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Cosmic Agnosticism

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No Final Answers in the Final Frontier

Major progress has been achieved in space science in the past half century, especially now with *in-situ* observations of space plasmas and space-based platforms for solar physics and astrophysics. And within the past two decades, important gains have been made in obtaining observations of very distant astronomical systems (i.e. high red shift or 'z' value) that provide increasingly effective tests of models in physical cosmology. This evolution in observational capability has been accompanied by an even greater evolution in theory and modeling, which has enhanced the explanatory power of the dominant hot Big Bang research program (BB).[1] There is broad agreement, even among detractors, that BB has been highly productive of hypotheses, models, and a major motivation for new and important research programs such as the Hubble space telescope (see http://hubblesite.org/).

However, new and challenging observational results and, for a growing number of scientists, persistent problems with BB hypotheses have encouraged research in alternative cosmological models. Although my own field is space plasma physics, I have taken some time in the past two years to evaluate such claims and counter-claims. My tentative conclusion is that there is no current model in physical cosmology that adequately meets all key observations – thus my "cosmic agnosticism." This paper calls attention to this ongoing scientific debate without going into details. For those scholars in philosophy and religion who use research results in physical cosmology, I recommend caution and encourage the recognition at least that such debate exists and is part of ongoing research.

Dangers in too closely linking science and religion are clearly articulated by Eddington:

> "The lack of finality of scientific theories would be a very serious limitation of our argument, if we had staked much on their permanence. The religious reader may well be content that I have not offered him a God revealed by the quantum theory, and therefore liable to be swept away in the next scientific revolution" (*Eddington*, 1928).

Following a discussion of outstanding problems, important distinctions are made between physical cosmology and both metaphysics and philosophical cosmology. This paper is then completed with a discussion of how productive linkages can be made between these areas in the spirit of the process philosophical tradition as exemplified by Alfred North Whitehead's famous defense of speculative philosophy (*Whitehead*, 1929a).

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[1] The scope of BB includes a wide-range of models and hypotheses that are best characterized, collectively, as a scientific research program as introduced by philosopher Imre Lakatos. A concise summary of this concept is given by *Murphy and Ellis* (1996).

Examples of Outstanding Problems in Physical Cosmology

Geoffrey Burbidge, professor emeritus of the University of California San Diego, is one eminent physicist who seriously questions the BB. He states that "there have been very few real predictions," and that "while the black body nature of the radiation was predicted by the big bang theory, the numerical value of the temperature was not, and cannot be (see *Turner*, 1993)." Burbidge critiques how BB uses dark matter and dark energy to provide a [95% level of] missing mass energy. He states how "An elaborate 'theory' (more appropriately a 'scenario') of galaxy formation then rests on this <u>belief</u> that this missing mass is real, because only if [cold, dark matter] CDM exists in large measure is it possible to simulate galaxy formation at all" (*Burbidge*, 2006).

On the possible existence of "dark matter" you may have seen headlines about a recent "proof" of dark matter based on data from a collision of galaxies. The title of the paper, to be published in the prestigious Astrophysical Journal, is "A direct empirical proof of the existence of dark matter" (*Clowe et al.*, 2006). Upon reading this title, I became immediately suspicious because, as philosopher of science James Hall states, "Our hypotheses may get support or they may go down in flames, but they never, ever get proved" (*Hall*, 2005). The paper features some impressive technical discussion, but contains no discussion of some critical caveats. In particular, the argument assumes that normal matter is fully accounted for by the inventory of visible stars and hot plasmas. However, it has been reported that non-visible interstellar gas, lower-energy plasmas and brown dwarfs, in combination, likely exceed luminous stars in the local mass budget of our own galaxy (e.g., *Fuchs, Jahreiss, and Flynn*, 2006).

