FOREWORD

In 1921, Cambridge University Press published Arthur Eddington's monograph, *The Mathematical Theory of Relativity,* arguably the first systematic and comprehensive textbook on the theory. It embodies Eddington's view that "The investigation of the external world is a quest for structure rather than substance". It had a deep influence on how researchers thought of general relativity in subsequent decades.

Five decades later the Press published another monograph, *Large Scale Structure of Space-time* by Stephen Hawking and George Ellis in 1973. Hailed immediately *as "a masterpiece, written by sure hands"* it too focuses on `structure' –but now on *global aspects* of space-time structure that had been almost entirely ignored in earlier books. The monograph solidified the new approach to understand gravitational phenomena, introduced by Roger Penrose through his use of global methods and causal structures, that transformed the way the community thought of strong gravity. It has had even greater impact on the development of relativistic gravity than Eddington's monograph because it helped shape the `golden age' of general relativity during the 1970s.

Before the appearance of this monograph, contributions to general relativity were by and large dominated by tensor-calculus and partial differential equations in local coordinates. The monograph served as a powerful catalyst that changed our way of understanding the physics of general relativity. Thanks in large part to its influence, a sizable fraction of researchers started thinking invariantly, in geometrical terms, using space-time diagrams and light cones. The emphasis shifted to global issues. In subsequent years, this shift led to numerous novel directions that created new frontiers of research: black hole uniqueness theorems; detailed investigations of the cosmic censorship hypothesis; introduction of quasi-local horizons that now play a key role in numerical relativity; and unforeseen connections between relativistic gravitation, quantum physics and statistical mechanics, through black holes. The transformative impact of the monograph is not confined to physics and astrophysics. Even in the mathematical community that provides us with rigorous proofs, the emphasis has shifted from local results based on partial differential equations to `geometric analysis' that focuses on global existence and uniqueness results for solutions to Einstein's equations, obtained using geometric structures that emphasize causality.

Hallmarks of this monograph are its conceptual clarity, mathematical rigor, and concise and precise statements that capture the essential underlying structures. The authors reverse the Machian view that the local laws are determined by large scale structure, and instead "take the local physical laws to be experimentally determined" and explore "what these laws imply about the large scale structure of the universe". This insightful switch guides their discussion throughout the monograph.

The organization of the monograph was also novel at the time. It used invariantly defined structures in differential geometry to present general relativity through a systematic set of postulates. Five decades have passed and yet this approach continues to be contemporary! Similarly, almost nothing new can be added to the presentation of the physical effects of curvature on test particles, the detailed mathematical discussion of energy conditions and the masterful treatment of the global structure of space-times --such as de Sitter, anti-de Sitter, Schwarzschild and Kerr-- that continue to feature prominently in the contemporary literature. The discussion of singularity theorems and strong field dynamics associated with gravitational collapse and binary black hole mergers are the crowning achievements of the monograph. A series of influential works from the then Soviet school led by Khalatnikov and Lifshitz suggested that the formation of singularities in gravitational collapse is an artifact of the high degree of symmetry assumed in the analysis, and generic solutions would be singularity-free. The comprehensive treatment of singularity theorems in the monograph was instrumental in causing a decisive shift in the community, away from this paradigm. Similarly, at the time many astronomers and physicists did not believe that black holes are physical entities. Inclusion of a detailed discussion of black hole dynamics in a monograph shows incredible foresight and confidence. It has been handsomely rewarded through discoveries of binary black hole mergers by the LIGO-Virgo collaboration. Discussions of these events routinely include not only the technical statements from the monograph, but even some of the diagrams!

In his Preface to this golden jubilee edition George Ellis has included a list of topics that are not covered by the book. Almost all of them refer to discoveries that were made since publication. However, the omission of gravitational waves is somewhat puzzling, given that Bondi, Sachs, Penrose, Newman and others had developed the subject in detail during the preceding decade, and the subject matter is intimately related to the large scale structure of space-time. Its inclusion would have made the work even more prescient! Perhaps it was left out because the volume is already close to 400 pages. Indeed, even as it stands, the monograph is peerless in the way it served to guide the subsequent developments in the field.

When it first appeared, I was a graduate student. I distinctly remember the excitement we all felt as we slowly absorbed the grandeur of the new vistas that the monograph opened before us. When I moved to Oxford as a postdoc, I eagerly went to Blackwells to buy my own paperback copy, which had just appeared. At £ 3.95, it is the best book purchase I have ever made! I still refer to it.

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