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A *THEMATIC* APPROACH TO SELECTION EFFECTS AND BIASES IN COSMOLOGY: FRED HOYLE AND THE REJECTION OF THE BIG BANG IDEA, DESPITE THE EXPERIMENTAL OBSERVATIONS

Abstract: *Despite some important observations and after decades of widespread consensus around the big bang cosmology, Fred Hoyle, one of the proponents of the steady-state cosmology, continued to fight the big bang idea throughout his life.*

We can try to understand this persistent attitude of Hoyle through a Holtonian thematic *approach, by admitting that personal preferences and choices of scientists are conditioned by* themata.

Thematic analysis shows that big bang cosmology is mainly based on a set of themata *consisting of* evolution, finitude, life cycle *(which has a* beginning*), and* change*; the steady-state cosmology is based on opposite* themata: steady-state, infinity, continuous existence*, and* constancy. *Personal preferences seem to have been important in the strong and passionate dispute between big bang and steady-state ideas, and Hoyle is a very illustrative example of a personal commitment remarkably long-lived to some* themata*, in this case to the opposite* themata *of the big bang cosmology. In his personal and persistent struggle against the big bang idea, Hoyle always refused the way how some experimental observations were considered decisive in favor of this cosmology. This is a typical* thematic *attitude: letting some personal* thematic *preferences influence the acceptance or rejection of scientific evidence. In this case, that corresponds to the existence of selection effects and biases regarding important cosmological observations, in order to sustain a persistent rejection of the big bang idea.*

Keywords: *big bang cosmology; experimental observations; Fred Hoyle; selection effects and biases; themata.*

1. Fred Hoyle, a persistent opponent to an idea which, ironically, he helped to consolidate

Big bang cosmology (commonly known as the Big Bang Theory) has dominated all modern cosmology for more than fifty years.

After a strong dispute between the big bang cosmology and its big rival, the steady state cosmology, some important experimental observations in the

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1960s, such as the observation of a great abundance of helium in the universe and the discovery of the cosmic background radiation were decisive for the progressive and wide acceptance of the big bang cosmology and the forgetting of the steady state cosmology.

Despite those solid experimental observations favourable to the big bang cosmology, Fred Hoyle, one of the proponents of the steady state cosmology[1] (with Hermann Bondi and Thomas Gold[2]), and the main opponent of the big bang idea (which, curiously, he baptized)[3], never gave up and continued to fight this idea throughout his life, even after decades of widespread consensus around the big bang cosmology.

Ironically, Hoyle was one of the scientists who most contributed to establish one of the strongest evidence in favor of the big bang cosmology: the great abundance of helium in the universe. He describes how it happened:

> Helium makes up about a quarter of the mass of the visible Universe (...). Could the stars alone be responsible for producing such a huge amount of material? Working on this problem in 1964, R. J. Tayler (...) and I reluctantly decided that the answer was no, by a considerable margin. We found ourselves convinced that all the matter in the Universe must have emerged from a state of high density and high pressure, as George Gamow had always maintained. (Hoyle 1983: 175–176)

However, continuing to reject the idea of a single big bang at the origin of the universe which could be responsible for the formation of chemical elements such as helium, Hoyle suggests the idea of multiple "small big bangs" – explosions associated with quasars – as an alternative to explain the great abundance of the helium:

> Nevertheless, even then the case for the big bang was by no means proven. It seemed that matter had passed through an unusually concentrated state, but this might well have happened within the Universe. The material we see in the stars of our galaxy, and in other galaxies, could have originated in events which did not have to call on an origin of the whole Universe. Quasars (...) seemed to be a pointer in that direction. (Hoyle 1983: 176)
>
> It is now widely believed that variations from quasars have a family relationship to the explosions which sometimes occur at the centres of galaxies, explosions which clearly involve matter at high densities and temperatures, just as in the early moments of the proposed big bang itself. On account of this similarity, as a group they are often referred to as "little big bangs" (...). (Hoyle 1983: 178–179)

1 Hoyle 1948.

2 Bondi and Gold 1948.

3 Cf. Kragh 2013: 15–17.

We can see that Hoyle surrenders to the explosive logic of the big bang cosmology but without surrendering to big bang cosmology, because, in his idea, the small and multiple big bangs scattered throughout the universe dispense a big, single, and primordial big bang, that is, dispense a beginning of the whole universe.

