Scientific Models and a Comprehensive Picture of Reality

May 20-21 2016, The House of Science and Letters, Kirkkokatu 6, Helsinki

Friday, May 20, 2016

8:30 Registration

9:00 Welcome, opening

9:15 Prof. Jayant Narlikar, What Should One Expect from a Cosmological Model?

This presentation is inspired by the ideas of Karl Popper and Hermann Bondi. The expectation from a cosmological model is that it makes testable predictions about the real universe. This restriction rules out concepts of parallel universe, for example. If a claim is made that our universe has a parallel companion, the above criterion would demand a testable prediction about the parallel companion: State an observational test that would rule out this concept if it fails to meet the prediction.

The big bang vs. steady state controversy did not give adequate exposure to this criterion. A noted example is that of radio source count. If the radio sources were counted (N) brighter than specified flux densities (S), then a static Euclidean universe produces a log N / log S plot with a slope of -1.5. The steady state theory predicts a plot with slope -1.5 at high flux end flattening to lower slopes -1.4, -1.3, etc. steadily as one observes fainter sources. Thus a steep slope like -1.8 can in principle disprove the theory. The typical big bang model can, however, produce any slope if one introduces suitable epoch dependent parameters. Thus the test is not suitable for the big bang cosmology since it is not disprovable, i.e., any data can in principle be fitted to the theory.

This idea will be developed further against the background of the standard model of cosmology today with inputs from inflation, dark matter and dark energy. It will be shown that rather than make clear predictions, the parameters of the model are adjusted to fit the data. In such circumstances, it is difficult to formulate a test that will disprove this model.

Finally, an alternative to big bang, developed in the 1990s using some features of the old steady state cosmology and some of the big bang will be described. This model makes testable predictions and can be considered more realistic than the standard model. Known as the quasi-steady state cosmology, it was first proposed and discussed in 1993 by its three authors Fred Hoyle, Geoffrey Burbidge and this speaker.

10:30 Coffee break

11:00 Dr. Heikki Sipilä, The Zero-energy Principle as a Fundamental Law of Nature – The Zero-energy principle of the universe, history and implications

The expanding universe does work against gravity. Based on this, as early as the late 1930s Pasqual Jordan first suggested that the mass energy of stars and the negative gravitational energy of the universe are equal and the total energy of the universe is zero.

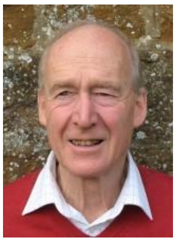
This hypothesis has been known to some physicists; e.g. Richard Feynman discussed this topic in his teachings on gravitation in the 1960s. However, this idea and its implications have not been widely known, since during recent years, the zero-energy principle has appeared again in several papers without any reference to earlier works. Tuomo Suntola found the zero-energy principle when studying energy balances in spherically closed space.

In Suntola's model, the universe is described as a three-dimensional expanding surface of a four dimensional sphere. The same was proposed by Richard Feynman but he did not develop the idea further. It appears that Mach's principle, the relation of the local to the whole, and the zero-energy principle are closely connected. Suntola's model links local phenomena to the rest of space; Mach's principle gets a quantitative explanation and the velocity of light in space is linked to the expansion velocity of space in the fourth dimension.

Observational evidence that the universe is a three-dimensional surface of a four sphere is discussed. Quantum mechanical explanations of the zero energy principle are also reviewed.

12:00 Lunch

13:30 Dr. Julian Barbour, The Origin of Time, Structure and Beauty



Without the experience of the change of things, we could never have formed the idea of time. I will show how one can formulate a law of change of the universe from which precise properties of time follow, specifically: what it means to say that a second today is the same as a second tomorrow, why experienced time has a direction even though the law does not distinguish a direction, and why time seems to have begun at the Big Bang although in fact there may be another universe on the other side of the Big Bang in which the direction of experienced time is the opposite or ours. A key aspect in our experience of time is the growth of structure. I will show how this too is mandated by a law of change. Finally, time and structure play an essential role in our experience of beauty, which thus also seems to be inseparably linked to the universe's fundamental law of change.

14:45 Coffee break

15:15 Dr. Tuomo Suntola, Restructuring of the Scientific Picture, A Holistic Approach to Relativity, Cosmology and the Essence of a Quantum

The ultimate purpose of a scientific model is to make nature understandable. Nevertheless, the major physical theories do not fit into the natural observational reality where time and distance have unequivocal meanings. Should we abandon an understandable reality or rethink the theory? In a holistic approach to space as a zero-energy system, we can identify relativity as a direct consequence of the finiteness of the total energy in space. Instead of describing relativistic effects in terms of distorted time and distance, the effects can be described in terms of locally available energy – thus saving the universality of the coordinate quantities, time and distance, essential for human comprehension. The zero-energy approach can be built on direct empirical evidence – it shows unification via unified expressions of energy and energy conversions rather than unifying force interactions. The zero-energy approach leads to precise and mathematically simple predictions of cosmological observables without additional parameters like dark energy, and cures the conceptual gap between macroscopic physics and quantum mechanics.

