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ROMANTIC VERSUS TOOLBOX SCIENCE AND THE FATE OF MODERN COSMOLOGY

Abstract

Reliance on conceptual and experimental tools with only provisional foundational commitments, theoretical minimum and practical (industrial) context-driven goals has come to dominate much of scientific pursuit (toolbox science). A less visible Romantic strand of scientific research has been led by a strong commitment to see nature, cosmos, life, and humanity as interrelated unity concepts and phenomena. Scientists and scientific fields have navigated between these two paradigms in defining their research targets and theoretical positions concerning them. And while toolbox science has prevailed since Industrial Revolution due to its flexible epistemic utility and ontologically non-committal approach, it has externalized any social values. It either offers short-term technological gains that indirectly connect to existing social values, or it has to risk uncertainty in utilizing the toolbox to help reinforce certain values. In contrast, although epistemically more demanding, the speculative platform of Romantic science harbors inherent values, it prioritizes humanity's cosmic destiny while assimilating reliable scientific gains into the study of the cosmos as a unified whole. This tension is present in the case of modern cosmology we analyze, potentially questioning its social and epistemic values in the context of rapidly advancing scientific knowledge and societal concerns. The Romantic goals seem to put the field on firmer ground in the long run, but this has to be decided by nuanced studies of the interplay between Romantic and toolbox approaches in shaping the trajectory of modern cosmology and scientific inquiry as a whole.

Keywords: scientific method · Romantic science · epistemic utility · social values · cosmology

1. Introduction[1]

In this paper, I explore two distinct currents in the history of science over the past 200 years, Romantic and toolbox science, highlighting the tension

1 I am grateful to the anonymous reviewer for a few substantial suggestions I adopted as well as suggesting a number of important details. I am also thankful to Steve Fuller and the members of the audience at the "Science, Faith and Superstition" conference held in Belgrade in June of 2024.

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between them. The tension concerns the way they chose and articulated the targets of research and the extent and nature of their theoretical elaborations. Despite their common pursuit of usual experimental and observational methods, these differences led them in very different directions, especially in terms of understanding the relationship between the values and science. I will not delve into technical details or the historical trajectories of specific theories, culminating in philosophical conclusions that invite debate. Rather, I will offer a broader perspective on two powerful paradigms, often at odds with each other, in the development of science and explain why it matters today.

The domain of scientific methodological approaches mostly discussed at present is almost exclusively within the so-called rationalist and empiricist streams, their revisions and offshoots, the latter starting "officially" with the work of Francis Bacon and the former with Descartes. Yet their actual emergence is unclear.[2] Be that as it may, I will focus on two currents in modern science, a rift prompted by the Industrial revolution and its entanglement with scientific and technological efforts, that followed these early precursor divisions. The toolbox science's use of both conceptual and experimental tools is basically non-committal, and provisional attitudes to it are driven by practical and reliable predictive outcomes. This pursuit of theoretical minimum is technology-driven and subordination to immediate practical and industrial goals. Yet, this isolates it from commitments to any social values. In contrast, very particular values are inherent to and an explicit starting point for Romantic science. Its scientific quest starts from nature, life, the cosmos, and humanity, perceived as mutually interrelated wholes. This is both the starting point and the target of scientific inquiry. In this understanding, the inherent value of science comes from humanity's self-reflection on itself as a feature of the big unities of life and the cosmos, and any scientific activities should be guided by it.

The two paradigms are inevitably split on values. This is evident in the heroic episodes of toolbox science, such as the discovery of DNA structure and its genetic functions. This discovery, and those that followed, were largely enabled by the toolbox attitude, with only provisional ontological commitments, the researchers focusing instead on the reliable manipulation of biological features. In contrast, Romantic value-laden science highlights the dangers of "mad science" – bogus poking and manipulation without proper guidance by values stemming from life, nature, and humanity as an intricately connected. Mary Shelley's *Frankenstein* is early but poignant anticipation of this tension.

