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At Home in a Super-Copernican Cosmos: The Genesis of John Wheeler's Participatory Universe

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Abstract: At the Smithsonian symposium for the 500th anniversary of the birth of Copernicus (1473-1543), the eminent physicist John Archibald Wheeler (1911-2008), paradoxically, gave a lecture with an "anthropic" flavor: *The Universe as Home for Man*. This left the audience perplexed, and still does today. By closely looking at the historical documentation, the present contribution will clarify how Wheeler reached those ideas and what he could possibly mean by them, also in the light of subsequent developments. Such contextualization can also allow us to put his views in dialogue with those of other distinguished figures, thus unveiling a series of interconnections that make the later debate about the so-called "anthropic principle" much more interesting and, at the same time, correct some frequent misunderstandings.

Keywords: cosmology, geometrodynamics, anthropic principle, biocentrism, super-Copernican principle.

1. *Épater les bourgeois*: the 1973 Copernican celebrations

Smithsonian Institute, Washington DC, 22-25 April 1973. At the commemorative symposium for the 500th anniversary of the birth of Copernicus (1473-1543), John Archibald Wheeler (1911-2008), chairman of the event, shook up the conference with a lecture that, even in the title, had an "anthropic" (slightly *ante litteram*) connotation, to say the least: *The Universe as Home for Man.* The audience did not fail to notice the paradoxical situation (Gingerich 1975, p. 587). But was it really possible that such an eminent physicist was just making a childish mistake like that about the Copernican Revolution? Moreover, it was not the first time Wheeler was celebrating the Polish astronomer: in October 1947 he had delivered a speech at the ceremony of placing wreath upon the statue of Copernicus in Krakow, while in 1967, for the centenary of Marie Curie, he compared her to her fellow countryman: *Maria Sklodowska Curie: Copernicus of the World of the Small* (Wheeler 1968). In September 1973, furthermore, he would reiterate his ideas in Poland (when Brandon Carter first spoke of "anthropic principle"); and the local committee for the Copernican celebrations would also award Wheeler the Nicolaus Copernicus Medal. Even recordings of his 1973 speech exist, while in the 1980s he still made use of his text in teaching.[1] Was all this just one of the ironies of History? A naïve series of mistakes from multiple sides? Or even a provocation? This paper will provide an interpretive key to Wheeler's highly original (and baffling) speculations, properly identifying the traits that – he thought – were bringing the legacy of Copernicus to a new level.

As has often happened in Wheeler's case, much confusion has been created by readers with troubles in understanding his flamboyant rhetoric and creative proposals, as well as by people without any historical inkling of his previous reflections (or in search of remarks from an illustrious scientist to

[1] John A. Wheeler Papers, American Philosophical Society Library, Philadelphia, box 189 (1947 event); box OS4 (Copernicus Medal); box 154 (teaching during the 1980s); rec. 206 and 226 (1973 recordings).

allegedly support their own beliefs). If even a superficial but diligent historical enquiry could trace some of Wheeler's sources and inspirations, such as Robert Dicke's questions about natural constants and their seeming fine-tuning for life, a proper historical-epistemological examination of Wheeler's archival papers is necessary to contextualize and understand the bold ideas he ventured to propose during the 1970s. We intend to offer the essential elements for this hermeneutic operation, after which Wheeler's positions will appear less paradoxical.