16:30 Lic. Phil. Avril Styrman, Economical Unification in Philosophy of Science

The goal to unify science and the preference for simplest empirically sufficient theories have been present in philosophical and scientific thinking from antiquity to the present day. Given all available empirically sufficient theories, the principle of economy favors the theory which incorporates the least sum of metaphysics. The history of the principle of economy is reviewed and the inseparability of unification and economy is emphasized. The central metaphysical postulates of the Relativity-based standard model of cosmology (FLRW) and the Dynamic Universe model are reviewed and evaluated.

17:30 – 18.00 Panel discussion

18:30 Reception at the University of Helsinki main building

Saturday, May 21, 2016

9:00 Prof. Ari Lehto, Period Doubling as a Structure Creating Natural Process

Period doubling is a general property of nonlinear dynamical systems. This presentation discloses period doubling as a fundamental mechanism in the creation of stable structures from elementary particles to planetary and galactic systems. Analysis of experimental data suggests that the period doubling process takes place in three and four internal degrees of freedom. Starting from the Planck units for mass, distance, time and electric charge, the period doubling process gives accurate values for the elementary charge, electron and proton rest masses and their magnetic moments, and organizes known elementary particles into a periodic table. Period doubling explains the quantized redshifts of galaxies (Lehto-Tifft equation) and the planetary orbits by disclosing the origin of the Titius-Bode rule and extending beyond that.

10:15 Coffee break

10.45 Prof. Ilkka Niiniluoto, Science Approximates Reality

According to critical scientific realism, an important aim of science is to find true and informative theories which postulate non-observable entities and laws to describe and explain observable phenomena. When such theories are successful, they are truthlike in the sense that they approximate reality. In the case of scientific laws, this notion of truthlikeness or verisimilitude is called legisimilitude. This paper discusses the idea of approximation by showing how the distance of a law statement from the true law can be defined.

12:00 Lunch

13:30 Prof. Atocha Aliseda, What Makes a Logical / Physical System a Comprehensive Picture of Reality? A Logician's Viewpoint

In Logic, the key concept is that of inference, a relationship between a set of premises and a conclusion. But this relation manifests itself in many different ways leaving ample room for several logical systems, each of which may be characterized by structural rules, stating properties of the underlying consequence. In classical logic, one such property is the monotonicity rule, which dictates that a conclusion remains valid regardless of premissed additions. This rule is not valid in many other logical systems. Still, there are weaker forms of monotonicity allowing addition of premises in a safe way, under certain conditions, but there is no unique form of the monotonicity rule which satisfies all logical systems.

The axiomatic theory of consequence relations has a long history and aims to describe a style of inference at a very abstract general level, providing a structural model. It has proved very successful in artificial intelligence for studying different types of inference (Gabbay 1985, 1994; Kraus et al 1990), as well as in dynamic semantics, where not one but many new notions of dynamic consequences are to be analyzed (van Benthem, 1985, 2011). The search of a set of minimal properties for a system to be considered logical may be exported to other areas, such as Theoretical Physics, in which coordinate quantities, such as time and distance, have several ways of relating to each other depending on the model of the Universe under which they exist.

My conclusion for logic is that although there is not a fixed set of minimal properties valid throughout the universe of logical systems, for a system to be considered logical, it should exhibit particular forms for reflexivity, monotonicity and the cut rules (Aliseda, 2005). This view allows to argue for a comprehensive picture of reality, while giving place to a plurality of systems.

14:45 Coffee break

15:15 Dr. J. Mikael Karimäki, Quantum Physics at the Crossroads of Philosophy, Mathematics, and Natural Sciences

The purpose of the talk is to place Quantum Physics in the context of other pursuits of human knowledge and to show how and why it occupies a central place among them. The ideas and theories in Quantum Physics have been influenced by other areas of research, and vice versa, advances in Quantum Physics, both theoretical and experimental, have provided new insights into those other fields.

Thus, Quantum Physics appears as a very rich and diverse, perhaps even confusing, area of research. It is a property of nature that things are this way, not a man-made choice. However, this exceptional diversity provides also a justification for using many different and seemingly unconnected approaches and strategies for research in Modern Physics, from Mathematical Logic, to giant accelerators and space missions.

Quantum Physics occupies an unquestionable position in the context of Physics in general. Modern physics stands firmly on three legs: Quantum Physics, Statistical Physics, and Relativistic Physics. All these three are connected to some 'constants of nature', and each one of them through the concept of energy ($E = hf$, $E = 1/2\ kT$, $E = mc^2$).

Other fundamental constants of nature (e, G, ...) also appear in Physics, and it is incumbent to try to understand their possible connections and interconnections, even by playing with numbers, or experimenting with very simple and crazy-looking ideas. This approach may be dismissed as too cheap, or too easy, or even as numerology, but it may also give us cost-effective shortcuts into some of the great unsolved mysteries in modern physics.

The diverse and multifaceted nature of Modern Physics should encourage us to try to see different approaches as not necessarily contradictory, but rather as possibly mutually compatible intellectual incursions into a single reality, albeit a very diverse and complex reality.

16:30 Panel discussion

17:00 Closing remarks