Extreme States оf Plasma on Earth and in Space

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Investigation of the physical properties of the plasma at extremely high pressures and temperatures plays an important role for our understanding the structure and evolution of astrophysical objects: neutron, quark and “strange” stars, black holes, pulsars, supernovas, giant-planets, exoplanets, and for many modern energy technologies. The report discusses pulsed methods for generation of extremely high pressures in the dense nonideal plasma based on the compression and nonreversible heating of matter in intense shock waves and waves of adiabatic expansion. To generate shocks in plasma at megabar pressure range the cylindrical and spherical high explosive charges, intense laser and corpuscular beams, high velocity impacts, and soft X-rays were used. The obtained experimental data and the physical models of strongly coupled plasma were analyzed, such as: the metallization and dielectrization of strongly compressed plasma, high temperature thermodynamic properties and plasma phase transitions, deformation of energy spectrum of compressed ions and atoms. The report presents physical properties of plasma and plasma phase transformations in a broad range of pressure – a few microseconds after the Big Bang, as well as an analysis of plasma properties in the astrophysical objects and their transformation. It was shown that two physical effects play an important role for strongly coupled plasma thermodynamics – the charges correlation and electron degeneracy. Based on the experimental data wide-range semi-empirical equations of state are presented. These semi-empirical models were applied for multidimensional computer simulation of pulsed high-energy processes at extremes.