BOOK REVIEWS

Helena Eilstein (ed.), *A Collection of Polish Works on Philosophical Problems of Time and Spacetime*, Kluwer Academic Publishers, Dordrecht, 2002, viii + 148 pp., Euro 60 (cloth), ISBN 1402006705.

This volume collects eight articles in English by Polish authors in philosophy of time and of spacetime. The main emphasis is on the debate regarding the objectivity of the flow of time. According to the preface, the first six papers approach the topic from the vantage points of classical, relativistic, and contemporary physics. While the sixth paper of the collection, by the editor herself, only contains one section which can reasonably be imputed to philosophy of physics, it nevertheless connects to the previous five articles. Unfortunately, the same cannot be said of the last two papers, which seem to engage in rather different debates and to partake in entirely distinct traditions. The seventh paper by Stefan Snihur, composed in the vein of traditional philosophy employing the methods of classical logic, operates against the background of everyday experience rather than of physical sciences. The final paper by Andrzej Póltawski exposes the philosophy of time of the Polish Husserl disciple Roman Ingarden. The inclusion of these two papers threatens the coherence of the volume. To be sure, the fact that its authors are all Polish may bestow a unifying theme on the collection, but at the same time, it just shows how variegated the landscape of Polish philosophy actually is. Perhaps a substantial introduction embedding the papers in a larger context and relating them to each other could have established such coherence and offered motivation for the choice of the included essays. Also, the collection would have benefited from more careful editing and referencing and some of the essays could have profited from clearer English. Be this as it may, the volume provides the much-needed and appreciated service of making the contributions of contemporary Polish philosophers to the problem of time more widely accessible. For this, the editor and the publisher deserve the gratitude of the philosophical community.

In the first essay of the collection, Jerzy Golosz defines absolute *vis-à-vis* relational conceptions of motion and links the controversy between

absolutists and relationists to the problem of what spacetime symmetries an adequate theory of motion should exhibit. His effort focuses on both pre-relativistic, classical physics as well as relativistic theories. In the section on classical physics, which presents itself as a rather adventurous back and forth between a contemporary discussion of spacetime symmetries and historical citations and claims, Golosz criticises Newton's heirs for considering it sufficient to reject Newton's distinguished reference frame in order to renounce the absoluteness of motion. Instead, he complains, they should have established the viability of relationism by constructing a relational theory of motion. Golosz further claims that Einstein's special theory of relativity (STR) must be interpreted as an absolute theory of motion, mainly due to the fact that the metric tensor in STR is an absolute object, i.e. it is not affected by interactions admitted by the theory. He attacks Earman's (1989) conclusion that no theory with a relativistic structure can offer a relational account of rotation on the grounds that a relativistic spacetime may not have the structure of a spacetime of general theory of relativity (GTR). But if there is one spacetime feature required to qualify as relativistic, then the causal structure as encoded in the light cone structure or an equivalent property has arguably the best claim. Since Earman's conclusion rests solely on this feature, Golosz's complaint is misguided. He also wants to argue that the absoluteness of motion, which seems to be present in most if not all theories of motion, implies the substantival character of space or spacetime. According to him, Earman's attempts to offer a via media between the Scylla of relationism and the Charybdis of substantivalism have failed. He finishes by claiming to have proved that a theory which would realise Earman's representational ploy cannot exist. Unfortunately, his argument – which should have been made the main focus of the paper – remains rather superficial and thus failed to convince this reader.

In his 'Quantum Spacetime and the Problem of Time in Quantum Gravity', Leszek M. Sokolowski addresses two main aims: to motivate the quantisation of gravity and to discuss difficulties which arise from this quantisation, mostly regarding space and time. What is rather strange about Sokolowski's paper is that it does not contain any references at all, omitting for example a reference to the pertinent Huggett and Callender (2001) in the first section where he discusses the physicists' motivations for attempting to quantise gravity. Having said that, Sokolowski offers an insightful and scientifically informed article. He motivates the ambition for quantising gravity with the deeply-felt unity of nature and quickly proceeds to the resulting difficulties emerging from incompatible conceptions of time and space in quantum theory and classical gravitational physics.