2 Their roots can perhaps be traced to a 13th century rift, with the emergence of transcendental immanentism. There was a split between Aristotelians and naturalists, who leaned towards views that later dissipated into rationalism and empiricism, but assumed a common naturalist worldview (Harrison et al. 2022). Meanwhile, the beginnings of rationalism are often attributed to Descartes, who, despite his rationalist leanings, held immanentist views (Milbank 2022). Newton's work also reflects a form of semi-immanentism, further complicating the landscape (Janiak and Schliesser 2012).

The challenge for contemporary science, especially fairly recently developed disciplines like cosmology, is to find a balance between these two approaches, recognizing the value of both practical utility and sought-after unities of studied phenomena in the quest to understand the world. Cosmology may be understood either as epistemically inferior in terms of the outcomes of its application of scientific tools or as a foundational science in a larger cosmic fate of humanity, helped by the synchronic insights of physics and special sciences, much like archaeology is helped by carbon-dating techniques.

2. Toolbox science: provisional nature of scientific research

The first current discernible in the flow of history of modern science, toolbox science, has its discernable roots in both empiricism and rationalism, but it has transformed substantially since Industrial Revolution, being largely driven by its goals. Thus, although there are glimpses of it earlier on, the division between it and the romantic science fully emerges only as modern science evolved in the 19th and the 20th century, especially with its symbiosis with the Industrial Revolution. Note, however, that both empiricists and rationalists, including their novel more recent instances and modifications, despite their major philosophical differences, converged on the idea that science relies on versatile and *provisional* conceptual and experimental tools. This convergence is often overlooked, as philosophers and historians focus on divergences between two (Markie 2024).

These scientific tools – even those taking the shape of idealizations (e.g., the concept of an ideal gas, or the concept of ideally black body) or entire formal axiomatic systems – are provisional. They help scientists predict and manipulate natural phenomena, but they are inherently replaceable as our understanding evolves through experimentation and conceptual elaboration. This includes the use of axiomatics, which became central in the 20th century (Steingart 2023), where formal systems serve as tools,[3] modeling, where concepts are treated as tools, and experimenting, where phenomena of interest are the result of the manipulation of physical tools. Various techniques and shapes of modeling, where concepts are used as disposable, increasingly enforced by computer simulations, are the most recent of such versatile elaborate tools.

3 Structural realists (Ladyman 2014; Worral 1989) may disagree and argue for certain irreplaceable formal structural features in ever-changing physical theories. Even if this is beyond dispute, these are tool-use necessities that structural realists think of as representations of natural realities, not conceptual, ever-more elaborate "prehensions," as Whitehead labeled them (1925), in Romantic science. The tool-use necessities may be replaceable in principle, but we cannot get away from the self-reflecting nature of the scientific quest. Even employing AI to do science would not do the trick, as self-reflection is the ultimate goal and value of science.

This practical and results-oriented approach to science on which both rationalist– and empiricist-minded accounts converge, emphasizes, albeit often reticently, epistemic utility: the success of science is measured by its ability to predict and manipulate phenomena reliably. Some classical rationalists like Leibniz saw science as in search of essential natural properties, yet by means of experience: one was seeking essential properties by *a posteriori* means, as it were. In time, the stronger versions of rationalism, which claimed *a priori* knowledge of at least some features of the universe, were sidelined in articulations of the scientific method across various historical, sociological, and philosophical fields, largely due to the successes of the toolbox pursuit. Instead, the focus on the practical application and predictive reliability of scientific tools as beyond dispute, whether in physics, biology, or even social sciences, is rightly emphasized as a guiding motif for articulating scientific pursuit.

This practical and results-oriented approach to science prioritizes the utility of conceptual tools over any particular ontological commitments. Figures such as Sadi Carnot (Carnot, Clapeyron, and Clauisius 1960) or James Watt (Dickinson 2010) drew on this approach in thermodynamics, and even James Clerk Maxwell with his formal unifying of electromagnetism, where the success of scientific models is measured chiefly by their ability to yield reliable predictions and (useful) manipulations, rather than their adherence to any foundational structures or propositions that philosophers of science like to focus on. In the modern era, scientists like Francis Crick, James Watson, Alan Turing, John von Neumann, Verner Heisenberg (at least in his young most productive phase), and a host of others, have carried this mindset forward, focusing on reliable outcomes, including prediction, rather than on particular, let alone preferred, underlying philosophical assumptions or implications. The indecisive nature of long-standing philosophical debates on reductionism vs. anti-reductionism with respect to the sub-fields of physics, such as thermodynamics and statistical mechanics, or other scientific fields like biology, should not be surprising given the vacillating and provisional conceptual and ontological commitments within these fields.