Hoyle also refused to accept the cosmic background radiation discovered by Penzias and Wilson in 1965 as an echo of the big bang, arguing that it was too weak for that and proposing an alternative explanation in line with the steady state theory.

In his alternative explanation, Hoyle even proposed that cosmic background radiation could be produced by microorganisms scattered throughout cosmic space:

> To many astronomers it may seem a fantasy to suggest that microorganisms are responsible for the microwave background, but it is not a fantasy that the required particles exist. One can read about them in any textbook or handbook on bacteria. If bacteria really have the universal presence which astronomical observations suggest, I would consider it likely that they are responsible for the microwave background. (Hoyle 1983: 182–183)

Based on the idea of a never observed "universal presence" of bacteria and on the idea of bacteria as microwave sources, this explanation is doubly and deeply speculative. And the fact is that Hoyle never presented evidences capable of supporting his steady state perspective against the big bang idea, even in the context of the new version of the steady state cosmology that he later proposed with some collaborators, the *quasi-steady state* cosmology[4].

2. *Thematic* reasons of Hoyle's attitude towards the big bang idea

If observations seem to be so strongly in favor of the big bang idea and if, over time, the scientific community has generally forgotten the steady state cosmology, it is justified to ask: why this Hoyle's obstinate rejection of the big bang idea?

According to his own words, Hoyle rejected the idea of the big bang even without first examining it in detail. He recognized this in 1952:

> This big bang idea seemed to me to be unsatisfactory even before detailed examination showed that it leads to serious difficulties. (Hoyle 1952: 94)

Hoyle assumes here with great frankness that his bad impression of the big bang cosmology preceded any scientific analysis, that is, any detailed and

4 Hoyle, Burbidge and Narlikar 1993.

objective analysis of its strengths and weaknesses, whether on the theoretical or the experimental level. It is an attitude of denial without a clear logical or epistemological foundation. In this regard, Jacques Merleau-Ponty, who dedicated to the epistemology of modern cosmology, would say:

> The physicist's preference for antithesis [to the idea of a unique origin of the universe] does not, therefore, have a very solid justification; it is not even epistemological, properly speaking; (...) It comes almost from a mental hygiene. (Merleau-Ponty 1965: 343)

Being outside of any solid theoretical or empirical reasons, usually recognized as being fundamental to validating scientific knowledge, this possible Hoyle's "mental hygiene" seems to refer to some dimension of scientific activity more associated with personal conceptions, even if unconscious or not publicly assumed, and this seems to have a *thematic* setting.

Indeed, the *thematic* analysis proposed by physicist and historian of science Gerald Holton identified in the scientific activity a dimension that, even unconscious or not assumed, is nevertheless very important in the work of scientists, in articulation with the theoretical and experimental dimensions of science. This is the *thematic* dimension, constituted by *themata* – concepts, methods, and hypothesis with a metaphysical, aesthetic, logical or epistemological nature, not only associated to the cultural context, but also to the individual psychology of scientists[5].

Adherence to *themata* is, in general, a lasting fidelity, a "loyal dedication" (Holton 1996a: 159), a personal commitment "remarkably long-lived" (Holton 1975b: 334), which can nurture strong convictions and, in some cases, sustain a will to be right even when there is no good evidence to support that convictions. In these cases, it is a question of *thematic* imagination, which consists, in Holton's words, in "letting a fundamental presupposition – (...) a *thema* – act for a time as a guide in one's own research when there is not yet good proof for it, and sometimes even in the face of seemingly contrary evidence" (Holton 1996a: 96).

According to Holton, a *thema* can function at an individual level as a "guide" (1996a: 96), a "deep conviction" (1996a: 59), an "attachment" (1996a: 158), a "preference" (Holton 1996b: 201), a "preconception" (1996b: 201), a "predisposition" (1996a: 153), a "belief" (1996a: 96; 2005: 145), which can be "obstinate" (1996a: 96), a possible "enchantment" (1996a: 101). As a result, *themata* are elements that establish a "conceptual and even emotional support" (1996a: 159) capable of strongly determining the scientific work, although they are often unconscious for scientists themselves.

