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Generation of electromagnetic emission during the injection of dense supersonic plasma flows into arched magnetic field

Mikhail Viktorov, Sergey Golubev, Dmitry Mansfeld, and Alexander Vodopyanov

Institute of Applied Physics RAS, Plasma physics department, Nizhny Novgorod, Russian Federation (mikhail.viktorov@appl.sci-nnov.ru)

Interaction of dense supersonic plasma flows with an inhomogeneous arched magnetic field is one of the key problems in near-Earth and space plasma physics. It can influence on the energetic electron population formation in magnetosphere of the Earth, movement of plasma flows in magnetospheres of planets, energy release during magnetic reconnection, generation of electromagnetic radiation and particle precipitation during solar flares eruption. Laboratory study of this interaction is of big interest to determine the physical mechanisms of processes in space plasmas and their detailed investigation under reproducible conditions.

In this work a new experimental approach is suggested to study interaction of supersonic (ion Mach number up to 2.7) dense (up to 10^{15} cm^{-3}) plasma flows with inhomogeneous magnetic field (an arched magnetic trap with a field strength up to 3.3 T) which opens wide opportunities to model space plasma processes in laboratory conditions. Fully ionized plasma flows with density from 10^{13} cm^{-3} to 10^{15} cm^{-3} are created by plasma generator on the basis of pulsed vacuum arc discharge. Then plasma is injected in an arched open magnetic trap along or across magnetic field lines. The filling of the arched magnetic trap with dense plasma and further magnetic field lines break by dense plasma flow were experimentally demonstrated.

The process of plasma deceleration during the injection of plasma flow across the magnetic field lines was experimentally demonstrated. Pulsed plasma microwave emission at the electron cyclotron frequency range was observed. It was shown that frequency spectrum of plasma emission is determined by position of deceleration region in the magnetic field of the magnetic arc, and is affected by plasma density. Frequency spectrum shifts to higher frequencies with increasing of arc current (plasma density) because the deceleration region of plasma flow moves into higher magnetic field. The observed emission can be related to the cyclotron mechanism of generation by non-equilibrium energetic electrons in dense plasma.

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