This approach has been advocated as the right, or even the only one, by numerous philosophers over the last century in various guises (pragmatism, logical positivism, instrumentalism, etc.). It is usually contrasted with the view of the central role of explanation in science, or in the context of the interplay between prediction and explanation. But this is not my main interest here. Another often overlooked current contrasts with toolbox science in numerous substantial ways.

3. Romantic science: the quest for unities in nature

The second current, emerging in the late 18th and early 19th centuries, is rooted in German and British Romanticism and is quite distinct from toolbox science on three key points: perception of research targets, extent of their theoretical elaboration and context, and the role of values in science. The experimental and observational methods, the Baconian package of science, so to speak, is a centerpiece of Romantic science but it is utilized for the pursuit of these goals. Thus, Romantic science (Richards 2010; Holmes 2010; Fulford 2002) builds on broad, holistic concepts like nature, cosmos, life, and humanity, not on practical aims or provisional approaches to phenomena, without a clear previous agenda on larger contexts and wholes. A prominent figure in the Romantic tradition, Alexander von Humboldt (Wulf 2016), studied nature as a unity, examining the common layers of climate and life, while guided by the cosmos as a broader unity. Humboldt's work exemplifies the core of the Romantic approach in many ways, as large unity concepts like nature, the cosmos, and life serve as platforms for humanity's self-inquiry.

British Romantics, including poets and writers like P. Shelley, M. Shelley, S. T. Coleridge, and W. Wordsworth, advocated this holistic view (Whitehead 1925, Ch. 5), seeking to understand the relationship between humanity and nature, in part as a reaction to the Industrial Revolution perpetuated by toolbox science. Some key figures of British science at the time, such as William Harvey (Holmes 2010), Michael Faraday, and Humphrey Davy, pursued their research in concrete symbiosis with these views (Whiteley 2018; Knight 2016; Holmes 2010), much like Humboldt's work was to a great extent an outcome of the philosophical ideas of German Romanticism.

German Romanticism (Richards 2010) was influenced by Goethe's empiricist-oriented and Kant's idealist-oriented notions of transcendentalism, both positing a transcendental conceptual unity as the foundation of knowledge. Romantic scientists working within these paradigms aimed to explore and understand the layers and details within the overarching concepts, feeding the details of scientific inquiry pursued through experimentation and observations back into them while defining the layers of the unity. Thus, the unity was understood as feeding scientific inquiry back into the studied whole – be it nature, the cosmos, life, or humanity – while defining the layers of that unity as an outcome. Such big unity concepts were used both as platforms and as targets of inquiry. The Romantic attitude shapes both the choice of the subject of research and its aims, and accordingly the use of tools such as experiment or observation in order to decode the details within the larger hypothesized unities. A scientific inquirer in the Romantic vein will never be content with any discovered detailed properties of, say, a living system, as a merely reliable manipulation tool in its own right; nor will any such properties be understood as a micro-reduction of the hypothesized unity, but rather as one layer of it. A glance at various journals of the so-called naturphilosophie of that romantic period, is often a combination of regular technical details of experiments and observations, predominantly in medicine and early life sciences, but with an elaborate theoretical clout around them more than occasionally drifting into obscure philosophizing.