Professor Burbidge notes that "none of this [elaborate theory] is necessary if we go back to the original observation of the He/H ratio and take the position that the observed ratio is the result of hydrogen burning in stars. Then of course, the whole of the mass must be baryonic." Burbidge then goes through a brief calculation that leads to black body radiation with T~ 2.75° K, which is very close to the measured value of 2.726° K. On this point, Burbidge concludes that "This is either a pure coincidence as it must be for those who believe in the big bang, or else it tells us that hydrogen burning was originally responsible for the [Cosmic Background Radiation] CMB" (*Burbidge*, 2005). Burbidge also calls attention to several non-BB estimates for CMB. A simple average of six such estimates made prior to the famed Penzias and Wilson measurement of 1965 yields ~3.1° K. In contrast, BB estimates by Gamow and collaborators ranged from 5 to 50° K (*Assis and Neves*, 1995). The typical textbook account describes Gamow's BB "prediction" and the 1965 "confirmation" without reference to this history; the real story is far more complicated.

In addition to Geoffrey Burbidge, there are other eminent scientists who have expressed concern about BB hypotheses including, among others, Halton Arp, Hermann Bondi, Thomas Gold, Jayant Narlikar, and Jean-Claude Pecker (*ACG*, 2001). In a comment on Arp's critique of standard red shift accounts, *Harrison* (1981) states that "When we leap to defend conventional wisdom we should remember that it cannot be proved true but only be proved false, and science is lost without those few people who are bold enough to interrogate its treasured doctrines."

At the present time, leading recognized problems with BB are as follows:

• Continued evidence of anomalous alignments and non-Gaussianity in data from the Wilkinson Microwave Anisotropy Probe (WMAP, see http://map.gsfc.nasa.gov), which indicate non-primordial CMB components (e.g., *Copi et al.,* 2006)
• Age problem for BB of certain high redshift objects (e.g., *Jain and Dev*, 2006)
• Difficulties explaining Lithium 6 (^{6}Li) isotope observations – Given that ^{7}Li is reduced by a factor of four in stars as required for BB, ^{6}Li should be even more effectively destroyed, but is not (e.g., *Steigman*, 2006)
• Direct experimental tests for "dark matter" have continued for twenty years without any definite conclusion (e.g., *Freeman and McNamara*, 2006).

As an example of a straight-forward observational test and potential falsification, there is a clear prediction of the Friedman-Robertson-Walker (FRW) geometry model (upon which BB depends) that galactic surface brightness should decline with distance or redshift (z) as $(z+1)^{-3}$. In contrast, all non-expanding cosmological models predict that surface brightness will remain constant with distance. In the first surface brightness study to use high-z data (up to z=6) from the Hubble Ultra Deep Field (HUDF), the observational results yield roughly constant surface brightness with z values up to 6 and thus appear to falsify FRW predictions (*Lerner*, 2006). No published critique of these results is yet available,[2] but BB arguments about galactic evolution have been used to account for earlier reports at lower z values of such discrepancy with FRW prediction. However, such arguments would seem ad hoc if applied to much higher z values and many more galaxies (here including 114 galactic samples). For some, Ockham's razor suggests a simple solution; namely a flat geometry or Euclidean non-expanding universe (e.g., *Montanus*, 2005).

With new observational results coming available, there are possibilities arising for definitive tests and falsification instances for cosmology models. Continuing limitations of modern cosmology include the following:
• Lack of a unified field theory; debates about string theory, loop quantum gravity theory, and other approaches illustrate this continuing debate (see *Smolin*, 2001).
• The means for experimental test are exceeded by the proliferation of theories of gravity (see "gravitation" and "bimetric theory" entries at Wikipedia); however, new results from NASA's Gravity Probe B, to be available in 2007, will provide a serious test for many such theories, including Einstein's; see http://einstein.stanford.edu/).[3]
• Like geology and unlike particle physics, cosmology is intrinsically an historical science and lacks direct experimental testing for many key hypotheses.
• Data in cosmology are limited to remotely sensed photons; there is no direct, *in situ* measurement as in space physics or planetary science.
• Most existing cosmology models focus on only one long-range force field (gravity) and ignore potential long-range effects of electromagnetism and plasmas.