After a splendid exposition of time in GTR and in quantum theory, he characterises the problem of time in quantum gravity. Due to its quantum nature, it requires a universal physical time conceived of as an external parameter. But as a theory of gravity, time as a geometric aspect of gravity should be considered as a local dynamical variable to be quantised. When the author, in the light of this dilemma, expresses pessimism regarding the extant characterisations of quantum spacetime and discusses Wheeler's fluctuation-of-topology approach, it is curious that he ignores loop quantum gravity, which, in some sense at least, represents a theory in Wheeler's vein and offers promising new developments towards resolving the issue.

Next, Michal Heller ('Time and Physics – A Noncommutative Revolution') explores the implications of the general mathematical tool of noncommutative (NC) geometry for the debate on time and change. Defending the thesis that real progress regarding the problem of time is always associated with a corresponding advance in the application of elegant mathematical tools in natural sciences, he draws the reader's attention to a relatively new mathematical structure, NC geometry. Define a linebreak differentiable manifold as the pair (M, C), where M is a nonempty set and C is the algebra of the family of all smooth functions on M. NC geometry then emerges if one considers a noncommutative algebra instead of a commutative one. If fundamental physics is modelled on an NC geometry, time and space, and with them motion as traditionally conceived of, vanish at the scale of fundamental physics. The reason for this distressing disappearance stems from the fact that NC geometry disallows any local concepts such as points and neighbourhoods in favour of purely global ones. Resisting the temptation of invoking the full mathematical apparatus, Heller skillfully explains how one can nevertheless construct authentic dynamics from global concepts alone. This is done by starting out from the global properties of vector fields and deriving an algebra by recasting these properties in a delocalised NC setting. The dynamics are then encoded in mappings from one NC algebra unto itself which satisfies linearity and the Leibniz product rule. More specifically, the dynamics in the NC geometry assumes the form of a set of equations describing the evolution of the system at stake. Time, or an ersatz thereof, then reemerges as a parameter with respect to which this evolution occurs. This 'noncommutative revolution' also involves a generalisation of the concepts of causation and chance. Perhaps shockingly to many philosophers of science, regularity theories of causation, depending as they do on an identification of individual events, are precluded in fundamental physics based on NC geometry. Thus, Heller concludes, we are well advised to conceive

of causation as a dynamical nexus rather than as the distinct events of cause and effect and their temporal order.

Jan Czerniawski then argues in favour of the flow of time as a selection rule in GTR. The hole argument establishes that the generally covariant Einstein field equations do not uniquely determine their spacetime solution: for any finite spatio-temporal region (the 'hole'), the Einstein field equations admit infinitely many extensions of an external gravitational field to the inside of the hole. This excess generality, Czerniawski urges, should be eliminated by invoking time flow as a non-ad hoc selection rule. Since regions containing solid objects as well as empty space qualify as regions of possible histories of matter for Czerniawski, the possibility of a global time flow, and thus of introducing global time, he continues, should provide the condition which must be satisfied by a spacetime acceptable as a physical solution. In a stark contrast to the usual eventistic ontology of GTR, Czerniawski proposes to prefer what he dubs a reistic ontology: an ontology in which physical objects retain their identity through a global time. Unabashed by the increasingly remote connections between fundamental physics and our immediate experience, he defends his proposal by insisting that we should endorse a reistic ontology rather than an eventistic one in the light of our immediate experience. Obviously unimpressed by the lessons of contemporary physics as related, for instance, in the preceding essay by Heller, Czerniawski further asserts that evolution and dynamics must be conceived of as reistic (and thus localised) concepts, viz. as systems of bodies and fields co-evolving according to their propensities to do so. Similarly, he concludes, solutions with 'causeless irregularities inside the "hole" ' must be eliminated on the basis that they do not conform to the extension of the regularities outside the hole to within it. Unfortunately, Czerniawski fails to convince the author of this review in what I take to be his chief concern: introducing time flow as a non-ad hoc criterion to weed out excess solutions. The resources of GTR are insufficient to determine regularities to within the hole. But why should we endorse an extra criterion with no connection to GTR rather than just admit that GTR is an incomplete theory in the sense of the hole argument and similar considerations? The lesson to be drawn, one might argue, should be to keep looking for a more powerful theory (of quantum gravity) which will arguably resolve these issues without reverting to ill-motivated metaphysical principles.

