Local characteristics of self-compressed plasma streams in external magnetic field

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Self-compressed plasma streams generated in a quasistationary mode have numerous applications, including materials testing in conditions close to thermonuclear reactors, development of plasma sources, electric propulsion, modelling the processes found in astrophysical plasma, etc. We have experimentally studied the spatial distributions of magnetic fields and electric currents in the plasma streams generated by a magnetoplasma compressor device (MPC) [1], applying an external magnetic field of 0.24 T inside its accelerating channel. First local measurements of the electron temperature in the plasma flow have been performed using double electric probes [2, 3]. When an external magnetic field is applied, the electric current flowing in the plasma stream outside the accelerator increases by almost 20%. Additionally, imposing a magnetic field leads to a growth of the volume of the plasma stream containing a compression zone, which is a distinct part of a plasma stream confining compressed plasma of high density and temperature. It has been demonstrated for the first time that the electron temperature of the principal part of the plasma flow increases approximately tenfold (about 60-70 eV) in the presence of an external magnetic field. The plasma density profile estimated qualitatively from the double electric probe measurements reaches a peak in the compression zone; its maximum value increases twofold as compared to the case with no magnetic field. A neutral current sheet has been detected in self-compressed plasma streams generated by the MPC. This finding makes it possible to model complex astrophysical phenomena in a laboratory plasma.

References

[1] Distributions of magnetic field and current in pinching plasma flows: axial magnetic field effect, D.G. Solyakov, Yu.Ye. Volkova, I.E. Garkusha, et al. Eur. Phys. J. Plus 136, 566 (2021).

[2] V.I. Demidov, S.V. Ratynskaia, K. Rypdal. Electric probes for plasmas: The link between theory and instrument. Review of scientific instruments 2002, v. 73(10), p. 3409-3439.

[3] The probe study of the near-wall plasma in confined electric arc XIX Int. Conf. on Gas Discharges and their Applications (2nd – 7th September 2012, Beijing, China). Proceedings / Ed. Z.C Guan. – Beijing: Tsinghua University, 2012. – P. 786 – 789. V A Zhovtyansky, E.P. Kolesnikova.