Let us first depict the stone of scandal. If we were just to externally characterize the 1973 Smithsonian event, it would be easy – either for someone who attended it back then or for a generic historian – to have expectations more or less like the following: a renowned scientist, no longer in his prime, will now repeat few historical commonplaces for the big celebration in which he is routinely involved and then, maybe, add some words about the scientific enterprise that, a few centuries later, still goes on, towards new horizons. That is a scene which occurs regularly. Wheeler, however, starts on a different note: "'The last of life, for which the first was made, is yet to come.' Can one change these words of Robert Browning from a statement about life to a question about discovery?" – and he goes on: "Are the discoveries from Copernicus to today only the prelude to greater discoveries? Are we ever to clear up the greatest mystery of all, the origin of this universe that is our home?" (Wheeler 1974, p. 683). Our typical attendee must already be thinking that Wheeler surely meant *home* in some loose, metaphoric sense – they are celebrating the man who dethroned the human species from the center of the universe, after all. The speaker proceeds with some reference to Hutton and Lyell, Freud, Darwin: something may not sound exactly on point, but – one could reason – he must be referring to the usual trio that disillusioned mankind. Then Wheeler dedicates the first part of his speech to recent developments in the astronomical and astrophysical picture of the universe (in particular, X-ray and radio astronomy, as expected in those years, and a foreshadowing of gravitational waves, as expected from Wheeler). All clear, pretty much.

Before explicitly turning to cosmology (the lecturer is one of the leading figures in general relativity), however, some apparently idiosyncratic remarks begin to appear. "The discoveries of the future will outnumber those of the past, we can believe, because of the pace in today's science, the tools, and the pressure; but will they be greater? Nothing so much encourages an affirmative answer as the mysteries encountered wherever we turn". Sure, why not. "Each one of us has his own catalogue of the great unknowns: three at the top of my own list are the mind, the universe, and the quantum". That is intriguing. "I know no area where the mystery is greater than it is in these three fields, or any where the linkage between observer and system observed is stranger, or any more suggestive of things hidden beyond present imagination" (Wheeler 1974, p. 685). Then, quite out of the blue, Wheeler starts to recall the case of a "patient lying on the operating table, with brain case open, following past and present in an amazing stream of double consciousness, a consciousness more over strangely observing consciousness". He then raises questions that may almost sound outrageous (at least to a certain mindset): "The brain is small; the universe is large. In what way, if any, is the universe, the observed, affected by man, the observer? Is the universe deprived of all meaningful existence in the absence of mind? Is it governed in its structure by the requirement that it give birth to life and consciousness?". Luckily, such outlandish suggestions are immediately counterbalanced by a couple of others: "Or is man merely an unimportant speck of dust in a remote corner of space? In brief, are life and mind irrelevant to the structure of the universe? or are they central to it?" (*ibidem*).

Any half-breath of relief gets nonetheless interrupted by Wheeler's verdict: "Lack of conclusive evidence on so cosmic an issue suggests that something is still to be learned about how the universe came into being" – at which point he begins a survey of relativistic cosmology and black holes, as probably anticipated by whoever knows his name, but first he calls the universe nothing less than "the home of man". The already evoked fascination of "mystery" is repeatedly emphasized: "The cat in *Alice's Adventures in Wonderland* disappeared from view, all except its grin" (Wheeler 1974, p. 687), like matter completely collapsed into a black hole. "What strange picture of physics are we coming to?

[...] Collapse is dissolution. There is not one law of physics that does not require spacetime for its statement. With the collapse of the universe, the framework falls down for everything ever called a law" (Wheeler 1974, p. 688). And here we go again: "What role, if any, does a future requirement for life and mind play in the structure of the universe?" Not a common question for scientific cosmology, which at that time had only recently started to gain respectability. However, "[p]hilosophy debated this issue before it began to come within the purview of science". There follows some dizzying name-dropping – or so it seems – that can probably add perplexity to perplexity: Parmenides, Socrates, Plato, Aristotle, Berkeley… But Wheeler does not go off on a wild tangent: he soon rephrases what he has been trying to say, even speaks of experimental testability, and explicates the link to Dicke's questions about the purported coincidences between the numerical values of natural constants and the emergence of life: "[Is] the 'initial adjustment of the structure of the universe' made in such a way as to render possible the existence of the knower? If so, this is a testable prediction, in the sense that it exposes itself in principle to destruction in a dozen ways" (*ibidem*). Well, that might not be so clear and simple, concretely speaking; or, at least, it may involve an unusual notion of testing: "To make the test, examine the effect of a change in the original adjustment and see if it would rule out life". Still, what is truly important at this point is the following statement, which sheds light on Wheeler's overall plan (and subversive aims):

