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THE BEGINNING OF THE UNIVERSE AS AN EPISTEMOLOGICAL FRONTIER- LEMAÎTRE TO GAMOW

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Abstract

It was in 1922, when Alexandre Friedmann proposed some models for cosmic evolution, that modern cosmology faced for the first time in a scientific way the problem of the origin of the universe. It was the inaugural step of the big bang cosmology (usually known as the Big Bang Theory), to which several important cosmologists contributed over the following decades. Among these cosmologists, there were two who played a special role: Georges Lemaître, who proposed the primeval atom theory, and George Gamow, who later assumed the hot and dense primordial state of the universe which contemporary cosmology continues to admit. In this paper, I present and compare the perspectives of these two great cosmologists towards the idea of the beginning of the universe as an epistemological frontier, that is, as an unsurpassable limit to the physical knowledge of the universe, namely with regard to an explanation of what caused this beginning and how the primordial universe had come into existence. Both cosmologists assumed that the beginning of our universe is located before everything that physics can achieve, but we can identify one important difference: according to Lemaître, the beginning of the universe is located before space and time, and we can admit that is an epistemological beginning and also an ontological beginning; according to Gamow, the beginning of our universe may have been the result of a preexistent cosmological state of the universe which is just inaccessible to physics, and therefore is not an ontological but just an epistemological beginning.

Keywords: Epistemological beginning; Georges Lemaître; George Gamow; Ontological beginning; Origin of the universe; Limit of scientific knowledge;

1. INTRODUCTION

It was in 1922, when Alexandre Friedmann proposed three possible models for cosmic evolution, that modern cosmology faced for the first time in a scientific way the problem of the origin of the universe. Indeed, through a relativistic approach, Friedmann admitted a beginning for the universe and even proposed formulas to calculate the age of the universe (Friedmann, 1922). Regarding his variable universe models (a monotonous universe in expansion from a zero-initial radius, a monotonous universe



in expansion from non-zero initial radius, or an oscillating universe with cycles of expansion and contraction), Friedmann later wrote in a book addressed to philosophers (Friedmann, 1923):

“This reminds certain mythological conceptions of the Hindus regarding “cycles of existence”; we could also speak of a creation of the universe from nothing. But all of this should only be taken as a curiosity (...).” (Friedmann and Lemaître, 1997, p. 275; original italics)

This Friedmann’s remark touches on the big and unavoidable question never solved by cosmology: how the primordial universe had come into existence and, even more, what caused this existence, that is, what caused the beginning of the universe (Kragh, 2007, p. 240).

As a unique and unrepeatably event, the beginning of the universe later baptized “Big Bang” is experimentally inaccessible, but, in a certain way, we can say that it is possible to reach it from a theoretical point of view and through observations of traces of the primordial universe, such as the cosmic background radiation or the relative abundance of chemical elements such as helium. But, as important authors have noted, the inflation theory, the best explanation of the big bang cosmology about the beginning of the universe, “starts shortly the Plank time [10⁻⁴³ s], but has nothing to say about earlier times, not to mention the magical moment of $t = 0$ ” (Kragh, 2007, p. 240).

Indeed, at quantum level, such as the earliest states of the universe would be, according to the big bang cosmology, the Planck time marks a limit for all physical knowledge, an epistemological limit for any scientific explanation of the beginning of the universe. This means that the state of the universe at the instant 10⁻⁴³ s of its existence is a limit of the cosmological knowledge not because a better scientific explanation has not yet been achieved, but because it is an ultimate physical limit (or first physical limit, given the context!) for what cosmology can achieve.

Friedmann did not develop his remark and just considered it as simple curiosity, as we saw in the quote above, but, since he has proposed his cosmological models, the assumption of a beginning for the universe has always confronted cosmologists with an epistemological frontier, that is, an unsurpassable limit to the physical knowledge of the universe. Among these cosmologists, there were two who played a very special role in the construction of the big bang cosmology (usually known as the Big Bang Theory): Georges Lemaître, who was the first to relate the recession of galaxies with space expansion and proposed the primeval atom theory, and George Gamow, who later assumed the hot, dense primordial state of the universe that standard big bang cosmology continues to admit. It is pertinent to search and compare the perspectives of these two great cosmologists about the great question behind this epistemological frontier: how the primordial universe had come into existence and, even more, what caused this existence. And that for at least two significant reasons: Lemaître and Gamow were two of main founders of big bang cosmology; one of them (Lemaître) was also a Catholic priest, which raises a pertinent curiosity about the way he scientifically faced the question of what caused the beginning of the universe.