In practice, *themata* can be expressed through personal preferences and choices which guide the individual and collective work of scientists. In such work orientation, which can be more emotional than rational,

5 Cf. Holton 1975a: 54–58.

rarely conscious and even more rarely admitted, there could be a strange relationship with truth and falsity: if some objective knowledge (analytically and/or experimentally achieved) does not fit into the *thematic* matrix (a set of personal *themata*) of a scientist, it is quite possible that this scientist is suspicious of that knowledge, seeing it as false or, at least, as incomplete or imperfect, and imagining a truth not yet discovered, but conforms to his personal set of *themata*.

Therefore, the acceptance or rejection of a certain idea may be conditioned by personal *themata* and something which is accepted by a scientist as a proof of that idea may be considered by another scientist, who defends different or even opposites *themata*, as something that may or should be interpreted in other way.

The big bang cosmology is mainly based on a set of *themata* consisting of *life cycle* (with a *beginning*), *evolution*, *finitude*, and *change*. The steady state cosmology is based on opposite *themata*: *continuous existence*, *steady-state*, *infinity*, and *constancy*[6]. The passionate controversy that these cosmological views carried out is part of an old cosmological opposition: the *thematic* opposition between an evolutionary view of the world (traditionally associated to Heraclitus) and a stationary view (traditionally associated to Parmenides)[7].

The relationship with *themata* always has very personal contours and modern cosmology seems to have been no exception. In addition to theoretical issues and experimental observations, adherence to one or the other cosmological current also had to do with adherence to one or the other *thematic* matrix of cosmology, which brought an important personal dimension to the dispute. This was, in fact, what Jacques Merleau-Ponty proved, although without knowing or using the concept of *thema*, when he showed how, in the 20th century, the answers to important cosmological questions that were difficult to answer were driven by the «uncertainties of opinion and belief» (Merleau-Ponty 1965: 107).

According to Helge Kragh, "scientists can have emotional preferences for a theory for all sorts of reasons" (Kragh 1996: 267). And, being a territory especially open to personal preferences, cosmology allowed disputes that occurred, not only theoretically and experimentally, which are traditionally considered scientific, but also, and very intensely, in other domains traditionally and considered not scientific, such as the domain of philosophical (especially aesthetic and metaphysical), religious and even political motivations and options (Kragh 1996: x, 220–232, 237, 249, 251–268).

Other authors, like Yuri Balashov, also showed how "philosophical considerations have been essentially involved in the origin and development

6 Cf. Holton 1975a: 62; Cf. Barbosa 2021: 9.

7 Cf. Holton 1975a: 45; Cf. Merleau-Ponty 1965: 300.

of the steady-state cosmological theory" in explicit and implicit ways (Balashov 1994: 933).

Right in the introduction to the 1948 paper in which he presented his steady-state theory, Hoyle wrote:

> The following work (...) arose from a discussion with Mr T. Gold who remarked that through continuous creation of matter it might be possible to obtain an expanding universe in which the proper density of matter remained constant. This possibility seemed attractive, especially when taken in conjunction with aesthetic objections to the creation of the universe in the remote past. (Hoyle 1948: 372)

It is remarkable how the starting point of a scientific paper is an assumed aesthetic preference, with Hoyle presenting the creation of the universe in the remote past as an aesthetically repulsive idea, as opposed to the idea of continuous creation of matter.

From a *thematic* point of view, we can say that it is an aesthetic preference for the *thema* of continuous existence over the *thema* of life cycle, for the *thema* of steady-state over the *thema* of evolution, for the *thema* of constancy over the *thema* of change.

This preference that Hoyle classifies as aesthetic is linked to a fundamental metaphysical issue related to causality, as Hoyle immediately adds in the following sentence:

> For it is against the spirit of scientific inquiry to regard observable effects as arising from "causes unknown to science", and this in principle is what creation-in-the-past implies. (Hoyle 1948: 372)

This metaphysical issue related to causality was an important question to the founders of the steady-state cosmology. Bondi, whom Hoyle thanked the contributions to his paper of 1948 and to "many discussions on the general problems of cosmology" (Hoyle 1948: 372), also expressed his preference for a theory "in that the problem of the origin of the universe, that is, the problem of creation, is brought within the scope of physical inquiry" (Bondi 1960: 140), which, according to him, was not the case of the big bang theory.