[2] These observational results will inevitably be contested by BB proponents. Any reader who knows about any critical problem in the analysis methodology is requested to advise the author of this survey paper; the same request applies to all other research results reported here.
[3] Recent bimetric theories of gravitation (with heritage going back to Whitehead) appear to remain viable (*Drummond*, 2001; *Herstein*, 2006; *Coleman*, 2005).

On this last point, it is well known that electromagnetism is very effectively shielded out, which allows gravity to generally dominate over long scale lengths. Nevertheless, electromagnetism and plasmas can still be significant because

> "By definition, plasmas are an interactive mix of charged particles, neutrals, and fields that exhibits collective effects. In plasmas, charged particles are subject to long-range, collective Coulomb interactions with many distant encounters. Although the electrostatic force drops with distance ($\sim 1/r^2$), the combined effect of all charged particles might not decay because the interacting volume increases as r^3. Magnetic field effects are often global with their connections reaching to galactic scales and beyond" (*Goedbloed and Poedts*, 2004).

The potential importance of electromagnetism and plasmas is indicated by the rapidly growing field of plasma astrophysics (see links and references at http://www.plasmas.org/space-astrophys.htm). As one example of its significance for altering conventional assumptions, *Kundt* (2005) shows in detail how observed signatures of existing "black-hole" candidates can be more effectively interpreted as neutron star magnetospheres with accretion disks or neutron star binaries. Efforts to assess the potential impact of the new plasma astrophysics on cosmology issues are just beginning (e.g., *Peratt*, 1995).

Resolutions to be achieved in the coming century to some of the problems raised above may come from unexpected directions. For example, Reginald Cahill of Flinders University has introduced a new dynamical theory of space and provides in-advance predictions for Gravity Probe B results to appear in 2007 (*Cahill*, 2005a, 2005b). Knowing that such innovative alternatives will receive no attention without experimental testing, Cahill has designed and implemented a state-of-the-art gravity detector based on coaxial cables, optical fibers and atomic clocks. Preliminary results appear to support Cahill's predictions, and independent experimental systems are under development in at least two other countries.

Distinguishing Cosmology and Metaphysics

Based on Whitehead, Jorge Nobo (2006) states that "the distinction between metaphysics and cosmology is the distinction between what a speculative philosophy theorizes to be the necessary features of any possible world and what it theorizes to be the contingent, though perhaps pervasive, features of the one and only actual world." Further, "the distinction between metaphysics and cosmology is a distinction between pure and applied theory." Here, the term "cosmology" includes both physical and philosophical aspects, the latter providing propositions that bridge from physical cosmology to metaphysical propositions.

These distinctions and an open, cross-disciplinary approach provide an important *via media* for the Cosmology & Process dialogue, which can help avoid two errors. One error is the failure to make needed distinctions resulting in a confusion of science and metaphysics and their proper domains. A second error is to make overly sharp distinctions in which the practice of metaphysics is unaffected by any empirical consideration, however well founded. Nobo (2004) provides an excellent example of metaphysics and philosophical cosmology that incorporates these distinctions. In a complementary way, the works of Murphy and Ellis (1996) and Ellis (2004, 2006) illustrate possible linkages of physical cosmology with an integrative philosophical cosmology, which is very much in the Whiteheadian tradition of speculative philosophy along with cautionary notes like that of Whitehead's warning about dogmatic finalities (*Whitehead*, 1933).[4] In particular, Ellis (2006) states that "Cosmology is not well served by claims that it can achieve more explanatory power than is in fact attainable, or by statements that its claims are verified when in fact the requisite evidence is unavailable, and in some cases must forever remain so."

Scholars in process thought have important contributions to make in both metaphysics and philosophical cosmology, independent of the outcome of debates in physical cosmology. At the most fundamental metaphysical level, philosophical results should not depend on contingencies of the current cosmic epoch. Further, even though our scientific ideal is to achieve understanding of invariant relationships that are independent of historical context, actual scientific practice is always imbedded in a particular history. For cosmology, historians Helge Kragh (1996, 2004) and Malcolm Longair (2006) have provided very insightful summaries of developments throughout the 20th century. Simon Mitton expands on this history with a focus on the life and work of Fred Hoyle (*Mitton*, 2005).

