量子物理学・ナノサイエンス第 162 回セミナー

Manifestations of Dark Matter and Variations of Fundamental Constants in Atomic and Astrophysical Phenomena

講師　：　**Professor V. V. Flambaum**
University of New South Wales, Australia

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場所　：　理学院第２会議室　本館３－４５

概　要

Low-mass boson dark matter particles produced after the Big Bang form classical field and/or topological defects. In contrast to traditional dark matter searches, the effects produced by the interaction of ordinary matter with this field and defects may be first power in the underlying interaction strength rather than the second power or higher (which appears in a traditional search for the dark matter). This may be advantageous for the observation of dark matter since the interaction constant associated with it is extremely small.

The interaction between the density of the dark matter particles and ordinary matter produces both ‘slow’ cosmological evolution and oscillating variations of the fundamental constants including the fine structure constant alpha and particle masses. Recent atomic dysprosium spectroscopy measurements and the primordial helium abundance data allowed us to improve on existing constraints on the quadratic interactions of the scalar dark matter with the photon, electron and light quarks by up to 15 orders of magnitude. Limits on the linear and quadratic interactions of the dark matter with W and Z bosons have been obtained for the first time.

In addition to traditional methods to search for the variation of the fundamental constants (atomic clocks, quasar spectra, Big Bang Nucleosynthesis, etc), the talk will focus on variations in phase shifts produced in laser/maser interferometers (such as giant LIGO, Virgo, GEO600 and TAMA300, and the table-top silicon cavity and sapphire interferometers, changes in pulsar rotational frequencies, non-gravitational lensing of cosmic radiation and the time-delay of pulsar signals. We also address other effects of dark matter and dark energy which include apparent violation of the fundamental symmetries: oscillating or transient atomic electric dipole moments, precession of electron and nuclear spins about the direction of Earth’s motion through an axion condensate (the axion wind effect), and axion-mediated spin-gravity couplings, violation of Lorentz symmetry and Einstein equivalence principle.

Finally, we explore a possibility to explain the claim of the DAMA collaboration of dark matter detection by the dark matter scattering on electrons.

連絡教員　物理学系　Bhanu Das（内線 3045）

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