ABSTRACTS

C2.3 Philosophy of the Physical Sciences

The conceptual foundations of Symmetry Breaking and the origin of physics

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Symmetry principles play an important role with respect to the laws of nature, but much of the texture of the world is due to mechanisms of symmetry breaking. In this lecture we want to explore the argument structure of the concept of spontaneous symmetry breaking in the physical Model, we highlight the essential rôle of the asymmetry and finally we dicuss the signification of the symmetry breaking principle in the context of the observed reality.

Quotidian, scientific and fictitious objects under a Russell-Schrödingerian approach: the case of light

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Following a Russell-Schrödingerian approach to the construction of reality, based mainly on Schrödinger’s “Mind and Matter” (1956), Russell’s The Analysis of Matter (1927), and The Analysis of Mind (1921), it is possible to say that human beings ‘objectivate’ the world, forming invariants to build reality as we know it. The process of invariant formation involves the subject/object duality as a leading empirical principle. In the dual world, subjects tend to pull apart the general sphere of objects in two parts: scientific and everyday objects, each one built up in a different way. Daily objects are, according to Schrödinger, constituted of real plus virtual perceptions (or expectations), while scientific objects are made of virtual perceptions only. Hence, the objects of science have no direct link to sensations, being described by Schrödinger as ‘pure form’, composed of pure ‘expectations’. On the other hand, some objects are known to take part in both domains. This paper aims to analyze the case of light, advancing that its scientific status changed drastically in the quantum revolution. It has become, since then, much more distant from everyday life’s light. Quantum experiments suggest that light can be described neither as a particle nor as a wave; such descriptions alone are not sufficient to explain some experimental results. In addition, we can also place light in another sphere of objects – that of science fiction. For instance, the scientist in H.G. Wells’s “The Invisible Man” has to deal with properties of light in order to create the invisibility formula. Finally, science fiction objects, such as light, are based on scientific objects, which in turn depend on everyday objects to be constituted. Therefore, from a Russell-Schrödingerian
standpoint, only first order objects are directly linked to sensations, while the third order fictitious objects are built by expectations of expectations.

**Prediction in General Relativity**

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Various prominent physicists and philosophers (among them Earman, Geroch, and Manchak) have claimed that prediction is essentially impossible in the general theory of relativity, the case being particularly strong, it is maintained, when one fully considers the epistemic predicament of the observer. I argue that the conditions on prediction advocated by these authors rest on philosophically misguided and unphysical intuitions. For example, it is argued that an observer has epistemic access to all events in her causal past, but no physical mechanism can account for such powers (due to, for example, the ubiquity of scattering and other physical considerations). Also the result rests on an austere epistemology that requires the observer to know with certainty that she can make a prediction based solely on information which she can gather from her causal past, yet fallibility of knowledge is by now widely accepted as the mainstream position in contemporary epistemology. I show how the concerns I raise thoroughly undermine these authors’ results. I therefore claim that they should be rejected as inadequately explicating the concept of prediction in general relativity. Along the way I clarify the epistemic situation of observers and discuss the significance of these arguments for cosmology as well.

**On two arguments for the non-renormalizability of gravity**

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We will discuss two arguments for the non-renormalizability of gravity. First, there is the perturbative argument: in the effective field theory action for general relativity almost all couplings diverge, hence renormalization fails. The asymptotic safety scenario is a way of disabling the perturbative argument by showing that the couplings do not blow up, but rather approach a non-trivial UV fixed point. As a consequence, general relativity can be presented as a renormalizable quantum field theory.

There is also a different argument for the non-renormalizability of gravity. It is supposed to show that the asymptotic safety is not a satisfactory option by using the supersymmetric methods, as there is no conformal field theory whose density of states coincides with the density of states given by the Bekenstein-Hawking entropy formula in black hole.
thermodynamics.

From a philosophical point of view there are several noteworthy issues to be considered here. First, the supersymmetric argument faces difficulties in spacetimes with positive cosmological constant, which significantly limits its applicability. Second, we can circumvent the supersymmetric argument, e.g. via dimensional reduction. In particular, numerical simulations hint that dimensional reduction is a feature of causal dynamical triangulations interpreted as implementing the asymptotic safety scenario.

Finally, we will argue that even if the supersymmetric argument worked, non-renormalizability in general relativity is due to gravitational processes. This is yet another reason for abandoning the traditional understanding of renormalizability as a consistency check for a theory.