A key figure in this tradition, Alexander von Humboldt, circumnavigated the globe to study the biosphere, producing works like "Cosmos" in a bid to unify scientific knowledge under a grand conceptual framework. He formulated the concepts of the spread of plants and animals within climate zones on Earth and the spread of continental land masses, to mention two highlights of his long scientific career. J.W. Goethe and E. Hackel (Steigerwald 2019) were rather different in their standing and influence from incomparable Humboldt, but their approaches similarly focused on the study of the organism as a unit, and they understood life as a unifying phenomenon. Famously, Goethe, whose influence on Humboldt and the entire generation of German intellectuals and scientists was invaluable, insisted on the essential difference between studying *in vivo* and studying dead organisms in the lab. Schelling, whose intellectual roots were the same as Humboldt's also developed philosophical reflections on life and the physical world in this philosophical vein (Kabeskhin 2017). Although our primary aim is to point out a distinct strand of science and similarities in approach of these authors, it should be noted that distinction between them was often quite substantial. Thus, Humboldt criticized Schelling's transcendentalist approach to science, while one of the most prominent physicists at the time, H. K. Oersted in Danmark was directly inspired by his ideas. (Shanahan 1989)

The British strand of Romanticism involved a network of poets, writers, and scientists who were peers and friends. British Romantics, such as Wordsworth and Coleridge, sought to understand the relationship between humanity and nature, seeing science as an endeavor to explore the interface and our place within the larger natural world in detail. Whitehead (1925) encapsulated this strand particularly well. The British Romantic paradigm emphasized awe and wonder as the starting point of scientific inquiry – what we might term the "Sea of Ice" moments after the glacier flowing down Mont Blanc, a sight that riveted members of this group in their nature-inspired pilgrimages. These moments reinforced the interface between humans and nature, driving inquiry back into the foundational concepts of the cosmos, life (later the biosphere), nature, and humanity. Romantic thinkers nurtured their awe of nature and humanity's destiny in it in the Alpine natural diversity and were especially impressed by the central Alpine scenery, where they could see the interplay between Earth, ice, and the elements, with themselves standing in the middle and experiencing it.[4] The Sea of Ice glacier at Mont Blanc not only inspired poems and other works of literature, but was also the setting of a key scene exhibiting a moment of Romantic self-reflection on the *role* of the scientific method and the wider role of science within humanity. I am alluding to Mary Shelley's *Frankenstein*, to which I turn later. Predictably, the work of poets and writers was, to a great extent, a negative reaction to the Industrial Revolution and the actual way science was used for its purposes.

4 See Vincent 2023 and Hollis 2023 on the Alpine context in the romantics' vision of nature and science.

In Romantic science, awe and wonder are the starting point of scientific inquiry into the humanity-nature interface – feeding experimental and other tools and techniques back into it. In "Science and the Modern World" Whitehead (1925) used the word "prehension" to grasp this approach to science, thereby indicating unification is both the initial platform and the target of inquiry – scientific method being a feedback loop of sorts. The approach is thus inherently foundational, guided by big unity concepts of the cosmos, life, later on the biosphere, nature, and humanity – especially in comparison to the provisional nature of toolbox science.

The Romantic perspective inevitably contrasts sharply with the more utilitarian toolbox science, whose origins are closely tied to the Industrial Revolution and the rise of modern technology. Romantic science resists this utilitarian drive and the instrumentalist provisional attitude underlying it, emphasizing the intrinsic value of understanding nature as a whole, rather than approaching it as a collection of manipulable phenomena that can be physically deconstructed. Yet it should be noted that any approach to natural phenomena, scientific as it may be, that starts with personal awe, impressions, and natural locations of one's choice and feeds back into them is unavoidably local. One's impressions, phenomena, and locations as the platform are always very particular and dependent on the historical and social context. This is in stark contrast to the universal character of utility-oriented, universally-applicable toolbox science.

Great British scientific figures participated in and were inspired by Romantic ideals and ideas. An obvious example, Faraday, sought to unify forces through the concept of an omnipresent electro-magnetic field via experimentation, reflecting the Romantic perspective. In his elaborate experimental work, he was seeking natural unities and appropriate ways of conceptualizing them, rather than a reliable deconstruction of the supposed basic units underlying phenomena observed in experiments.

