The Philosophy of Cosmology Project and New York University Workshop on Philosophy and Physics. La Pietra Florence July 23-27, 2012.

Organized by Tim Maudlin (NYU)
Supported by NYU and the Philosophy of Cosmology Project[1]

There will be some "live blogging" and further discussion on the Cosmology blog at http://philocosmology.rutgers.edu/

Workshop Patricipants are:

Scott Aaronson (M.I.T.), Nancy Abrams (UCSC), David Albert (Columbia), Katalin Balog, (Rutgers), Gordon Belot (U of Michigan), Sean Carroll (Cal. Tech), Dan Darg Oxford, Rachel Darg (Oxford), Tracy Day (C.E.O World Science Festival), Detlef Dürr (Munich), Veronika Dürr (Munich), Bob Geroch (U of Chicago), Shelly Goldstein (Rutgers), Brian Greene (Columbia), Paul Horwich (NYU), Barry Loewer (Rutgers), Tim Maudlin (NYU), Vishnya Maudlin (NYU), Priya Natarajan (Yale), Jennifer Ouellette (Author), Joel Primack (UCSC), Laura Ruetsche (U of Michigan), Simon Saunders (Oxford), Ward Struyve (Rutgers), Rodi Tumulka (Rutgers), David Wallace (Oxford), Jim Weatherall (UCI), Nino Zanghì (Genoa U)

Schedule:

Pick up at hotel San Gallo for ride to La Pietra 9:30

Workshop begins each morning at 10.

We will have morning talks to get us started by Sean Carroll, Joel Primack, Priya Natarajan, and Brian Greene, on cosmology and string theory followed by discussion.

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[1] Funded by a grant from the John Templeton Foundation.

12:30 Lunch

2: Every afternoon we will have free wheeling discussion. Among the proposed issues for discussion:

1.) What is the evidential situation with respect to the existence and distribution of dark matter?

1a) Discuss how one decides among competing types of explanation for, e.g., the rotation curve of galaxies. In particular, following a recent post by Sean, consider the debate between modifying the basic dynamical equations (MOND) vs. keeping the Einstein Field Equation and postulating a dark matter distribution to fit the data. What about approaches that have some of both? What is the evidential situation here?

1b) More abstractly, can one make a clear distinction between postulating new matter and postulating new laws? How does this play out with respect to dark energy and cosmological constant? If one puts the cosmological constant on the "geometry" side of the EFE, then it looks like a modification of law; if you put it on the stress-energy tensor side then it looks like the postulation of a new sort of "energy". Are these distinct theories, or the same theory? How do you tell?

2) The low-entropy Big Bang state of "our" universe: does it require an explanation at all? Must the explanation be in terms of something that *preceded* it and out of which it arose by dynamical law? What are the constraints on such an explanation?

2a) "Multiverse" scenarios: what is their explanatory power, and what is the situation for evidential support?

3) Direction of time as it appears in the foregoing explanatory scheme: In particular, thinking of our Big Bang state as explained by how it was produced from some antecedent state seems to rely on a direction of time in the explanation. Is it then consistent to regard the direction of time itself as somehow emergent from a non-directed basic ontology?

3a) More generally, what should we make of claims that space-time in general "emerges" from some non-spatio-temporal foundation? What does "emerge" mean here? What does "non-spatio-temporal" mean?

4) The account of gravitational phenomena afforded by the General Theory appears to be fundamentally different from the account of the non-gravitational forces afforded by various quantum theories. I have in mind the idea that there is no "force of gravity" at all: the effects are "geometrized away" in a way that, e.g., electromagnetism cannot be. Many years ago I asked Ed Witten whether this basic connection between gravity and space-time geometry remains in string theory, which purports to give a quantum theory of

gravity, or not, and at the time he said that the situation was just not clearly enough understood to give an answer. Are we any further along on this?

5) Black hole complementarity: can anyone make any sense of this?

6). The measure problem in the multiverse: how should we think of probability on multiverse accounts? Are there any special problems?

7) What are fundamental laws; what makes claims of lawfulness true? How do physicists think about such metaphysical questions?

8) What are the plausible options for the ontology of quantum theory, of quantum field theory? The paper by Pusey et al. about the reality of the quantum state might be a good one to get a discussion of wave function realism going.

9) What constitutes an acceptable explanation in science more generally, but in cosmology in particular? In particular how are they bounded methodologically by science in situations where we have no reliable theories and have to resort to extrapolations of known/tested/accepted theories into domains where their validity is profoundly questionable?

10) To what extent is modern cosmology a satisfying "cosmology" in the anthropological sense? How does the cosmic level of reality link to the reality of our everyday lives? What aspects of the new universe are essential for an overall, accurate picture and which are details that can be left to experts or to future research? How should we start thinking about what's "real" given what we now know — and don't know?

Some additional questions, provided by Sean Carroll:

1. The definition and status of time reversal. (I.e. what it means to be "time reversal invariant," apart from questions of the thermodynamic arrow of time.) Both you and David A. (and I'm sure others) have written interesting things about this topic with which I think disagree. Although the subject seems a little dry, it may underlie some other disagreements, and is certainly related to the question of whether time "really" has a direction.

2. What we're supposed to do about the fact that the early universe had a low entropy. I.e. is it something to be explained, or merely accepted? I think that we need to explain it, and suspect that people who suggest otherwise are mostly being contrarian, and don't actually think that physicists should stop trying to explain it.

3. Can we ever talk about "likely" or "natural" in situations where an infinite number of things can happen? This is related to the above, since I am inclined to believe (although I'm not wedded to the idea) that the state space of the universe is infinitely big, and we have to be careful about making sense of our intuitive feeling that a certain state of affairs is "unnatural."

4. Also relatedly, questions of the measure problem in cosmology and ”who we are in the multiverse.” What is the correct way of calculating probabilities if observers with exactly our data occur infinitely often? If we knew the wave function of the universe exactly, would that be enough to calculate the probability of observational outcomes, or do we need an additional subjective probability distribution?

5. Less directly related to the interests of our assembled crowd, I’m interested in understanding the relationship between different theories/vocabularies that speak to different “explanatory levels.” Questions of emergence and reduction and so on. I think there is some connection to our questions about time, as I think that the thermodynamic arrow ultimately underlies our folk intuitions about things like causality and free will, which ultimately involve very coarse-grained descriptions of the reversible dynamics underneath.