Active space experiments as a tool for studying the strongly-coupled (non-ideal) plasmas

Yu.V. Dumin

IZMIRAN, Russian Academy of Sciences, Troitsk, Moscow reg.
(dumin@yahoo.com / Phone: +7-495-6198127)

Starting from 1960's, the experiments on artificial plasma ejection into space played an important role both in the investigation of plasma phenomena already realized in the terrestrial conditions and the ones unattainable in the laboratory devices (e.g., because of the wall effects or inability to generate a considerable mass of sharply-expanding ionized gas in a large volume). The aim of the present report is to demonstrate a potential of the active space experiments for studying yet another interesting phenomenon, namely, transition of plasma to the strongly-coupled (non-ideal) state.

Analysis of the ionization–recombination dynamics in an expanding ionized cloud shows that, under certain relations between the kinetic and thermodynamic parameters of the gas, Coulomb's coupling parameter of the charged particles $\Gamma_e^* = e^2 N^{1/3}/k_{\rm B}T_e$ can increase up to considerable values, on the order of unity [1]. Therefore, the investigation of such plasmas created in space is a valuable supplementary tool to the laboratory experiments with laser-cooled plasmas in the magneto-optical traps, which are widely performed in the recent few years. One of remarkable examples of such cooperation is that the limiting values of the Coulomb's coupling parameter $\Gamma^* \approx 3$, initially derived by the analysis of plasma behavior in active space experiments [2], are excellently confirmed now by the immediate laboratory measurements [3].

References:

1. Yu.V. Dumin, *Astrophys. Space Sci.*, v.**277**, p.139 (2001).
2. Yu.V. Dumin, *J. Low Temp. Phys.*, v.**119**, p.377 (2000).
3. C.E. Simien, Y.C. Chen, P. Gupta, *et al.*, *Phys. Rev. Lett.*, v.**92**, p.143001 (2004).