> One view holds that as we keep on investigating matter, we will work down from crystals to molecules, from molecules to atoms, from atoms to particles, from particles to quarks – and mine to forever greater depths. A very different concept might be called the 'Leibniz logic loop'. According to this view the analysis of the physical world, pursued to sufficient depth, will lead back in some now-hidden way to man himself, to conscious mind, tied unexpectedly through the very acts of observation and participation to partnership in the foundation of the universe. To write off the power of observation and reason to make headway with this question would seem to fly against experience (Wheeler 1974, p. 689).

In line with the previous emphasis on mystery, Wheeler now turns to the "quantum principle", which he compares to nothing less than Merlin the magician, the shapeshifter. If the designation is unconventional, the underlying attitude is quite unusual, too: Wheeler is considering on equal footing *all* the various formulations of quantum mechanics (without distinguishing between formulations and interpretations, so that Birkhoff and von Neumann's attempt at putting quantum logic at the basis of quantum physics is in the same list as Everett's views), with the notable exceptions of those trying to recover a fundamental classical level. Those are the shapes that Merlin adopted. The challenge is to look at each one of them in search of clues, capable of heuristically leading to a deeper understanding, instead of fossilizing in debates to make one prevail over the others. At that point, another remarkable statement of intent appears:

> Three mysteries we have passed in review that call out for clarification: the quantum, the universe, and the mind. All three lie at that point where, in the phrase of Fred Hoyle, 'mind and matter meld'. All three threaten that clean separation between observer and observed which for so long seemed the essence of science (Wheeler 1974, p. 690).

That is a task for the future, perhaps for the next 500 years – the continuation of the legacy of Copernicus, "to whom more than any other we give the credit for initiating the last 500 years of science" (Wheeler 1974, p. 691). In other words, Wheeler is not-so-tacitly assuming that the usual way the adjective "Copernican" is (mis-?)used in contemporary cosmology will be swept away by the great discoveries that await mankind, still in its infancy.

> Surely the ever-increasing pace, tools, and pressures of science augur more discoveries in the next 500 years than in the last 500 years. That the discoveries will be greater, nothing argues so strongly

> as the depth of the mystery in which we live. We can believe that we will first understand how simple the universe is when we recognize how strange it is (Wheeler 1974, p. 691).

A commonplace scientific optimism has rarely been so outrageous toward scientific commonplaces. As if the one above was just a smooth and incontestable passage, Wheeler then adds a final sigil, in the form of a sort of prayer-poem to Copernicus, elected as patron saint of those future endeavors: "Remind us that there is no other universe / Than the universe of mind and man, / The universe that is our home" (Wheeler 1974, p. 691). Can there be a more bizarre prosopopoeia for Copernicus? No wonder that, after the speech, the philosopher Daniel J. Callahan, who was present there, commented: "In a curious sense, and particularly after hearing Professor Wheeler this morning, I came to feel that, despite all the talk of the Copernican Revolution – which supposedly displaced man from the center of the universe – he was really coming back to say that indeed man is still the center of the universe" (Gingerich 1975, p. 587).

