COLLISIONLESS PLASMA MAGNETIZATION IN LABORATORY-ASTROPHYSICAL STUDIES

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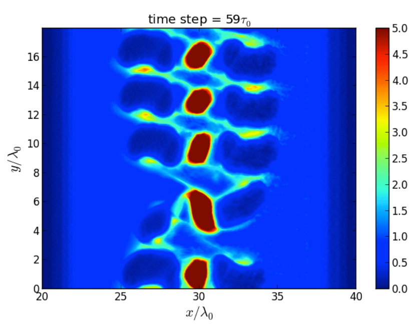
Laboratory astrophysical studies are approaching astrophysical conditions, at least in terms of dimensionless ruling parameters. Terawatt-class lasers along with efficient magnetic pulsers allow to study physics related to collisionless shocks in supernovae remnants (SNRs), at the stage of the interaction with an ambient magnetized interstellar medium. Such studies aim to give a deeper understanding of the formation of magnetized collisionless shocks and their structure, interaction of a plasma flow with the magnetized medium, including collisionless magnetization, particle acceleration and energy redistribution.

During the analysis of experimental results, we have found that in a laser-produced TNSA plasma expansion in an ambient magnetic field, a series of stages are passed. They may be related to a collisionless astrophysical-like magnetized plasma interaction.

The first stage, reported previously as a magnetic field compression stage, develops in our studies along with the charge separation effect, at a time scale much shorter than a collisionless shock formation time. The compression scaling factor relates to the conservation of the magnetic flux and results in few orders increase of the magnetic field strength. The next stage is a magneto-electrostatic instability which develops in the interpenetration region (see a typical magnetic field map below featuring this instability and [1] and [2]). After this fast instability development, slow collisionless magnetization of the interpenetrating plasma flows takes place. It results in a formation of a magnetized plasma cloud in the interaction region, which may accumulate a sufficient part of the total energy in the magnetic field. This latest stage is clearly seen in the experimental data, which we compare with transparent physical models and with Particle-In-Cell simulations.



[1] Ph. Korneev, E. d'Humières and V. Tikhonchuk, Collisionless plasma interpenetration in a strong magnetic field for laboratory astrophysics experiments, Physics of plasmas **21**, 022117 (2014).
[2] Ph. Korneev, E. d'Humières, V. Tikhonchuk et al. TNSA-like plasmas collision in an ambient magnetic field as a route to astrophysical collisionless shock observation in a laboratory, High energy density physics in press (2014) - doi:10.1016/j.hedp.2014.10.002.