

PREFACE

Recent progress in observational astronomy, astrophysics and cosmology has raised important questions related to the fundamental composition of the Universe, its evolution and its ultimate destiny. Results from well-conceived space-based physics experiments could provide critical clues to uncover the answers to the challenging questions facing modern physics today. There are two complementary approaches to physics research in space: one can detect and study signals from remote astrophysical objects (observational physics), or one can perform carefully designed in-situ experiments (laboratory physics). Most of the attention to date has focused on observational physics studies, while the laboratory physics approach has received relatively little attention.

The space environment offers unique conditions for precision laboratory investigation which can be improved by many orders of magnitude to explore the limits of modern physics. Examples are the availability of variable gravity potentials, large distances, and high velocity and acceleration regimes. Importantly, many recent technological advances now make it possible for researchers to take full advantage of the unique space environment.

The purpose of the recent international workshop “*From Quantum to Cosmos: Fundamental Physics Research in Space*”^a, held at the Airlie Center, Warrenton, VI, USA, May 21–24, 2006, was to demonstrate how fundamental physics research in space can provide the knowledge needed to address outstanding questions at the intersection of physics and astronomy. The focus of the workshop was on laboratory physics, although a large portion was also dedicated to explore observational physics aspects.

The meeting participants addressed motivation and current status of space-based laboratory experiments in fundamental and gravitational physics. Specific research areas discussed in detail at the workshop included various tests of general relativity and alternative theories, search of physics beyond the Standard

^aInternational workshop “From Quantum to Cosmos: Fundamental Physics Research in Space”, Airlie Center, Warrenton, VI, USA, May 21–24, 2006, <http://physics.jpl.nasa.gov/quantum-to-cosmos/>. There were two recent successful workshops in the “From Quantum to Cosmos” series: “From Quantum to Cosmos: Space-Based Research in Fundamental Physics and Quantum Technologies”, Bremen, Germany, June 10–13, 2007, details at <http://www.zarm.uni-bremen.de/Q2C2/> and “From Quantum to Cosmos: Fundamental Physics in Space for the Next Decade”, Airlie Center, Warrenton, VI, USA, July 6–10, 2008, details at <http://physics.jpl.nasa.gov/Q2C3/>

Model, investigations of possible violations of the Equivalence Principle, search for new hypothetical long- and short-range forces, variations of fundamental constants, tests of Lorentz invariance and attempts at unification of the fundamental interactions. The scope of the workshop also encompassed experiments aimed at the discovery of novel phenomena including dark matter candidates and studies of dark energy. The meeting featured new technologies for space experiments including atom interferometry, precision optical clocks and their applications for space-based physics experiments and also provided a forum for scientists to discuss policy and the long-term future of space experiments.

From the enthusiasm of the over 100 participants at the workshops, it was clearly seen that space-based laboratory research in fundamental physics is an emerging research discipline that offers great discovery potential and at the same time could drive the development of technology advances that are likely to be important to scientists and technologists in many other different research fields.

It was also clearly demonstrated at the workshop that many of the fundamental physics investigations that were discussed at the meeting can be carried out in space with much higher precision than on the ground; moreover, some of these activities can only be carried out in space.

It is my great pleasure to thank all the speakers for their participation in the workshop and especially those who were willing to contribute to this volume.

Slava G. Turyshev
Jet Propulsion Laboratory
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