nebulae, and how far away were they? From his studies of the Cepheids, Shapley had already established that our galaxy was some ten times bigger than scientists had previously thought. Because our galaxy was so big, Shapley reasoned that the spiral nebulae were related to our galaxy, and could not lie very far outside it.

Heber Curtis took the side of the old school: Our galaxy was far smaller than Shapley's Cepheid measurements had indicated. Since our galaxy is small, those remote spiral-shaped fuzzy patches are comparable in size and nature to our own galaxy, and are probably far away from it. Curtis had strong support from another important scientist: Back in 1914, Arthur Eddington suggested that the remote nebulae were really galaxies like our own.

Although no one knew it at the time, history records that Curtis won the debate by using the wrong argument – against Shapley – to come up with the right answer. The spiral nebulae are comparable in size to the Milky Way, and they are at incredibly vast distances from it. Although Shapley was correct in his argument about the size of our galaxy, he was wrong about the nature and distance of the spiral nebulae. Curtis was right about the nature of the spirals, but for wrong reason. Using the observational data of the time, both scientists did the best they could. It is interesting to compare scientific debates with political ones, where poise and the power of persuasion are paramount. In scientific debates neither poise nor persuasion have anything to do with it. Nature itself watches the arguments, quietly keeping score and choosing the winner [9].

VIII. Concluding remarks

(1) In the present contribution the distinction between facts and hypotheses is stressed. There are mentioned also some points of view on the interpretation of observations of the Universe. Mutual complementarity between religion and sciences is briefly sketched, too.

(2) While the science, especially the contemporary physical cosmology, indicates the end of the Universe (after several decades of billion years), the faith emphasizes a special mission of the human being. The appearance of the life and the creation of the man cannot be reliably described in terms of contingency. The science and the belief (or better: the faith) are essentially complementary, not contradictory.

(3) In the process of looking for answers to several questions more or less clearly outlined also in the present contribution, the light in darkness is brought by idea of John Paul II, in his encyclical letter "Fides et ratio", namely, *the belief and the reason are like two wings that help to move the human spirit towards contemplation of truth. The desire to recognize the truth and eventually to realize that God's image was put into the heart of the man by God himself with the aim that whenever the man will acknowledge and love God, he can reach also the full truth about himself.*

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