This general Romantic current, although not visible as the toolbox current, at least not in the eyes of the public and most professional scientists, continued uninterrupted into the 20th century with biologists such as V. Vernadsky (2012) and his first elaboration of the now commonly understood biosphere at the beginning of the 20th century,[5] and J. Lovelock (1989) with his now non-controversial idea of the self-regulation of the biosphere. Their work stands in rather poignant contrast in biology to Crick and Watson's push for reliable manipulation-driven molecular reduction.[6] The big comeback

5 P. Florensky's (2014) late Romantic ideas (early 20th century) and the influence of the German Romantics and Faraday on his work may be a direct historical link to Vernadsky's ideas about the biosphere that steadily evolved in his bio-geo-chemistry research from a positivist-oriented initial approach. The two were friends. (Lenka 2020) (Thanks to Stefano Furlan for this suggestion.)

6 Monod diverged from the extreme reductionist bent in biology, illustrating the vacillating non-committal foundational nature of toolbox science, but E. Chargaff's

of the ecological paradigm in biology, in synthesis with the evolutionary paradigm which it essentially predates, is arguably a final example of an entire field coming close to Romantic goals. In cosmology, John Wheeler (1973)[7] understood evolution in the cosmological context (I return to this later), while D. Bohm (Bohm and Peat 2010) reflected on micro-to-macro physical unity, to name two obvious examples.

But we should tread carefully here. Where does an individual scientist or a scientific field fall on the Romantic-toolbox scale in terms of goals and commitment to those goals during the execution of research? This question also applies to the earlier division I mentioned: for example, Newton was an immanentist and selected his subjects of study accordingly, but he also produced the key elements of what eventually became toolbox science. Humboldt, while Romantic in his approach, articulated mechanisms of struggle for resources within ecological niches and organisms' fitness, concepts not typically associated with an ecological but with an evolutionary paradigm.[8] Thus, we could ask where exactly each individual case is on the Romantic-toolbox scale. Probably only a handful of cases sit squarely at one end or the other. This may be true of each scientific field as well. Clear tendencies may be easily recognizable among both individuals and fields.

4. The split on values

Despite the fine-grained continuity between toolbox and romantic science, an ongoing tension between these two paradigms has become consequential, because each paradigm inevitably shapes the choice of its respective research subjects and goals. Toolbox science, with its emphasis on epistemic utility and technological offshoots, has become dominant, but Romantic science continues to influence certain fields, particularly environmental and Earth science and ecology.

The early Romantic critique of toolbox science, exemplified by Mary Shelley's *Frankenstein*, warns of the dangers of a purely utility-driven and instrumental approach to science, as it can have unintended and potentially disastrous consequences. The toolbox paradigm, while powerful, is impartial when it comes to determining whether any unities exist, and as a consequence, the values guiding it are external to it and can vary based on external research goals and outcomes. Therefore, external ideologies are likely to influence the values of the inquiry (Ratti and Russo 2024). In contrast, Romantic science holds

(1978) perspective closely aligned with that of Goethe on the nature of non-neutral study of life and the need to avoid destroying it may be contrasted with Crick-Watson's work. (Thanks to Stefano Furlan.)

7 See also Furlan (2022).

8 This may be true of Buffon as well.

that ever more elaborate self-reflection within big wholes is an inherent value of scientific inquiry and its starting point. These wholes are the mainstay features in a long-term project of the self-reflection of humanity. The tension between approaches is reflected in the contrast between the local and foundational tendencies of Romantic science and the universality of tool-oriented science and its effortless internationalization. In that sense, the toolbox has won for all practical purposes. Moreover, the Romantic balloon of foundational intentions is easily punctured by the toolbox: the toolbox approach itself will impartially determine whether any unities exist to begin with.

