Preface

The International Association for Relativistic Dynamics was organized in February 1998 in Houston, Texas, with John R. Fanchi as president.

Although the subject of relativistic dynamics has been explored, from both classical and quantum mechanical points of view, since the work of Einstein and Dirac, its most striking development has been in the framework of quantum field theory. The very accurate calculations of spectral and scattering properties, for example, of the anomalous magnetic moment of the electron and the Lamb shift in quantum electrodynamics, and many qualitative features of the strong and electroweak interactions, demonstrate the very great power of description achieved in this framework. Yet, many fundamental questions remain to be clarified, such as the structure of classical relativistic dynamical theories on the level of Hamilton and Lagrange in Minkowski space as well as on the curved manifolds of general relativity. There, moreover, remained the important questions of the covariant classical description of systems at high energy for which particle production effects are not large, such as discussed in Synge’s book, *The Relativistic Gas*, and in Balescu’s book on relativistic statistical mechanics, and the development of a consistent single and many body relativistic quantum theory.

In recent years, the very high accuracy of telescopes and advanced facilities for computation have brought a high level of interest in cosmological problems such as the structure of galaxies (dark matter) and the apparently anomalous expansion of the universe (dark energy). Some of the papers reported here deal with these problems, as well as other fundamental related issues. It was for this purpose, to bring together researchers from a wide variety of fields, such as particle physics, astrophysics, cosmology, foundations of relativity theory, and mathematical physics, with a common interest in relativistic dynamics, to investigate fundamental questions of this type, that this Association was founded.

The second meeting took place, in 2000, at Bar Ilan University in Ramat Gan, Israel, the third, in 2002, at Howard University in Washington, D.C., and the fourth, on June 12-19, 2004, in Saas Fee, Switzerland. In 2006, the fifth meeting took place at the University of Connecticut campus in Storrs, Connecticut, and the sixth meeting, in Thessaloniki, Greece, in 2008, with the significant guidance of Ioannis Antoniou, the help of the Aristotle University of Thessaloniki, at the Telegrion Foundation. The seventh meeting was held in Hualien, Taiwan in 2010, organized by Da-Shin Lee with the gracious help of Bei-Lok Hu. The eighth at the Galileo Galilei Institute for Theoretical Physics (GGI) in Florence (Firenze), Italy, in 2012 and chaired by Luca Lusanna. The ninth meeting took place again at the University of Connecticut in 2014 under the guidance of Philip Mannheim and James O’Brien.

The tenth biennial meeting of IARD in 2016 was held in Ljubljana, Slovenia, organized by Matej Pavšič in cooperation with Jožef Stefan Institute. This meeting forms the basis for the Proceedings that are recorded in this issue of the Journal of Physics: Conference Series. Along with the work of some of the founding and newer but already much engaged members of the
Association, we were fortunate to have lecturers from application areas that provided strong challenges for further developments in quantum field theory, cosmological problems, and in the dynamics of systems subject to accelerations and the effects of general relativity.

We dedicate the Proceedings of IARD 2016 to the memory of Jacob Bekenstein of Hebrew University, who served on the Scientific Advisory Committee, and David R. Finkelstein of the Georgia Institute of Technology, who served on the IARD Standing Committee. We gratefully recall their support and encouragement.

Topics treated in this issue include studies in relativistic statistical mechanics, fluid mechanics and thermodynamics with relevance for the dark matter and dark energy problems, for example, in the context of Wheeler’s quantum foam and its associated thermodynamics. There are also studies of the dynamics of a perfect fluid of point particles, a treatment of surface tension analog in spacetime, and advances in conformal gravity, as well as the possibility of dark matter phenomena emerging from metric modifications which change dynamically the relation between inertial and gravitational masses. The dynamics of deformed neutron stars and the effects of acceleration, expressed in a modified metric relation is studied. Work is also reported on a fundamental development of a generalization of Newtonian mechanics, and a study is made of relativistic Coulomb systems in velocity space, providing new insight into the relativistic Kepler problem. A fundamental study of the structure of spacetime is reported which provides an interpretation of time in the presence of matter, and results in an estimate for the size of the observable universe.

Discussions of electromagnetism, including a “skewon” modification (a covariant tensor quadratic term in field strengths) of the standard electrodynamics, and a study of the field equations for moving media in covariant form, a continuum dynamics in the scalar ether theory of gravitation, as well a wave equations of massless particles of any spin. There are discussions of Pizzella’s experiment apparently demonstrating instantaneous Coulomb interaction.

Quantum and particle physics are discussed in a proposed spin-charge family theory as a successor to the standard model, and a study of branes and quantized fields. A geometrical model for electro-gravity, the quantum dynamics of bound states with spacetime fluctuations, and quantum models as classical cellular automata are also reported. Integrability of geodesics with the use of action angle variables is studied, and a study of the Feynman-Dyson theory, with a justification of the Feynman formulation of quantum mechanics, is reported.

Progress is reported in our understanding of the (off-shell) relativistically covariant formulation of Stueckelberg, with (classical) approaches to the stabilization of particle mass after interaction, and the relation of the 5D gauge fields resulting from the gauging of the evolution term in the Stueckelberg-Schrödinger equation to the standard Maxwell fields is discussed. In this framework, there is a new and fundamental study of neutrino oscillations.

Spinor theory is discussed in a study of free particle wave equations in curved spacetime. A generalized spin statistics theorem is given, and the transformations of spinors under automorphisms of their associated Clifford algebras are also discussed.
We thank the Scientific Advisory Committee for their invaluable guidance and advice:

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We thank the participants who contributed through their lectures, personal discussions, and these papers, to the advancement of the subject and our understanding.

For the Editors and Organizing Committee,

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