2. GEORGES LEMAÎTRE AND THE VEIL HIDING THE CREATION

According to Lemaître, the beginning of the universe is an entirely natural state (Lemaître, 1972, p. 9), but the physics is unable to reach that beginning because it is located before space and time, and therefore is something before and outside everything that physics can achieve. That is the meaning of these Lemaître’s words, regarding his primeval atom theory, which defended the idea that all cosmic multiplicity results from an evolution which started from a single initial entity:

“In absolute simplicity, no physical problems arise. The beginning of multiplicity really means the beginning of the very meaning of any notion that encompasses a large number of individuals. Space and Time are among such notions. The beginning is located even before the beginning of space and time, which progressively acquire meaning as the multiplicity grows sufficiently. As space and time are the indispensable instruments for any physical notion, the beginning is located even before Physics. It is the inaccessible foundation of space-time.” (Lemaître, 1972, p. 9)

If the beginning of the universe is located before space and time, that is, before everything that can be studied by physics, then as it goes back in the cosmic history, cosmology is unable to reach and explain that beginning. We can say that the beginning of the universe is an epistemological limit, which is unattainable and even less unsurpassable. Or, in other words, the beginning of the universe is an epistemological beginning.

According to this Lemaître's vision, that it is not worth looking for explanations for the cause of the beginning through physics. Indeed, if the beginning is out of the reach of physics, even more out is any cause of this beginning. In spite of that, it is worth paying attention to one of the most important Lemaître's cosmological texts – "The Beginning of the World from the Point of View of Quantum Theory" (Lemaître, 1931). In this one single page article, Lemaître speaks briefly about the origin of the universe as quantum event and brings quantum indeterminism to the history of the universe, ending with this sentence: "The totality of matter in the universe must have been present from the beginning, but the story it tells us can be written step by step". However, it was later discovered that the manuscript paper contains this unpublished final paragraph, which Lemaître decided not to include in the published version of his text:

"I think that everyone who believes in a supreme being supporting every being and every acting, believes also that God is essentially hidden and may be glad to see how present physics provides a veil hiding the creation." (cited by Godart and Heller, 1985, p. 73)

This unpublished paragraph, which ends the manuscript paper preserved at the Archives Lemaître, Louvain-La-Neuve (Lambert, 1999, p. 77), is very significant. As a Catholic priest, Lemaître was aware of the risk that his scientific ideas could be easily associated with his religious beliefs. Throughout his scientific career, Lemaître has always tried to separate cosmology from theology (Robredo, 2011, p. 87-94; Lambert, 1999, p. 97-98), and the decision not to publish this paragraph of his manuscript may be understood in the light of this attitude. However, as someone "who believes in a supreme being", Lemaître is implicitly admitting in the unpublished paragraph that the universe was created by God. And we can admit that Lemaître, in line with Christian theology, is implicitly recognizing that the beginning of our universe is a divine creation from nothing (as Friedmann also mentioned in the quote above), that is, a true ontological beginning of the physical and cosmological reality we know.

Adding this to the idea that the beginning of the universe is located before space and time, that is, before everything that can be studied by physics, we can admit that, according to Lemaître, the beginning of the universe is not only an epistemological beginning but also an ontological beginning.

3. GEORGE GAMOW AND THE IMAGINATION FLYING BEYOND ANY LIMIT

In 1948, in the article "The Evolution of the Universe", Gamow presents for the first time an idea about the origin of the universe. Sketching an explanation for the primordial state of matter and for the current expansion, Gamow imagines, not only the initial state of the universe, but also a hypothetical previous state. For this, Gamow has to, in his own words, "let the imagination fly beyond any limit":

"According to this point of view, one must imagine the original state of matter as a very dense and superheated neutron gas that may have originated (if we let the imagination fly beyond any limit) as a result of a hypothetical collapse that preceded the current expansion. In fact, the extremely high pressures obtained near the point of complete collapse (singular point at $t = 0$) would have compressed the free electrons with the protons, transforming the matter into a superheated neutron fluid state." (Gamow, 1948, p. 680)

This imaginative exercise gives the hypothetical idea that the universe has, not only a history, but also a prehistory. Apparently do not remain any "archaeological records" that testify this hypothetical prehistory, unlike what happens to the subsequent history, "archeologically documented" by the relative abundances of some chemical elements (at this time, it was not yet known the cosmic background radiation). But this empirical emptiness did not stop Gamow from imagining an involution prehistory which would base a subsequent evolution history. This is an imaginative exercise about an inverted image of the initial history of the universe.

