AGPhil 11: Time and Temperature

Time: Thursday 16:15–18:45 Location: AGPhil-H14

AGPhil 11.1 Thu 16:15 AGPhil-H14

Taking seriously the problem of time of quantum gravity — •Alvaro Mozota Frauca — Autonomous University of Barcelona

In this paper I raise a worry about the most extended resolutions of the problem of time of canonical quantizations of general relativity. The reason for this is that these resolutions are based on analogies with deparametrizable models for which the problem can be solved, while I argue in this paper that there are good reasons for doubting about these resolutions when the theory is not deparametrizable, which is the case of general relativity. I introduce an example of a non-deparametrizable model, a double harmonic oscillator system expressed by its Jacobi action, and argue that the problem of time for this model is not solvable, in the sense that its canonical quantization doesn't lead to the quantum theory of two harmonic oscillators and the standard resolutions of the problem of time don't work for this case. I argue that as general relativity is strongly analogous to this model, one should take seriously the view that the canonical quantization of general relativity doesn't lead to a meaningful quantum theory. Finally, I comment that this has an impact on the foundations of different approaches to quantum gravity.

AGPhil 11.2 Thu 16:45 AGPhil-H14

quantum gravity and time's arrow: why primitivism should leave the floor to (local) reductionism — •luca gasparinetti — Venice, Italy

According to some primitivist approaches about the debate on time's arrow, spacetime is characterized by an intrinsic and global anisotropy of time, i.e., the temporal direction is a primitive and no further analyzable feature of the universe's geometry (Earman 1974 and Maudlin 2007). However, in several approaches to quantum gravity (e.g., causal set theory, loop quantum gravity, string theory), most philosophers of physics, e.g., Huggett (2021), Le Bihan (2021), Wüthrich (2018), state that spacetime disappears at the fundamental level and emerges in some sense from a non-spatiotemporal structure. Thus, the following question arises: given the disappearance of spacetime from the fundamental structure, what are the consequences for the primitivist approach about time's arrow?

In this paper, I argue that primitivism about time's arrow is seriously challenged by what quantum gravity theorists state about spacetime. More specifically, since spacetime is emergent, the direction of time, if it exists, reduces on a more fundamental asymmetry. It follows that if time's arrow is not primitive, the primitivist approach is false in the context of a theory of quantum gravity. Hence, I conclude that quantum gravity theorists have at their disposal only (local) reductionism, i.e., time's arrow is an extrinsic and, local or global, anisotropy of time.

AGPhil 11.3 Thu 17:15 AGPhil-H14

On the Status of Temperature and Thermodynamics in Relativity — •Eugene Y. S. Chua — University of California San Diego, La Jolla, CA

The project to understand black holes thermodynamically (i.e. black hole thermodynamics) was motivated by how stationary black holes can be characterized by laws analogous to the laws of classical thermodynamics. Taking this analogy seriously as evidence that black holes are thermodynamical seems to require that thermodynamics be relevant in the large-scale relativistic regime, viz. that there is a relativistic thermodynamics to speak of. However, an unresolved debate from the 1960s over the (lack of a) canonical Lorentz transformation for a central thermodynamic concept - temperature (and heat) - undermines this very assumption by asking whether thermodynamics could be relativized at all. By examining this debate, I argue that temperature, like absolute simultaneity, is not relativistic. We can readily judge simultaneity within a frame, just as co-moving observers can readily discern a system's temperature. However, the debate suggests there is no fact of the matter about the temperature of a moving object, just as there is no absolute sense that two objects moving relative to one another are simultaneous with each other. This pushes back against the idea that classical thermodynamics should be extended into the relativistic regime. The upshot for black hole thermodynamics: the thermodynamical analogy should not be taken too seriously.

AGPhil 11.4 Thu 17:45 AGPhil-H14

The physical reality of a directed time — •Grit Kalies — HTW University of Applied Sciences, Dresden, Germany

Irreversibility has occupied philosophers and physicists for centuries. While quantum mechanics and special and general relativity interpret processes as reversible, thermodynamics describes every macroscopic process as irreversible. This divergence is called "Paradox of Time" [1].

In the 19th century, Max Planck was searching for a genuine irreversible microscopic process and refused to accept Ludwig Boltzmann's purely statistical interpretation of the second law of thermodynamics, which does not describe irreversibility at the quantum level [2]. Later, Boltzmann's interpretation was accepted.

Recent studies [3-7] show that Boltzmann and Clausius could not yet formulate the second law comprehensively due to the limited data available. As a result, physics was founded on symmetry principles. And yet: it exists, the irreversible process at the quantum level. The second law of thermodynamics can be further developed and understood as a fundamental law of nature, i.e. time symmetry is excluded.

[1] I. Prigogine, I. Stengers: Das Paradox der Zeit, Piper, München, Zürich, 1993; [2] L. Boltzmann, Sitzungsber. kaiserl. Akad. Wiss. Wien 66 (1872) 275-370; [3] G. Kalies: Vom Energieinhalt ruhender Körper, De Gruyter, Berlin, 2019; [4] G. Kalies, Z. Phys. Chem. 234 (2020) 1567-1602; [5] G. Kalies, Z. Phys. Chem. 235 (2021) 849-874; [6] G. Kalies: Back to the roots: The concepts of force and energy, Z. Phys. Chem. (2021) 1-53, DOI: 10.1515/zpch-2021-3122; [7] G. Kalies: On the unification of mechanics and thermodynamics, submitted (2021).

AGPhil 11.5 Thu 18:15 AGPhil-H14

Breaking Symmetry in Scientific Explanation — •Benjamin Faltesek — Texas A&M University, College Station, TX, USA

The causal asymmetry problem plagues argument-form accounts of scientific explanation such as Kitcher*s unificationism. Such accounts require explanations to be sound and have some additional property; for Kitcher, the additional property is unifyingness: theory A is more unifying than theory B iff A explains more phenomena than B using as many or fewer ultimate facts and argument forms than B.

The causal asymmetry problem is that such accounts cannot distinguish good from bad explanations when there is an equation among the premises. An argument pattern that explains the length of a building*s shadow from the building*s height, for instance, can equally well explain the building*s height from the length of its shadow. Each explanation is equally sound and unifying, but the latter goes against causal dependence.

I propose a solution without relying on causal intuitions. For any explanation with an equation premise, the equation has a term E such that if E takes the value 0, the system at issue in the explanation cannot exist. This is not true of the other terms C. E represents the effect of the system, the phenomenon to be explained. I provide a schema for constructing explanatory argument forms that avoids the causal asymmetry problem by conditionalizing equations on the Cs.