Let us take a brief look at a defining heroic episode of toolbox science, if ever there was one: the discovery of the DNA structure and function and its aftermath. This episode is exemplary of the triumph of the toolbox approach. Importantly, there were no definite and stable ontological commitments. Although Watson and Crick modelled the reduction of inherited properties at the level of molecular structure – a rather obviously reductionist move – soon thereafter, the regulative role of RNA through feedbacks with DNA discovered by J. Monod (Monod 1974) was couched in anti-reductionist terms. This started a long-running debate between these seemingly opposed reductionist and anti-reductionist molecular (and genetic) understandings of life, and it has not been resolved. The resolution is, in a way, inconsequential to actual biological practice – it vacillates between the two paradigms, depending on the tasks and the sub-field in which the tasks are pursued. All along, the focus of research has been the reliable manipulation of biological organisms and their elements, without strong commitment to any particular foundational structure favoring a useful conceptual tool. In that sense, biology is much more adequately and easily accounted for in epistemological terms as practice-oriented rather than theory-driven science (Waters 2014). Its ontological flexibility and provisional character are rightly perceived as its strength.

At the same time, the toolbox balloon has been deflated by the Romantics, in a less visible but equally profound way. Values are external to toolbox science, and the outcome of the toolbox applied to the study of values can go either way in debates on particular values. This is where ideology often steps in, for better or worse. This is our current moment, given the prevalence of toolbox science. It is understandably the subject of debates among philosophers of science, who often try to "rescue" science from the "deluded" public.

I will not dwell on the current debate, however. Instead, I want to look at the anticipatory illustrative critique of the conundrum of toolbox science and values. This critique is a fictional episode in M. Shelley's *Dr. Frankenstein*. In that episode, in a shack at the mouth of the Sea of Ice glacier, the monster Dr. Frankenstein has created in his laboratory schools the doctor in the mad science he has been practicing. Dr. Frankenstein's approach is described as bogus, albeit partially successful, tinkering and manipulation. The tinkerer never really knows what is manipulated or how and what will be produced within a wider context – sidelining the kind of unity-driven knowledge readily reached by the Romantics. The method and thus the product are the result of an abdication from inherent scientific values of reflecting on humanity and other natural wholes in research. Such essentially mindless, hasty, and misguided poking around in the fabric of life and humanity, as impressive as it may seem at the moment of "discovery" and reliable "results", will eventually produce monsters without the tinkerer being mindful of the whole he interacts with or the fine nature and fragility of its constitutive layers. A tinkerer Shelley had in mind may have been Benjamin Franklin, labeled "Prometheus" of science by Immanuel Kant. (Sha, 2023,131)[9]

When we apply Shelley's warning to Watson, we see that he understood the genetic inheritance of race rather too seriously, taking it outside the current dominant scientific and social context. Because of this, he was eventually stripped of much of the glory his discovery brought him. The Romantic insistence on humanity as a whole as the platform of scientific research immediately opens up a much wider context that avoids simplistic attempts to pin down particular human traits in the way Watson did – these inevitably become ideologically bogged down. It should be noted, however, that this was one strand, albeit probably dominant, of the romantic view of humanity, along with those less humanistic, tied to the idea of the cosmic whole as taking precedent, or downright nihilistic strands like Lorenz Oken's.[10]

Moreover, the results of the toolbox scientific endeavors – those pioneered by Carnot and Watt – are very obvious at the Sea of Ice where the conversation between Shelley's monster and the doctor occurs. The current surface of the melting glacier is 150 meters below the spot where it was in 2010, and much lower than where the fictional conversation took place. Indeed, sidelining the figures bent on understanding the biosphere as a whole, for example, people like Vernadsky or Lovelock, may have derailed a more nuanced approach to natural phenomena that could have prevented such easily visible consequences.

In summary, while toolbox science offers practical and universal tools for manipulating the natural world, it often lacks the broader conceptual framework that Romantic science provides. The challenge for contemporary science is to find a balance between these two approaches, recognizing the value of both practical utility and conceptual unity in our quest to understand the world. This is perhaps nowhere clearer than in contemporary cosmology.

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9 It is also possible to interpret Dr. Frankenstein as Shelley's reflection on her own husband's Prometheus-like self-imposed role in science.

