# New mechanism of magnetic field compression in collisionless magnetosonic shocks

Q. Moreno[1],, M. E. Dieckmann[2], Ph. Korneev[3], C. K. Li[4], L. Gremillet[5], S. Jequier[1], V. Tikhonchuk[1,6], X. Ribeyre[1], E. d'Humières[1]

[1] CELIA - University of Bordeaux - CNRS - CEA, 33400 Talence, FRANCE

[2] Department of Science and Technology, Linköping University, Sweden

[3] MEPhI,115409 Moscow,Russian Federation

[4] Plasma Science and Fusion Center, MIT, Cambridge, MA 02139 USA

[5] Committee à l'Energie Atomique, DAM, DIF, 91297 Arpajon, France Federation

[6] Institute of Physics of the ASCR, ELI-Beamlines,18221 Prague, Czech Republic

Collisionless shocks are ubiquitous in astrophysics but very difficult to create in laboratory because of stringent criteria on the kinetic energy of colliding plasma flows and on the size and the time of shock formation. We demonstrate a possibility of formation of a collisionless shock on a much shorter time and spatial scales thanks to a magnetic field transverse to the ion flows and frozen in the electron fluid. In such a collisionless structure the ions are interpenetrating freely, while the magnetic compression front propagates slower accompanied with heated and compressed electrons. This new magnetic compression mechanism operates on the electron time scales and corresponds to a magnetosonic collisionless shock. Its characteristics depend on the density ratio of colliding plasmas and the magnetic field strength. Formation and evolution of these magnetosonic collisionless shocks is demonstrated in two-dimensional kinetic simulations and observed experimentally on the OMEGA facility in a collision of a fast, laser-driven plasma stream with a plasma contained in a thin plastic bag [1]. The magnetic field was generated self-consistently in time of the plasma jet formation due to the Biermann battery effect.

A quasi one-dimensional shock structure is unstable with respect to the ion Weibel instability, which is reinforced in the magnetic shock front and transforms in a strong magnetic turbulence downstream and magnetic front. A combination of a strong compression of the average magnetic formation of magnetic turbulence provides favorable conditions for an efficient particle acceleration that can be studied on a laboratory time scale. The proposed mechanism mechanism of a fast collisionless shock formation may play an important role in the collisionless shocks formation also on the astrophysical scale.

[1] C. K. Li et al., Weibel-mediated collisionless shocks driven by supersonic plasma flows, Nature Comm. submitted (2018)