2. Prolegomena and aftermaths

Let us try to make sense of the singular performance we have just re-evoked. By 1973 Wheeler could boast a couple of decades of research in general relativity (or "geometrodynamics", as he called it) and related astrophysical and cosmological issues: after the success of the first part of his career as a nuclear physicist, he had also become one of the leading authorities in matters of gravitation, at the head of one of the most important groups – the Princeton group – in the recently born relativistic astrophysics. His efforts at dusting off Einstein's general relativity and exploring its untapped potential, however, as original and fruitful as they were, still kept a quite conventional "naturalistic" outlook in the background. By the late 1960s, Wheeler's most ambitious aims for geometrodynamics – not just the treatment of new astrophysical and gravitational phenomena, but a comprehensive geometrization of everything at a fundamental level – entered into a crisis: the tools of general relativity seemed no longer sufficient to pursue his guiding vision (Blum & Furlan 2022). This led him back to Niels Bohr's lessons about the role of the observer and, as usual, Wheeler's transfigured other people's ideas in his own way. The result (actually quite different from Bohr's epistemology, but clearly inspired by it) was the "observer-participator": echoing Wheeler's own words (Wheeler 1973), we may say that the observer could no longer be omitted, in a classical fashion, or imagined to be behind a looking glass, through which the self-playing mechanism of the universe could be investigated – instead, the glass had been crashed and the observer could no longer be conceived as remaining outside of the world, undisturbing. If this led to exaggerations or misunderstandings that Wheeler's own way of speaking may have fostered, we can still say, with a slightly more refined philosophical lexicon, that such a turning point represented quite a deep change from a naturalistic outlook, in which the observer was just considered as a being emerging way down the road of complexity, to a "critical" view (in a loosely Kantian sense), which *ab initio* considers the role of the observer and focuses on the preconditions of knowledge. While this is certainly a key element to which we shall return, we also have to better outline how Wheeler reached that point in his reflections.

The answer is to be found not only in the shortcomings of geometrodynamics, but also in the deep suggestions or hints that it had offered, at least according to Wheeler himself. The most spectacular novelty of those years (and one of the reasons of Wheeler's fame), the black hole, had indeed been pushing him to question the fundamentality (in a straightforward ontological sense) of space, time, and even physical laws. Black holes seemed to tear space apart and to mark the "gates of time": as such, they were also a sort of window on the initial and final singularities of the universe itself, the Big Bang and the Big Crunch, of which Wheeler was strongly convinced due to his picture of a closed cosmos (Blum & Furlan 2022). Furthermore, the notion itself of physical law was, in Wheeler's eye, called into question by the properties of black holes: the impossibility of distinguishing leptonic and baryonic forms of matter, once they crossed the event horizon, was read by Wheeler not much as a violation, but as the "transcendence" of well-established laws, such as

the conservation of baryonic and leptonic numbers (Wheeler 1973), which were simply losing any meaning in that situation. Wheeler's speculative conclusions, then, were denying that physical laws are given "from everlasting to everlasting", or that they could be seen as pillars of a metaphysical order that no physical event could help but obey. The metaphysical objectivity of a naïve naturalistic outlook was thus radically challenged: perhaps there was no autonomous central mechanism of the world, at all.

This philosophical (or epistemological) shift was accompanied by a cosmological one, too, which allows us to introduce other crucial elements. Previously, Wheeler's cosmology, within his geometrodynamical view, was cyclic: a closed universe undergoing expansion and contraction, in a series of Big Bangs and Big Crunches. Wheeler, however, had added a touch of originality, intertwining this model with another issue he had been considering, that of fundamental constants. If his sensitivity as a theorist had long made him dislike the free parameters represented by the constants' numerical values (so that he was hoping to somehow derive them from deeper principles), we should recall again that, in the Princeton *milieu* (and in quite close contact with Wheeler's group), Robert Dicke had been raising questions about fundamental constants and their seeming fine-tunedness as to allow for the emergence of life as we know it (Blum & Furlan 2022). Wheeler's peculiar cyclic cosmology was a purely naturalistic (in the sense of autonomous and observer-independent) machinery which, from cycle to cycle, assigned randomly (in a quantum way) new sets of values to fundamental constants: if they seem to be fine-tuned to our life's prerequisites, it just means, since we are here, that the universe happens to be in one of the cycles with values compatible for life. With the crisis of geometrodynamics and the questioning of its implicit metaphysics, however, Wheeler changed cosmology, too: getting rid of cycles, he tried to link the participatory role of the observer to the fundamental features of the universe – and thus we find again the questions he raised in his "Copernican" speech. The *pars destruens* of his twenty years of geometrodynamics – laws getting "transcended" – had been illustrated at the great Trieste symposium for Dirac's 70th birthday, in October 1972 (Wheeler 1973). In that same period, indeed, he was also taking action to finalize the organization of the celebrations of the other great anniversary recurring a few months later: 500 years since the birth of Copernicus. Wheeler was at the head of the Smithsonian event that was to take place in April: there and then, as we have seen, he would sketch the *pars construens* for a new physics, or at least his hopes for it. The speech itself, besides (and before) getting published in the proceedings of the celebration (Gingerich 1975), was published in the *American Scientist* (Wheeler 1974). Accompanying the text, a stylized portrait of Copernicus with a flower in his hand is suggested to represent the human mind, the "flower of creation" (Fig. 1). Clearly, Wheeler was not afraid of exhibiting his unusual views about Copernicus.

