Revisiting the Foundations of Relativistic Physics:
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A general relativist trained in the 1950s, John Stachel is a seminal figure in the philosophy and history of relativity of the last quarter-century, and one of the rare physicists to have exercised such an influence. The papers in his Festschrift, contributed by members of what Stachel fondly calls his "intellectual family," bear witness to this influence, addressing many of the subjects with which he has wrestled over the years. Within the covers of this volume alone, the Stachel family counts forty physicists, philosophers, and historians of science.

The philosophy of physics is strongly represented in this Festschrift, with contributions from ten leading practitioners, including three papers concerning general relativity, and four on questions of quantum physics. In keeping with the "family" theme, few of these philosophers challenge positions taken by Stachel, the exception being Simon Saunders, who takes him to task for his view of the non-applicability to Newtonian gravity of the so-called "hole argument" in general relativity. Other philosophers contributing to the Festschrift choose topics tangentially related to those on which Stachel has pronounced himself. David Malament's study of relative rotation in relativity, for example, is related to Stachel's reconstruction (1980) of Einstein's path to general relativity, which highlights Einstein's desire to consider "rotation as rest." At the same time, Malament provides a fine example of conceptual analysis in the philosophy of spacetime.

Current topics in general relativity form the hard core of the volume, with thirteen contributions on subjects ranging from DSS 2+2 (a method for de-

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composing spacetime into two families of spacelike 2-surfaces due to Stachel, R. d'Inverno, and J. Smallwood), to the rigidly rotating disk (C. V. Vishveshwara), to gravitational lensing (J. Ehlers, S. Frittelli, and E. Newman). The papers in this section are aimed at an informed audience, much like the historical and philosophical contributions; all are written in such a way that they may be read with profit by anyone familiar with general relativity. Completing the set are two surveys: one by G. F. R. Ellis on cosmology in the last 35 years, the other on the action-at-a-distance concept of spacetime, by Daniel Wesley and John Wheeler.

One of the most accessible and thought-provoking papers of the latter set offers a wide-ranging reflection on the phenomena of time in cosmology. As an alternative to the anthropic principle, Lee Smolin speculates that some mechanism may be at work on a cosmological scale, fixing the parameters of the standard model (assumed to be dynamically determined) in such a way as to result in the observed universe of high structural complexity, much as the theory of natural selection in biology explains the existence of current life forms. (Smolin's theory is developed at length in *The Life of the Cosmos*, 1997.) Along the way, Smolin delves into the history of time, and suggests that we consider Einstein's notion of relative time in special relativity (operationally defined in 1900 to first-order in v/c by Henri Poincaré) as a turning point in the history of physics, as it prepared the ground, in different ways, for both general relativity and quantum field theory.

This sort of recourse to the history of physics is typical of the philosophical contributions, in that facts are carefully selected in order to construct a narrative of progress, or a "sense of history". An eloquent argument in favor of a more rigorous approach to the history of science is presented by Catherine Goldstein and Jim Ritter, in their ground-breaking study of unified field theories (UFTs) in the 1920s. Goldstein and Ritter innovate on an historiographical level by considering UFTs in relation to *collective* processes of knowledge production. On the basis of quantitative publication data, the authors seek answers to basic questions concerning, for example, the relative importance of UFT research with respect to investigations in the domains of relativity or quantum theory. This external approach is complemented by a close reading of the original papers (in German, French, English, and Italian), enabling Goldstein and Ritter to disentangle the historical dynamics of their subject, while keeping faith with its multi-faceted complexity. They resist, for instance, a facile interpretation of UFT research based on a Kuhnian model of discipline formation: while work on UFTs in the 1920s may be considered mainstream, "normal" science, there were no unification specialists, in contrast to the situation in, say, differential geometry, or general relativity.

Among other results, Goldstein and Ritter find that the shape of UFTs during their period of study was often a consequence of technical constraints. A similar conclusion is arrived at by Michel Janssen, in his study of the Trouton electrodynamical ether-drift experiment (1902) and its aftermath. Janssen compares four explanations of the observed null result: two pre-relativist accounts, based on Joseph Larmor's electron theory (1902), and on Max Abraham's definition of electromagnetic momentum (H.-A. Lorentz, 1904), and two modern four-dimensional (Minkowskian) accounts, based on Max von Laue's energy-momentum tensor (1911), and on Enrico Fermi's 1922 definition of 4-momentum of spatially extended systems. Janssen finds the latter explanation to be the best, but one has to wonder if Larmor, Lorentz, or von Laue would have agreed with the analysis.

Given the broad range of topics, and the quality of the contributions in this volume, an index would have been a particularly welcome addition. My experience was that connections between the various papers proved to be more numerous–and more profound–than I had guessed from the table of contents alone. In this sense, John Stachel's resolutely interdisciplinary family hangs together. *Revisiting the Foundations of Relativistic Physics* is a first-class source for the study of physics at the forefront of historical and philosophical reflection.