10 I thank the anonymous reviewer for this comment, and a number of other detailed suggestions.

5. The value of current cosmological research

The distinction I make here is not purely of historical and philosophical interest, nor is it a lament. Rather, it goes straight to the heart of key epistemic and funding dilemmas in contemporary and future science. The value of current cosmology as a discipline has been debated within the context of Romantic and toolbox science, although in a somewhat subdued manner (Kragh 2006). Yet the dilemma should be considered carefully: cosmology has entered the age of Big Science. Its moment of public reckoning will arrive soon enough and may derail it the way particle physics was derailed by the fiasco of the Superconducting Supercollider project in the United States.

There are interrelated social and epistemic values at stake here. It is important to point out that in this debate, many toolbox science advocates will question the epistemic priority of cosmology over other physical sciences, given its meager evidence when judged by rationalist and empiricist standards that inevitably lead to comparisons with "hard" physics. And from a social values perspective, essentially external to toolbox science, more prescient social issues are likely to be prioritized over the long-term cosmic destiny of humanity.

In contrast, the Romantic scientific rationale, despite possible differences among its proponents, is that the study of the cosmos as a whole, even if evidence is thin, is crucial to humanity's project of self-reflection on its inherent relationship to nature. Two historical figures embodying the contrast between these two approaches are S. Weinberg and the aforementioned J. Wheeler (Furlan 2020, 2021).[11] It is indicative and a warning, that despite his acumen in modern physics, Weinberg's unsuccessful plea in Congress for the funding of the Supercollider became symbolic of the failure and subsequent ever-increasing tension between scientific community and the public. But the Weinberg-Wheeler contrast is only the tip of an iceberg that should be investigated historically in detail. For now, let us look at these two options in more conceptual detail.

In terms of social values, toolbox science usually vies for supremacy via short-term technical gains, seeking technical offshoots as justification of its eventual gains in social contribution. Yet once the toolbox is turned onto the field itself, to assess its social utility, scientiometric measures of success will likely not favor cosmology over other fields. If we tried arguing for a long-term benefit of cosmology, if there is any on toolbox terms, it is unclear why it should take precedence over more prescient social worries other fields can readily and more successfully address. In contrast, Romantics see the cosmic destiny of humanity as inherently a long-term target and the main goal of science. Cosmological knowledge, as fragile as it may be, is crucial to such a project.

11 Stefano Furlan suggested this to me.

As far as epistemic values go, toolbox practitioners and advocates ask why we would believe the cosmos is a unity at all, especially given the recent evidence that the universe expanded in such a way that the causal contact between its segments was very quickly lost. Moreover, evidence in cosmology is provisional when judged by the usual rationalist or empiricist standards of a reliable natural science. Some have questioned whether it is a proper natural science at all given its reliance on indirect observations of the deep past and the lack of experimental tests (Gee 1999; Hacking 1989). Given this, the toolbox should not make it a priority but opt for experimental micro-reductive sciences where cosmology can offer only marginal help.

The Romantic-minded response to this is a question: Why study the cosmos at all if not as a cosmos with a big C? This is a prescient question, especially as evidence is thin, in comparison to heavily experimental sciences: the cosmos-as-unity hypothesis is falsifiable only in an extremely long-term project hypothesis, so we should not risk abandoning the key project of studying and acting upon humanity as a cosmic species. Moreover, it would be presumptuous and shortsighted to claim to know exactly how the cosmic unity or unities will be conceptualized in the future given the inevitable wealth of unknown future observations. Nor can we know, based on the existing evidence, what alternative plausible conceptualizations will be developed. Finally, and most importantly, in the Romantic view, the study of natural and human history and its future is the main goal and the basic value of science. The epistemic value of physics to cosmology is thus a matter of supplying knowledge to these bigger projects – sort of what carbon-dating techniques are to archeology as a whole, as admirable as they may be in their own right.

Conclusion

In summary, while toolbox science provides practical tools for manipulating the natural world, it often lacks the broader conceptual framework offered by Romantic science. The ongoing challenge for contemporary science is to find a balance between these two paradigms, recognizing the importance of both practical utility and conceptual unity in our quest to understand the world. The case of cosmology is a good example of this need – its institutional public fate may depend on the ability to properly address its core Romantic scientific features.

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