Tomasz Placek, in his 'Branching for a Transient Time', presents a formal framework capturing transient time. Transientism advocates the objective reality of McTaggartian A-series change, maintaining that mere B-series change does not suffice to account for our experience of the

passage of time. Placek's ambition is to offer a mathematically precise and intuitively correct model for the passage of time. To this end, he presents the algebraic models of stochastic outcomes in branching space-times (SOBST), an isomorphic relative of Boolean algebras. The models of SOBST suggest what it would mean for a (classical) physical theory to accommodate becoming. SOBST models are modal models built on the notion of open future and the attrition of possibilities, i.e. the perpetual collapse of formerly undetermined possibilities into an actual and many non-existing ones. But as modal models, they are independent of physics. As Placek puts it, '[m]odality is hardly in the repertoire of extant physics, and explaining the workings of physical sciences is hardly the task for SOBST' (p. 87). He provides a very readable, and indeed, excellent, exposition of the SOBST models and relates them to a geometrical approach in the vein of relativity. There is only one concern with the paper: given its immense importance for the transientist, the key concept of attrition of possibilities deserves more attention. Placek refers to this attrition as the 'deleting of non-actualised outcomes' and explains how it is responsible for the asymmetry between past and future with respect to possibilities. But the reader is not offered insight into how such attrition is supposed to work. Is it a collapse of possible histories in the moment they are annihilated by the passage of the 'now'? Perhaps, however, it is the task of a physical theory rather than of SOBST to account for attrition. Or, as Eilstein thinks, such deleting is unanalysable. In either case, Placek would be discharged from the responsibility of explaining attrition.

In her masterful contribution 'Against Detensers (Not for Tensers)', Helena Eilstein addresses the debate between transientists and permanentists. The latter believe that the universe is nothing but the totality of existing events with definite spatiotemporal locations and with temporal relations to one another. Transientism as discussed by Eilstein entails a sharp distinction between the set of properties of individuals versus their ontological status. While the individuals' properties do not undergo qualitative change, their status successively changes from future through present to past. These successive transitions are unanalysable timeless jumps, displaying what Eilstein calls the 'atomicity of becoming'. A rather similar debate arises in philosophy of language, between detensers and tensers. The former maintain that all tensed linguistic expressions can be reduced to tenseless terms, whereas the latter insist that they are ineliminable. As the attempted reductions all fail in that they only manage to convince detensers themselves, Eilstein suggests to abandon the confinement to an analysis of language and to return to things in themselves. When attention is redirected to experience, transientism appears to command im-

pressive empirical support. However, Eilstein cautions, the atomicity of becoming stands in stark contrast with the perceived continuity of becoming. While this does not amount to a contradiction, determining the support that each camp can hope for clearly requires more work and becomes a matter of scientific inquiry. But which position is supported by science and to what extent such support goes is subject to close philosophical scrutiny. Thus, she defuses the transientist argument from indeterminism of quantum mechanics by arguing that indeterminism – in quantum mechanics or elsewhere – is also compatible with permanentism. Indeed, a closer look at physical sciences suggests that the prospects for transientism are rather dim. For instance, the (potential) extermination of time as a fundamental physical quantity in modern physics and the abolishment of absolute simultaneity spell trouble for transientists. Eilstein discusses – and dismisses – transientist attempts to reintroduce absolute simultaneity or preferred foliations of spacetimes in STR. But even if successful, the existence of an objectively privileged stratification of spacetime into instants is only a necessary, but certainly not a sufficient condition for transientism. Unfortunately, Eilstein decided to concentrate on a number of epicycles in the discussion of absolute simultaneity within STR and consequently neglects the more fruitful discussion more recent physical theories would have promised. The lesson for philosophers is that permanentism is not yet scientifically refuted (and not, as she claims, irrefutable). However, this does not imply that permanentism is true, only that it would be foolish to commit oneself to transientism.

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