If we have somehow outlined the logic behind Wheeler's "madness" and his reference to the role of the observer and the mind, it still seems as if he was making use of Copernicus just as the spark of the Scientific Revolution: we have not solved yet the tension between what came to be typically called "Copernican" and Wheeler's nonchalant proposals. For sure, he was not merely using the 1973 celebrations as a random pretext: as we have anticipated, already in 1967, for Marie Curie's centenary, Wheeler called her "Copernicus of the small" (Wheeler 1968): that is, Copernicus as a synonym for the initiator of a fruitful collective enterprise. However, the actual connection that Wheeler must have seen between his own baffling suggestions and Copernicus still seems missing.

We can get a clearer insight thanks to a later text, in which Wheeler, by then proposing a different but not unrelated framework (as we shall soon specify), spoke of a "super-Copernican principle":

> Are life and mind indeed unimportant in the workings of existence? Is life never to inherit the vastness of space because today its dominion is so small? Or is not rather life destined to take possession of all the out-there because the time available for conquest is so large? How easy it is to be overimpressed by the remoteness of the quasars; how tempting to discount as anthropocentric any purported place for life and mind in the construction of the world. Is it not even more

> anthropocentric to take man's migration by foot and ferry in fifty thousand years as the gauge of where life will get in fifty billion years? The fight against here-centeredness began with the 1543 *De revolutionibus orbium coelestium* of Copernicus. The time-bridging power of the elementary quantum phenomenon warns us today to battle against now-centeredness. Life and mind: for how much can they be conceived to count in the scheme of existence? Nothing, say the billions of light years of space that lie around us. Everything, say the billions of years of time that lie ahead of us. It cannot matter that man in time to come will have been supplanted by, or will have evolved into, intelligent life of quite other forms. What counts – in the ideal view being explored in this paper – is the rate of asking questions and obtaining answers by elementary quantum phenomena, acts of observers-participancy, exchanges of information (Wheeler 1988, pp. 125-126).

These lines are no less unconventional than those we have already examined, but they do make us quite easily understand, finally, what Wheeler was up to, under the aegis of the Polish astronomer: he was fighting the now-centeredness of our picture of the universe, in the same way Copernicus had fought the here-centeredness!

