Yu.N. Gnedin (Saint-Petersburg)

Lecture 1.
“Stars with Extremely Strong Magnetic Fields as Tools of Fundamental Physics”

I present a short review of astronomical discoveries of neutron stars and white dwarfs with extremely strong magnetic fields. The constraints on physical properties of stellar matter which can be inferred from the comparison of observations with theoretical models are outlined. In strong magnetic fields of neutron stars the electron-positron vacuum behaves as an anisotropic medium that has birefrigent properties. Vacuum polarization modifies the dielectric property of the medium and gives rise to a resonance feature in the opacity ; this feature narrow and occurs at photon energy, that depends on the plasma density. Vacuum polarization can also induce resonant conversion of photon modes via a mechanizm analogous to the MSW mechanizm for neutrino oscillation. I discuss the results of observations of vacuum polarization effects in the radiation of neutron stars and magnetic white dwarfs.

Lecture 2.
“Astronomy and Particle Physics: zones of intersection”

This lecture covers the next topics in modern astronomy: the cosmic Microwave background, dark matter, dark energy and cosmology as a probe of particle physics, especially, at the Planck scale. The link between SUSY Particle Physics and Astronomy is discussed. Recent astrophysical observations are described that indicate the SUSY particles as the candidates into dark matter and dark energy.

Lecture 3.
“Axion Astronomy: Searching for Dark Matter Particles”

This lecture presents a review of the astronomical methods of the search for Light Goldstone bosons (axions). The basic topics of this lecture are:

(a) ground-based cavity experiments with searching galactic and extragalactic axions,
(b) searching for the axion decay line into galactic and extragalactic light, including the observations by the Russian 6-m telescope,
(c) experimental search for solar and stellar axions, including CAST - CERN experiment,
(d) polarimetric search for cosmological massless and very light axions,
(e) the first positive indications,
(f) contemporary constraints on axion mass and coupling constants.