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The unfolding of the historical style in modern cosmology: Emergence, evolution, entrenchment

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ABSTRACT

This paper traces the emergence, evolution and subsequent entrenchment of the historical style in the shifting scene of modern cosmological inquiry. It argues that the historical style in cosmology was forged in the early decades of the 20th century and continued to evolve in the century that followed. Over time, the scene of cosmological inquiry has gradually become dominated and entirely constituted by historicist explanations. Practices such as forwards and backwards temporal extrapolation (thinking about the past evolutionary history of the universe with different initial conditions and other parameters) are now commonplace. The non-static geometrization of the cosmos in the early 20th century led to inquires thinking about the cosmos in evolutionary terms. Drawing on the historical approach of Gamow (and contrasting this with the ahistorical approach of Bondi), the paper then argues that the historical style became a major force as inquirers began scouring the universe for fossils and other relics as a new form of scientific practice—cosmic palaeontology. By the 1970s the historical style became the bedrock of the discipline and the presupposition of new lines of inquiry. By the end of the 20th century, the historical style was pushed to its very limits as temporal reasoning began to occur beyond a linear historical narrative. With the atemporal 'ensemble' type multiverse proposals, a certain type of ahistorical reasoning has been reintroduced to cosmological discourse, which, in a sense, represents a radical de-historicization of the historical style in cosmology. Some are now even attempting to explain the laws of physics in terms of their historicity.

1. Introduction: The historical style

In cosmology today, historical reasoning is ubiquitous. In the same way that historical explanations are given in geology—where, for example, the specific shape, form and other characteristics of a river are explained in terms of erosion over time—features of the universe are now universally understood in terms of historicity. In order to understand how or why an object in the cosmos is the way that it is, a historical narrative is often formulated. Stars are born and later die. Galaxies were formed through an evolutionary process due to the clumping together of matter under gravitational forces in the early universe. Evolving, dynamic processes are constituted as historical narratives; and historical explanations are everywhere.

Today, even the cosmos as a whole, (a rather unique object), is explained in terms of its history. Through a process of temporal extrapolation, the current features of the universe are explained with a linear temporal narrative. Simple summaries are pervasive in academic and popular literature. The universe 'began' with the Big Bang. Next, the very early universe went through different phases, including: The Planck Epoch (0–10^{-43} s after the Big Bang); The Grand Unification Epoch (10^{-43} s to 10^{-36} s after the Big Bang); The Electroweak and Inflationary Epochs (ending 10^{-32} s after the Big Bang). Following this are the Electroweak Symmetry Breaking and Quark Epochs, the Hadron, Lepton and Photon Epochs, followed by Nucleosynthesis (from 3 to 20 minutes after the Big Bang). Other epochs (Such as periods of matter domination, recombination, and well as habitable epochs and cosmic 'dark ages') in the temporal evolution of the universe are studied by cosmologists, and the historical narrative provides a story right up to the universe as we see it today. Practices such as forwards and backwards temporal extrapolation (thinking about the past evolutionary history of the universe with different initial conditions and other parameters) are now commonplace. Such questions as

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'When did the Big Bang occur?', 'What did earlier epochs of the universe look like, and what physical processes were occurring?' are not only intelligible to cosmologists, they are answerable. However, as this paper will show, explaining the universe in terms of its evolutionary history has not always been the accepted way of getting to grips with it.

In physics, general laws are often applied to particular things; the general principle helps explain a particular instantiation. However, with the historical style, particular features of the world are explained primarily in terms of their evolutionary history by giving a historical narrative. This move is predicated on the idea that the complexity of an object or event precludes it from being explained by a generalizable principle (Ereshefsky, 1992). Thus, historical explanations typically include the identification of past events that have a causal connection with the present (Scriven, 1959). The universe itself has particular features and specific characteristics, such as shape, size, and large-scale structure, and it is populated with a vast array of interesting and peculiar objects. Finding these features out and explaining the features of these objects with historical narratives represents the historical style in action.

It should be noted that the historical style was already present in some other disciplines at the beginning of the 20th century—such as evolutionary theories in biology in the 19th century (Bowler, 1989) or historical accounts of the earth in 18th century geology (Gohau, 1990). Objects of scientific inquiry were interpreted in terms of their historicity. Renowned physicist Richard Feynman made the following relevant comment in a 1973 short film:

> It is interesting that in many other sciences there is a historical question, like in geology – the question of how did the earth evolve to the present condition. In biology—how did the various species evolve to get to be the way they are? But the one field which has not admitted any evolutionary question is physics. Here are the laws, we say. Here are the laws today. How did they get that way?—we don't even think of it that way. We think: It has *always* been like that, the same laws—and we try to explain the universe that way. So it might turn out that they are *not* the same all the time and that there *is* a historical, evolutionary question (Dallas, 1973).

Feynman is referring here to theoretical physics in general. Nevertheless, his comments underscore the idea of the historical style in this cosmological context. It is the move to explaining objects of scientific knowledge in terms of their historicity that is significant.

This paper traces the way in which the historical style of reasoning unfolded in the domain of cosmological inquiry. The cosmos as a whole became an object of modern scientific inquiry in the early 20th century, and later a distinctive field of physics in its own right, through the deployment of the historical style in the domain.[1] I argue that the historical style emerged, became a major force, and later, the bedrock of the discipline and the condition of its possibility. Historical reasoning is built into and embedded in cosmology as we know it today. The historical style is the presupposition of new lines of inquiry and constitutive of cosmological inquiry in general. It has configured and re-configured the terrain of possibilities for modern cosmology. Approaches that do not build on the foundations laid by the historical style are, by and large, not seen as possible ways of doing cosmology.