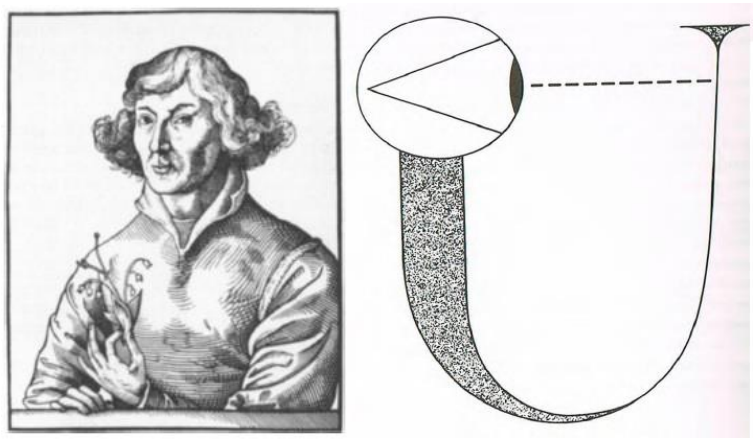

Fig. 1. On the left, Copernicus and the flower of creation. Wheeler's caption says: "Nicolaus Copernicus, Torun 19 February 1473-Frauenburg 24 May 1543. The flower that Copernicus holds, for him a symbol of medicine, may serve for us to symbolize a central mystery of today: What part do the future requirements for life and mind have in fixing the physics that comes into being at the big bang and fades away at collapse? Are the universe and life related as flower case and flower? (Courtesy Owen Gingerich.)" (Wheeler 1974, p. 690). On the right, Wheeler's self-referential cosmology: "Symbolic representation of the universe as a self-excited system brought into being by "self-reference". The universe gives birth to communicating participators. Communicating participators give meaning to the universe" (Patton & Wheeler 1975, p. 565).

We may say that the emphasis on the community of "observers" was already in the 1973 paper, even if, back then, it mainly seemed a side remark about the collective nature of science, while, by the late 1980s, the relevance of such a community had become entrenched within the physics itself, with explicit epistemological components, that Wheeler was trying to envision. Regarding this point, therefore, we have to add a few words about the aftermath of the Copernican celebrations. Wheeler's 1973 exploit was not isolated, not even in written publications: he would go on developing those ideas in other papers, notably *Is Physics Legislated by Cosmogony?* (Patton & Wheeler 1975) and *Genesis and Observership* (Wheeler 1977). This phase, however, was transitional. As typical of Wheeler, he never rejected the proposals he put forward in that trilogy of papers, but kept elaborating on them, with tacit but crucial changes. By the end of the 1970s, for instance, it is clear that Wheeler had abandoned even the overtones that could make his 1973 speech resonate with Wigner's positions about quantum mechanics and the role of consciousness (Wheeler 1978). A gradual "soberification" of Wheeler's views was taking place: a more conventional explanation would trace this to his move to Texas and the new *milieu* that he encountered

there (and that he contributed to create), with an attention to the foundations of quantum physics closer to experimental situations. More surprisingly, but no less importantly, a parallel channel that allows us to document such a metamorphosis is represented by Wheeler's engagement with none other than Leibniz. It is not the case, here, to expand upon Wheeler's own "upgraded" monadology" (Wheeler 1982; Furlan 2020) – suffice it to say that, in a sense, the potentially solipsistic model of the cosmogonic observer-participator was in this way pluralized (by the plurality of monads, of course): it is not that we are at the center of the cosmos, exclusively, but we are a center nonetheless. At the same time, the cosmogonic observer-participator, as mentioned a few moments ago, was getting de-conscientialized, since the observer or the monad was not necessarily a human or conscious being: Wheeler, echoing Bohr, started to repeat that "[n]o elementary phenomenon is a phenomenon until it is a registered (observed) phenomenon" (Wheeler 1982, p. 560), no consciousness was strictly required to set the cosmic quantum game in motion. From such a peculiar monadology, then, we get the picture of a participatory universe with a plurality of "centers", which, if not Copernican, is quite Brunian and thus post-Copernican – but certainly not Aristotelian-Ptolemaic or pre-Copernican. It is in the context of similar reflections that Wheeler would speak of the already mentioned "super-Copernican principle", involving a network of observers *lato sensu* (not necessarily anthropomorphic), scattered in space *and* time.