In this cosmogony we find an initial singularity that corresponds to a "complete collapse point" of matter (a "singular point") at time $t = 0$ in the history of the universe. We must note, however, that talking about $t = 0$ does not mean talking about the beginning of time, because that moment is just the transition from an involution era to an evolution era, from prehistory to history, and not a moment, therefore, of an absolute temporal beginning, such as 12 am of a day is nothing more than 12 pm of the previous day.

Later, in the book *The Creation of the Universe*, Gamow explicitly assumes himself as a supporter of the “hypothesis of a ‘beginning’” for the universe, in line with the “imaginative Belgian scientist, Abbé Georges Edouard Lemaître” (1957, p. xii).

But, contrary to what the hypothesis of Lemaître's primeval atom, which, according to Gamow (1957, p. 57), provides "spectacular views" about the evolution of the universe, the beginning considered in the "hypothesis of a beginning" does not correspond to the beginning of the universe nor to any beginning of time and space. On the contrary, the beginning in Gamow's hypothesis is only the beginning of a cosmological era, the era in which we find ourselves, the era in which evolution has transformed a disorganized elementary material, highly compressed and hot, into everything we currently know in the universe. In other words, this beginning is only the beginning of the universe as we know it, it is only the beginning of our universe, which is built from existing raw material.

This beginning would have been the starting point of the expansion and evolution of our universe, but, according to Gamow, it would also have been the arrival point of a previous collapse process:

“We can now ask ourselves two important questions: why was our universe in such a highly compressed state, and why did it start expanding? The simplest, and mathematically most consistent, way of answering these questions would be to say that the Big Squeeze which took place in the early history of our universe was the result of a collapse which took place at a still earlier era, and that the present expansion is simply an “elastic” rebound which started as soon as the maximum permissible squeezing density was reached.” (Gamow, 1957, p. 36; original italics)

Jacques Merleau-Ponty (1965, p. 372) considers that the initial state of the universe in Gamow's cosmogony functions as “an impenetrable screen to any attempt to know what was going on before it”, which has an obvious similarity with the Lemaître's primeval atom. But, despite some similarity, there is an essential difference that seems to escape this idea of impenetrable screen: although we must recognize that it is impossible to know what would have existed before the Big Squeeze, we can talk about involution, collapse, destruction of entities that would be built with the elementary particles that would later constitute the Big Squeeze. Neutrons would have existed in this era and it is possible to imagine the organization and involution processes that would have led to the Big Squeeze, a material state that is in some kind of cosmological transition, rather than in some very first cosmological beginning. In other words, we still within the boundaries of physics if we try to explain by this way the before and why about the beginning of the universe we know. It is precisely about this epistemological possibility that Gamow talks when he says:

“Most likely the masses of the universe were squeezed to such an extent that any structural features which may have been existing during the “pre-collapse era” were completely obliterated, and even the atoms and their nuclei were broken up into the elementary particles (protons, neutrons, and electrons) from which they are built.” (Gamow, 1957, p. 37)

But this very short imaginative essay (of a sentence) is just a generalist idea. And in the next sentence, Gamow surrenders to the evidence of unknowability about the organization of the previous era and the details of its possible processes of compression:

“Thus, nothing can be said about the pre-squeeze era of the universe, the era which may properly be called “Saint Augustine's era,” since it was Saint Augustine of Hippo who first raised the question as to “what God was doing before He made heaven and earth”.” (Gamow, 1957, p. 77)

The most distant past in the universe is thus assumed to be an inaccessible era to physics. At the conclusion of the book, Gamow adds:

