METHODOLOGY AND EPISTEMOLOGY IN COSMOLOGY CONFERENCE

University of California, Irvine
Social and Behavioral Sciences Gateway Room 1517
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SPEAKER TITLES & ABSTRACTS

Kev Abazajian (UC Irvine) ***The Limits of Scientific Cosmology***

The measure problem in cosmology has brought the questions from the philosophy of science into the cosmological discussion. I will discuss some aspects of these questions as well as other junctures where scientific methods may hit limits, as well as efforts of working through some of these limits.

Anthony Aguirre (UC Santa Cruz) ***Cosmological intimations of aggravating infinities***

Cosmological inflation provides a very economical explanation of a number of aspects of the big-bang cosmology using a single postulate, that the universe underwent prolonged exponential expansion early on. However, in many models “prolonged” means “forever,” and the amount of spacetime eventually produced is infinite. I’ll discuss both the arguments leading to this conclusion, and some of the perplexing fundamental issues that arise in such an infinite spacetime.

Andreas Albrecht (UC Davis) ***Reflections on Cosmic Inflation***

Cosmic inflation has been extraordinarily successful in certain respects, but has also left deep questions unanswered. I will evaluate the current status in light of all these aspects. Topics will include the relationship between inflation and “fine tuning” in cosmology and the appropriate way to consider probabilities (aka “measures”) in the multiverse.

Feraz Azhar (Cambridge) ***Three aspects of typicality in multiverse cosmology***

Extracting predictions from cosmological theories that describe a multiverse, for what we are likely to observe in our domain, is crucial to establishing the validity of these theories. One way to extract such predictions is from theory-generated probability distributions that allow for selection effects---generally expressed in terms of assumptions about anthropic conditionalization and how typical we are. In this talk, I urge three lessons about typicality in multiverse settings. (i) Because it is difficult to characterize our observational situation in the multiverse, we cannot assume that we are typical (as in the 'principle of mediocrity'): nor can we ignore the issue of typicality, for it has a measurable impact on predictions for our observations. (ii) There are spectra of assumptions about both conditionalization and typicality, which lead to coincident predictions for our observations, leading to problems of confirmation in multiverse cosmology. And moreover, (iii) when one has the freedom to consider competing theories of the multiverse, the assumption of typicality may not lead to the highest likelihoods for our observations. These three entwined aspects of typicality imply that positive assertions about our typicality, such as the principle of mediocrity, are more questionable than has been recently claimed.

James Bullock (UC Irvine) ***Simulations and the Nature of Dark Matter***

(Abstract forthcoming)

Claudia de Rham (Case Western) *Beyond Einstein*

At the beginning of a new era of direct gravitational detections, the time is right to pause and ponder about the nature of the particle carrier of the gravitational force and whether the nature of the graviton may help tackling some of the most challenging of modern cosmology today.

Manoj Kaplinghat (UC Irvine) *Can we understand the nature of dark matter if it does not interact with the known particles?*

The possibility that dark matter may not interact with the standard model through non-gravitational forces seems to be a real now. Could we still hope to understand the nature of dark matter? Is the new physics in the gravitational sector or is dark matter made up of particles? I will present examples using hidden sectors to explore these questions.

Barry Madore (Carnegie Observatories) *A Philosophically-Informed and Computationally-Coordinated, Empirical Search for Pure Dark-Matter Galaxies*

Two philosophers of science (M. Jaquart and M. Weisberg, U. Penn) and two astrophysicists (M. Seidel and B.F. Madore, Carnegie Observatories) are currently undertaking a philosophically-informed observational (and computational) program to search for, identify and characterize pure dark-matter galaxies. These objects, by their very nature and definition, neither emit nor absorb electromagnetic radiation at any observable wavelength. In the context of "referential realism" Ian Hacking's famous statement about "entity realism" suggesting that "if you can spray them, then they are real" might best be rephrased in an astrophysical context when discussing "dark-matter galaxies" in the following way: "if they can spray other things, then they are real."

We will present results of the observational program already underway, show the computational simulations backing up, predicting and interpreting the empirical study, and place this study into a modified realist's approach to astrophysics, in particular, having numerous "cosmic experiments" trade places with the physicist's controlled laboratories.

Ashley Perko (Stanford University) *Effective Field Theory in Cosmology*

Traditionally, theories of inflation impose dynamics for the early universe from the top down, motivated by either phenomenological considerations or high-energy theories such as string theory. Since we can only hope to observe a few inflationary parameters in cosmological observations, and a vast models of inflation give the same predictions for any given value of each parameter, it is unclear whether inflation can be considered predictive as a theory. However, using the effective field theory mindset, we can write the most general theory of inflation from the bottom up, given the symmetries observed at the scales of observations. At leading order, the resulting Effective Field Theory of Inflation collapses every model of single-field inflation into just two parameters, which can in principle be observed. In this talk I will review the Effective Field Theory of Inflation and the current prospects for constraining its parameters using cosmological observations.

Sarah Shandera (Penn State) *Cosmology in a finite universe*

We hope to find clues about the particle physics of the primordial (inflationary?) universe in the statistics of cosmological perturbations. However, if the fluctuations are non-Gaussian then the statistics we observe can differ significantly from the global, mean predictions of an inflationary model. Current bounds on non-Gaussianity do not eliminate this possibility. I will discuss how the conclusions we draw about the primordial degrees of freedom are limited by the finiteness of our observable universe and how this relates to the initial conditions problem in inflation.

Chris Smeenk (Western) ***Challenges to Primordial Cosmology***

For several decades, cosmologists treated the early universe as the "poor man's accelerator," providing a means to test high energy physics in the course of reconstructing its history. What are the challenges to establishing the physics of the early universe, based on cosmological observations limited to a finite universe? In many areas of physics we have very strong evidence for accepting current theories, at least as approximations accurate within some restricted domain. The contrast with these cases of exemplary evidence will help to identify general challenges to establishing theories of early universe with a comparable level of certainty. I will further argue that multiverse theories, such as eternal inflation, undermine one way of responding to these challenges.

Frank van den Bosch (Yale) ***Numerical Simulations in Cosmology: tool kit or Pandora box?***

Numerical simulations are an indispensable tool in modern-day cosmology. They are used to study how structure formation proceeds in the non-linear regime, where analytical estimates fail, and are rapidly becoming the standard tool for constraining cosmological parameters, and therefore for testing and informing our cosmological paradigm. However, simulations are not always reliable, and there is a realistic risk that they may misguide us in our cosmological endeavor. After giving a brief outline of the various simulation techniques at use, I discuss how one goes about testing the reliability of numerical simulations. I end by giving a specific example of a cosmological topic were simulations have been misguiding us for decades; dark matter substructure.

Eric Winsberg (USF) ***"Testing this Extraordinary Scenario": Simulation and models of Big Bang cosmology***

The standard model of big bang cosmology, lambdaCDM, postulates that the dynamics of the universe's evolution are dominated by unseen matter and energy. But the observable evidence of the universe's structure comes to us primarily from stars, gas, and accreting black holes. Making connections between the underlying model and the observable evidence, therefore, is highly dependent on computer simulation. In this talk I review some elements of the epistemology of computer simulation and then use it to examine the strength of evidence for lambdaCDM that is available from simulation.

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