IAU Joint Discussion N. 9
Are the Fundamental Constants Varying in Space-time?

Rio de Janeiro, August, 2009

Scientific Organizing Committee

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FOREWORD

Dimensionless constants play an important role in our understanding of Nature. Their possible variations occupies quite a prominent place in theoretical physics and many theories, such as String theory, predict variations of various fundamental constants. Also the existence of scalar fields, of the kind invoked to explain the Universal acceleration might be revealed through a variation of some constants. This research field is highly recommended in the Science Vision Document, the ESA-ESO Working Group (WG) on Fundamental Cosmology and is one of the science cases considered by the ESO WG on E-ELT.

High precision frequency measurements with atomic clocks have established the fine structure constant to 17 significant figures. However, only astronomical observations can tell if the constants have maintained the same value through space-time. Meteorites allow us to go back in time to the birth of the solar system, while QSO absorption systems bring us to far earlier epochs.

In 2001, observations of spectral lines in distant QSOs brought the first hints, which have become stronger with successive larger samples, that the fine structure constant might change its value over time, with a variation of few parts per million. However, the subject is presently controversial with some other studies suggesting null variation. It is is lively debated and many researchers are involved in finding the solution of this controversy.

We thus proposed to hold an IAU Joint Discussion on the variability of fundamental constants within the IAU Generql Assembly 2009 which provided a timely opportunity to confront different points of view and discuss these topics. Recent related meetings on this subject have been the Astrophysics, Clocks and Fundamental Constants (2004, Bad Honnef (Germany) proceedings in Lecture Notes in Physics 648), and the meeting Atomic Clocks and Fundamental Constants (June 2007 again in Bad Honnef , proceedings in EPJ Ekkehard Peik and Savely Karshenboim Editors). Our aim for this Joint Discussion was to give an updated overview of both observations and theory trying to have an interdisciplinary exchange between scientists interested in the foundations of physics and in precision astronomical observations. The quest for finding variability in fundamental constants has also important bearings on many different astrophysical domains such as the chemical evolution of the absorbing galaxies, the high redshift molecular gas, detailed features of primordial nucleosynthesis yields and of the CMB power spectrum. It is also producing a strong demand for an increasing precision in the instrumentation conceived for the next generation of extremely large telescopes.

The meeting was extremely successful with the participation of most of the active researchers in the field.

We wish to thank the Scientific Organizing Committee for their advice and their help organizing the scientific program, the Local organizing Committee for a smooth run of the Joint Discussion and Sergio Monai from INAF-OATs for the maintainig of the web page and for mastering these proceedings. Finally we wish to thank all participants to the meeting for their enthusiasm and for sharing with us their most recent results.

The Organizing Committee:
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