So, we could say that some aesthetic and metaphysical preferences seem to have somehow influenced and even conditioned important scientific ideas about the universe, namely in the construction of the steady-state theory. In the case of Hoyle, we can say that, from a *thematic* point of view, some observations were difficult to fit or even seemed to contradict the personal set of *themata* to which he was faithful, especially the *continuous existence*, which dispenses *a beginning* of the whole universe.

In his personal struggle, Hoyle refused throughout his life the way how some experimental observations were considered decisive in favour of the big bang idea, always looking for alternative explanations for those observations.

Considering the *thematic* features in question and because it was a persistent and long-lived attitude, we can say that the obstinate rejection of the big bang idea is a Hoyle's *thematic* attitude.

It should be recognized that, apparently, this attitude has somewhat changed throughout Hoyle's life. Indeed, recognizing that each of the theories (big bang and steady-state) has its strengths and its weaknesses, Hoyle stated in 1983:

> I have always tried to hold a balanced point of view between several possibilities, whereas some scientists often seem to feel the need to declare themselves unequivocally for one theory or another, rather as if they were supporting a political party or a football club. (Hoyle 1983: 179)

If from the 1940s to the 1960s Hoyle was a radical and fierce opponent to the big bang idea, some decades later he had a more moderate position, materialized in theoretical proposals like the "small big bangs" idea or the quasi steady-state theory (proposed with Burbidge and Narlikar). From a *thematic* point of view, these Hoyle's later ideas conciliate in some way continuous existence with life cycle, steady-state with evolution, constancy with change. However, if we can recognize a softening of attitude towards the big bang idea and its *thematic* matrix, we also must recognize that, in the most essential, Hoyle's fidelity to continuous existence, steady-state and constancy has remained, as we can see in these words of *The Intelligent Universe*, about two decades after the defeat of the steady-state theory and a few pages away from those in which he talks about small big bangs:

> The present orthodox concept of a Universe as a kind of island in time [the temporal finitude advocated by the big bang idea] is all too reminiscent of the erroneous older conception of the Universe of stars as an island in space. The mistake is essentially the same, and it springs not from objective scientific reasons but from sociological and cultural prejudices. (Hoyle 1983: 166–167)

3. *Thematic* preferences, selection effects and biases

This *thematic* attitude expresses a personal *thematic* preference. But scientists' *thematic* preferences are, at bottom, valuations (or overvaluations) of certain aspects to the detriment of others. Indeed, if *themata* can guide the individual and collective work of scientists and, therefore, conditionate the acceptance or rejection of a scientific idea, we can recognize that personal *thematic* preferences of scientists can influence the personal assessment of theoretical or empirical scientific elements: such preferences can compel a scientist to overvalue elements that fit well in his *thematic* matrix and to devalue, or even to ignore, elements that are difficult to explain by a theory belonging to his *thematic* matrix.

Another way of saying this is to recognize that the conditionings that *themata* and *thematic* preferences operate in the ideas and work of a scientist or a scientific community materialize in the form of selection effects and biases.

According to Hoyle, the defenders of the big bang idea devalue alternative possibilities, such as the little big bangs, and ignore the difficulties of the idea they defend:

> Most astronomers and physicists do not like the idea of attributing such great significance to little big bangs, even though there are evidently very many of them. (...) The majority of astronomers and physicists seem to prefer to commit themselves to the idea of the big bang, although by doing so a number of serious difficulties have to be ignored, swept under the rug, difficulties which indeed it may never be possible to resolve from within this particular theory. (Hoyle 1983: 179)

In other words, we could say that, from Hoyle's point of view, the acceptance of the big bang cosmology is, after all, a problem of selection effects and biases concerning some cosmological observations.

However, the defenders of the big bang idea could legitimately say the same thing about Hoyle: his interpretations and alternative explanations about the observations widely regarded as important evidence of the big bang idea "suffer from the same problem" of selection effects and biases. It is a problem easily unconscious and difficult to recognize for those who "suffer" from it, because *thematic* preferences are often unconscious and strongly defended even facing insufficient evidence or contrary evidence.

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