Investigations of the laboratory plasma rotating in the magnetic field

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The work is aimed at investigation of possibility of modeling of magnetorotational instabilities (MRI) on relatively simple installation with laboratory magnetized plasma. These instabilities draw attention of astrophysicists in connection with anomalous viscosity of accretion discs.

The hydrogen plasma in the experimental installation is created in a gas discharge source with a thermoemission tungsten cathode and a ring-shaped anode. Plasma from the source travels along magnetic field ($B_0 < 0.1$ T) and reaches a tube with inner diameter 6.5 cm, forming a flow with length about 0.4 m. A niobium rod electrode is placed along the axis of the tube. For creation of plasma rotation in the crossed E and B fields a negative voltage relative to the tube is applied to the rod, forming a radial electric field.

Plasma rotation radial velocity distribution is monitored using three ring electrodes – probes with different radii. Radial time dependencies of electric potentials of these probes and of the central electrode were obtained. Negative potentials became established at the three ring probes during the first 100 μs after the voltage application to the central electrode, which is connected with the electric field penetration into the plasma. It causes polarization and rotation of plasma. During the next several milliseconds a radial current with the value about 100 mA flows in the plasma. The value of the current is increases with increase of the hydrogen pressure value in the working volume.

The measured radial potential distributions correlate with distribution of potential between the co-axial electrodes calculated in the case of plasma absence. The potential difference increase between the central electrode and the first ring with pressure increase possibly can be explained by potential drop in the near-cathode layer. From the experimental data on the potential distribution the profiles of plasma rotation were estimated. The estimation shows, that MRI criterion for the tested regimes are not fulfilled. However, the results of measurement indicate on possibility of carrying out of MRI investigations on the created installation.