A Constructive Program for Dialogue

For philosophical cosmology, there are many relevant features in contemporary science, including physical cosmology, that are common to available observations, BB and most alternative models, including among others:

(1) multi-level evolution of systems (e.g., *Kauffman*, 1995)
(2) hierarchies of complexity, from quantum to cosmos (e.g., *Murphy and Ellis*, 1996)
(3) importance of networks of relationships at multiple levels (e.g., *Jungerman*, 2000)
(4) importance of both reduction (exclusive focus on efficient cause) and emergence with both bottom-up (efficient causality) and top-down causation (e.g, *Silberstein and McGeever*, 1999; *Laughlin*, 2005; *Ellis*, 2004, 2005; *Clayton*, 2004a)
(5) dualities without dualism arising from modern physics (e.g., both continuity and quantization; both symmetry and asymmetry, both particles and fields; *Eastman*, 2004)
(6) fine-tuning of physical systems (e.g., *Koperski*, 2005)
(7) ultimate limitations of cosmology (*Murphy and Ellis*, 1996)

These common features are characteristics of some firmly established components of modern science (quantum theory, nonlinear dynamics, etc.) and ones for which appeal to less established theories in physical cosmology is generally not needed. Further, these features are all highly compatible with a process view of nature, which is open to, and influenced by, any and all scientific research results, and which can remain relatively neutral to the outcome of debates in physical cosmology.

For me this raises three basic questions concerning issues relevant to philosophical cosmology. (1) What characteristics of our current cosmic epoch, inferred from observations and common to most alternative models for physical cosmology models, are most relevant for philosophical

[4] In his *Function of Reason*, Whitehead cautioned that "Science has always suffered from the vice of overstatement. In this way conclusions true within strict limitations have been generalized dogmatically into a fallacious universality." (*Whitehead*, 1929b).

cosmology? (2) Which of these characteristics, if any, are uniquely associated with BB or other particular physical cosmology models? (3) For features having dependence on a particular model for physical cosmology, can philosophical cosmology help refine our questions needed for crucial physical cosmology tests? In addressing such questions, in addition to a basic critique of presuppositions and issues of social and historical context, there is an important role for philosophical criticism and reflection (*Torretti*, 1999, 2006).

The best science and philosophy results from sustained dialogue, sound methodology and openness to alternatives from both physical and philosophical cosmology. In the spirit of modern rational empiricism, we need to shift our focus from assimilation and confirmation to crucial tests and genuine in-advance prediction and falsification. Science provides understandings of the physical world achieved through successive and unending attempts at problem solving enabled by efforts towards ever greater coherence, consistency, and closure in observation, theory, hypothesis formation, modeling and simulation, and experiment. Science is constituted by such methodology and not by any particular content or results. For metaphysics and philosophical cosmology, the focus can remain on consistency and coherence (*Whitehead*, 1929a), albeit with ultimate grounding in experience. However, in physical cosmology and science more broadly, linkages to observation and experiment are essential. Although complexities have arisen with all efforts to distinguish proper scientific propositions from non-scientific propositions, some helpful concepts have been developed, principally falsification (hypotheses should be falsifiable in principle) and Ockham's razor (keep hypotheses as simple as possible). It is often assumed that scientific methodology is fully characterized by the hypothetical-deductive framework. *Niiniluoto, Ilkka, and Raimo Tuomela* (1973) have shown the need for a hypothetical-inductive framework to characterize scientific practice that focuses on causal implication versus logical implication and which maintains a balance of theory, observation and experiment. Based on recent advances in large databases, supercomputing, and data mining, I have proposed an "observational-inductive" framework to describe methodologies arising from this confluence of new technologies (*Eastman*, 2006a). These new developments suggest the possibility of relying less on model-dependent approaches to resolving certain issues in physical cosmology.