Rather than of anthropocentrism, at this point, we could be tempted to speak of biocentrism (hence Wheeler's interest in ideas about the origins of life, such as Eigen's or Prigogine's),[2] even if that too could perhaps constrain and mislead about the meaning that Wheeler assigned to "observation" during the 1980s. Incidentally, his famous "it from bit" descends from all this: far from being *ab ovo* a reification of some abstract and objectively given notion of information, Wheeler's bits are the most simple answer to a "question" due to observer-participancy: a binary alternative, for a system having just two quantum states (Wheeler 1988). In this sense, the blueprint of the cosmogonic observer-participator, or self-referential cosmology (Fig. 1), with its deep intertwinement between the coming into existence of the universe and the emergence of the observer (and the relevance of the latter to the former), got "recycled" and encapsulated into Wheeler's new vision. Information, for him, is not simply given, but is indissolubly linked to acts of observer-participancy. Needless to say, the boldness (and the vagueness) of this proposal is the reason why it has been almost always misunderstood, but also, at the same time, the reason why it offered inspiration to so many viewpoints that took it with a different, or even incompatible, kind of one-sidedness, from C. Fuchs to D. Deutsch and more. That is the fate (and the fruitfulness) of many of Wheeler's ideas.

Misunderstandings, however, were the order of the day even when it came to his (or his interlocutors') early "anthropic" considerations. It is well-known, after all, that people have been for a while distinguishing between different forms of "anthropic principle" (Barrow & Tipler 1986) – but arguably its very designation as "principle" betrays Wheeler's intentions.[3] As for the adjective "anthropic", it does seem quite fitting for his 1973 talk, but, as we have sketched, it is quite misleading when applied to his reflections just a few years further on (as much as he did not give up considering the universe "as home for man"). Brandon Carter himself – the man to whom the origin of the phrase "anthropic principle" is usually ascribed (Barrow & Tipler 1986), as much as his views had long been in dialogue with Dicke's and Wheeler's – would later complain about how "anthropic" carries unduly restrictive connotations, since the same order of ideas can be equally referred to any extraterrestrial or non-human civilization (Carter 1993); but by then it was too widespread to be replaced. Of course, this comment by Carter and the de-anthropomorphization of Wheeler's observers can open a whole new

[2] See again the fourth section of Blum & Furlan (2022) for some guidelines about the otherwise unexplored dialogue and affinities between Wheeler and Ilya Prigogine, as well as between Wheeler and Manfred Eigen.

[3] If it is true that Wheeler wrote the preface to Barrow & Tipler (1986) with his usual enthusiastic tone, more or less in the same period we can also find signs of discontent and some clarification in a quite unexpected place: his tribute for Weyl's centennial anniversary (Wheeler 1986).

series of speculations that, however, Wheeler himself did not venture to follow – and thus, other than for reasons of space, we shall leave them to some other occasion.

In 1994, a semi-popular anthology of Wheeler's writings was published with the title *At Home in the Universe* (Wheeler 1994): an obvious echo of the speech of little more than twenty years earlier. On the cover of its second edition we can see the portrait of Copernicus with the flower, once again, and the poem-prayer *To Copernicus*, which we have mentioned above, was included, too. Evidently, if the categories of the debate on the anthropic principle are misleading or trivializing when it comes to Wheeler's ideas, or perhaps too narrow and "technical", his views can nonetheless be put in dialogue with other attempts from distinguished scientists to contrast the desolate picture of a "meaningless" universe *à la* Jacques Monod or *à la* Steven Weinberg (Blum & Furlan 2022). If Prigogine's attempt – *La nouvelle alliance* (Prigogine & Stengers 1979) – was an explicit answer to Monod, we could also mention, just to remain among Wheeler's friends and interlocutors, Freeman Dyson's response to Weinberg (Dyson 1979). Wheeler did not openly dispute either of the two, even if, in terms of *Zeitgeist* and reactions against it, we may certainly remark that the 1973 speech came shortly after *Le hasard et la nécessité* (Monod 1970). As he always did, Wheeler just went his own way – and in doing so, while trying to open new vistas for the future, he celebrated Copernicus with that sense of elation and liberation that, all too often, has been forgotten ever since the days of Giordano Bruno.

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