“In the dim pregalactic past we perceive a glimpse of a metaphysical “Saint Augustine's Era” when the universe, whatever it was made of, was involved in a gigantic collapse. Of course, we have no information about that era, which could have lasted from the minus infinity of time (...).” (Gamow, 1957, p. 134)

We see that, for Gamow, the cosmological era which preceded Big Squeeze is "metaphysical" in the sense that it is beyond the concrete reach of physics. It is only in this sense that we must interpret the use of the word “metaphysical” in this passage from Gamow, and not in a religious sense. Anyway, it is clear that the Big Squeeze is not an ontological beginning, but just an epistemological beginning, because, if physics cannot go further, this is the beginning of the universe which can be scientifically studied. Surrendered, Gamow would say (1954, p. 63) that "from a physical point of view we must completely forget the pre-collapse period".

4. CONCLUSION

Although Lemaître and Gamow both assumed that the beginning of our universe is located before everything that physics can achieve, we can identify an important difference: according to Lemaître, the beginning of our universe is located before space and time, before any physical existence, and, although he did not state it explicitly, we can admit that, in his point of view, the beginning of our universe is, not only an epistemological beginning, but also an ontological beginning of our universe; according to Gamow, the beginning of the universe we know may be the result of a cosmological previous state, a real but inaccessible state to physics, and therefore we cannot say that the beginning of our universe is an ontological beginning of the physical reality, but just an epistemological beginning.

Unlike Gamow, it seems that Lemaître did not need to look for any physical explanation for the origin of our universe. As a Catholic priest, we can think that perhaps it was personally satisfying for Lemaître the idea that the universe (namely the primeval atom he imagined) was created by God from nothing, outside the reach of physics, and behind, in his own words, “a veil hiding creation”. Therefore, it may be tempting to admit the hypothesis that Lemaître’s belief in a Creator did not compel him to seek any physical explanations for the original state of the universe. But we do not know any Lemaître statements that point in this direction. On the contrary, Lemaître wrote that the Christian scientist must “abstract himself from his faith in his research” (Lemaître, 1936, p. 70) and did not appreciate the cosmological-theological concordism expressed by Pope Pius XII regarding the emergent cosmological ideas (Robredo, 2011, p. 92).

Regardless of this, it is clear that the origin of our universe was considered by both cosmologists, Lemaître and Gamow, as a physical frontier, a limit of scientific knowledge that stops physics to reach any satisfactory explanation for the creation of the universe. And it is the awareness of that frontier (at $t = 0$ s or $t = 10^{-43}$ s, it is indifferent) which is probably at the origin of an attitude of many cosmologists: to avoid the problem of the creation of the universe and to only focus on the evolution of the universe.

BIBLIOGRAPHY:

- [1] Friedmann A. Über die Krümmung des Raumes. *Zeitschrift für Physik*. 1922;10:377-386.
- [2] Friedmann A. *Mir kak prostranstvo i vremya*. Petrograd: Akademiya; 1923.
- [3] Friedmann A, Lemaître G. *Essais de Cosmologie*. Paris: Éditions du Seuil; 1997.
- [4] Gamow G. The Evolution of the Universe. *Nature*. 1948;162:680-682.
- [5] Gamow G. *The Creation of the Universe*. New York: The New Library of World Literature; 1957.
- [6] Gamow G. Modern cosmology. *Scientific American*. 1954;190:55-63.
- [7] Godart O, Heller M. *Cosmology of Lemaître*. Tucson: Pachart Publishing House; 1985.
- [8] Kragh H. *Conceptions of Cosmos – From Myths to the Accelerating Universe: A History of Cosmology*. Oxford, UK: Oxford University Press; 2007.
- [9] Lambert D. *Sciences et Théologie: Les figures d’un dialogue*. Namur: Presses Universitaires de Namur; 1999.
- [10] Lemaître G. The Beginning of the World from the Point of View of Quantum Theory. *Nature*. 1931;vol. 127:706.
- [11] Lemaître, G. La culture catholique et les autres sciences positives. In: *Actes du VIe Congrès Catholique de Malines; tome V*; 1936. p. 65-70.
- [12] Lemaître G. L’Hypothèse de l’Atome Primitif et le Problème des Amas de Galaxies. In: Lemaître G. *L’Hypothèse de l’Atome Primitif*. Neuchâtel: Éditions du Griffon; 1972. p.1-99.