The New Physics and the Process View of Nature

With continuing progress in new observation and experiments, a really "new" physics is steadily emerging that is less dependent on the unstated substance metaphysics that infects the "standard view of nature," which has been dominant throughout most of the 20th century [*Eastman*, 2006b]. For example, it is ironic that the rigor of controlled laboratory experiments and constant, evolving interplay between theory and experiment has led particle physics to seeing the world not just as "particles," but as a plenum of events; thus, both "particles" and events.

The process-oriented scholarly community and many scientists as well have shown the explanatory power of a process view of nature in *Process Studies* and other journals and books that highlight the interface of process thought and modern science [see compilation in *Eastman and Keeton*, 2004a,b].

Ours is a multiply-interconnected, processual universe in which any finite actuality is necessarily constituted by some unifying response to the plenum of events constituting its local world.

Bootstrapping such networks of relationships builds up hierarchies of complexity through evolutionary processes that incorporate both bottom-up and top-down causation, both reduction and emergence. The domain of our direct knowledge of the cosmos has now reached to the outer solar system and is reflected in the great advances made in space physics and planetary science in the past half century through both *in situ* observation and remote sensing. Even without the practical possibility of *in situ* observation, astrophysics has made similarly dramatic progress in understanding stars, galaxies, galactic clusters, and the intervening interstellar and intergalactic medium although many fundamental questions remain for all these systems (*Kundt*, 2005). For physical cosmology, the fourth area of modern astronomy or space science, extrapolations from scientific foundations such as quantum theory for which we have very high levels of confirmation are being stretched to the limit.

As stated by astrophysicist Wolfgang Kundt, "frontline physics is not as unique and reliable as the multiply tested physics of every-day life. The further the frontline advances towards unreachably large, or unresolvably small separations, or timescales…[the more] plausible assumptions have to replace redundant experience, and hasty interpretations can lead astray." One danger, according to Kundt, is that "Our politically organized society then takes care of suppressing minority opinion" (*Kundt*, 2001). The hot Big Bang research program has been highly successful in generating fruitful scientific hypotheses and tests, and has achieved a significant level of confirmation for many hypotheses (*Peebles*, 1993). However, outstanding questions remain and substantial alternative cosmology models, which also have been fruitful, remain and continue to evolve. For example, Kundt favors cold big bang cosmology (see *Layze*r, 1990), Burbidge and Narlikar favor a quasi-steady state cosmology (*Hoyle, Burbidge, and Narlikar*, 2000; *Narlikar*, 2002), Peratt and Lerner favor an updated plasma cosmology (*Peratt*, 1991; *Lerner*, 2005), and there are others. Personally, I do not know how BB or any of these alternative approaches will stand up to future tests using burgeoning new data sets and potential for future critical tests and falsification instances. At the present time, I see both advantages and serious problems for all options – they may all be wrong – thus, my "agnosticism" in physical cosmology.

There have been significant advances in philosophical cosmology and metaphysics within the past few decades just as real progress is continuing in physical cosmology. Recent developments in both science and philosophy have added impressively to a process-oriented research program that (1) demonstrates the decisive advantages of event metaphysics over substance metaphysics (e.g., *Clayton*, 2004b), (2) links this fundamental metaphysical framework to concepts in philosophical cosmology that have benefited contemporary research in philosophy of physics (e.g., *Stapp*, 1993; *Epperson*, 2004), and (3) cultivates open dialogue that effectively bridges from philosophy to science while maintaining key distinctions between metaphysics, philosophical cosmology, physical cosmology and other sciences (e.g., *Griffin*, 1986; *Malin*, 2001). This latter bridgework is effectively illustrated by some recent works in physics and philosophy of physics (e.g., *Finkelstein*, 1996; *Ellis*, 2004, 2006).

Building on the many features of contemporary science discussed above, and others, that appear to transcend current debates in physical cosmology, I foresee ongoing and limitless progress in understanding for which the special skills and approaches of all scholars, scientists, philosophers and others, are mutually beneficial.

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