2. What is a style?

I need to briefly contextualize the term 'style' and describe how I am using it. Many historians, sociologists and philosophers of science have been concerned recently with the idea of different styles of reasoning, and many interrelated notions.[2] James Elwick explains that the term 'style' effectively means "collective and often uncharted beliefs" that form a "backdrop", characterised by "shared assumptions and similar practices" (Elwick, 2007, p. 1). As

[1] Certainly, cosmological questions have been around since long before 1917. Many ideas relating to cosmology and cosmogony can be traced back to the pre-Socratics (Furley (1987). *The Greek Cosmologists*. Cambridge: Cambridge University Press.). Later, the nature and structure of the cosmos was a topic of much debate and discussion among Aristotle, the Stoics and Epicureans in ancient Greece. Questions about whether there was a single universe or a plurality of worlds, whether the universe was spatially infinite or finite, and whether the universe had always existed were extensively debated by medieval scholastics. During the Renaissance and Early Modern period, the European conception of the cosmos went from being a finite sphere to an infinite universe. Works by Edward Grant, Alexander Koyré and Pietro Omodeo outline the shifts during this period (Grant (1981). *Much Ado About Nothing: Theories of Space and Vacuum From the Middle Ages to the Scientific Revolution*. Cambridge: Cambridge University Press, Koyré (1957). *From the Closed World to the Infinite Universe*. Baltimore: Johns Hopkins University Press, Omodeo (2014). A Finite and Infinite Sphere: Reinventing Cosmological Space *Copernicus in the Cultural Debates of the Renaissance* (pp. 158–196). Leiden: Koninklijke Brill.).

However, the philosophical speculations of this sort constituted a rather different form of intellectual endeavour to kind of cosmological inquiry that began to emerge in

(*footnote continued*)

the 1920s. At the dawn of the 20th century, the orthodox scientific conception of the universe, if there was one to speak of, remained limited to the conceptual framework given by Newtonian physics (See Harrison (2000 [1981]). *Cosmology, The Science of the Universe*. Cambridge: Cambridge University Press.). Newtonian gravity described the mechanics of the solar system and the movements of comets. Observational astronomy had significantly extended the reaches of the galaxy, yet what lay beyond was an infinite expansive universe of the unknown (ibid.). Furthermore, conceptions of the universe as a dynamic structure—a universe with an age, size, shape and composition—were entirely absent from astronomical discourse. For these reasons, the emergence of modern cosmology as a domain of inquiry demands robust philosophical and historical probing.

It is relatively uncontroversial to claim that large-scale cosmology as a serious endeavor can be traced back Einstein and his 1917 general relativity innovation. So, although cosmology as a subject of philosophical and theological speculation has a much longer history, for the purposes of this paper I define Einstein's move as the first in the foundations of 'modern' cosmology. The science of cosmology as we know it today is traceable to this occurrence, and Einstein's application of general relativity to the universe as a whole is generally considered to be the first seed sown in the era of modern cosmological inquiry. However, no 'cosmologists' *per se* emerged with Einstein's move. It is crucially important to note that cosmology as a serious scientific discipline began much later, not becoming established until as late as the 1960s. There is thus a subtle distinction between the first emergence of modern cosmological inquiry, which was undoubtedly scientific, and the emergence of cosmology as a scientific discipline.

[2] Ludwik Fleck gives us "thought styles", see Harwood (1986). Ludwik Fleck and the Sociology of Knowledge. *Social Studies of Science, 16*, 173–187.; Gerard Holton speaks of "themata", see Holton (1988). *Thematic Origins of Scientific Thought*. Cambridge MA: Cambridge University Press.; and John Pickstone prefers the phrase "ways of knowing", see Pickstone (2001). *Ways of Knowing: A New History of Science, Technology and Medicine*. Chicago: University of Chicago Press. Several authors have applied the notion to historical investigations. Jonathon Harwood's study into the styles of scientific thought, which permeated the German genetics community between 1900 and 1933, emphasized the importance of the relationship between social and political thought and scientific thinking. See Harwood (1993). *Styles of Scientific thought: The German Genetics Community, 1900–1933*. Chicago: Chicago University Press. Similarly, Anne Harrington's classic account of holism in German culture during the early twentieth century underscored the idea of a "national style"—a pattern of thought which emerges within a particular culture and at particular times, and resonated with scientific thinking. See Harrington (1996). *Reenchanted Science: Holism in German Culture from Wilhelm II to Hitler*. Princeton: Princeton University Press. James Elwick uses the approach of examining the style of scientific reasoning in the British life sciences in the thirty-eight years preceding Charles Darwin's *The Origin of Species*. In a sense, his investigation argues that Darwin's study was made scientifically possible due to the style of reasoning which was accepted at the time. See Elwick (2007). *Styles of Reasoning in the British Life Sciences: Shared Assumptions, 1820–1858*. London: Pickering & Chatto. Bernadette Bensaude-Vincent looks at the specific characteristics of the styles of thinking employed in the discipline of chemistry, see Bensaude-Vincent (2009). The Chemists' Style of Thinking. *Ber. Wissenschaftsgesch, 32*, 365–378. Jane Maienschein explores the two distinct epistemic styles in German and American embryology around 1900 and argues that the competing styles emphasized different goals, processes of investigation and standards of evidence, see Maienschein (1991). Epistemic Styles in German and American Embryology. *Science in Context, 4*(2), 407–427.

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