The study of the rotational motion of dust structures in DC glow discharge in a magnetic field

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The experimental results on the influence of an external magnetic field on the dust particles suspended in the strata of a glow discharge are reported. Measurements were performed in the strata located between the coils, under the coil, and above the coil. We observed an interesting behavior of dust structures, which was not previously reported. It was found that the dust particles rotate clockwise above the coil and counterclockwise under the coil. At considered plasma and magnetic field parameters, the dust particles located between the coils do not have rotational motion. The dependence of the average angular velocity on the magnetic field induction in different areas was measured and a model was proposed to describe the behavior of the dust structures in the magnetic field.

The study of the influence of a magnetic field on dusty plasmas is of a great interest due to possibility of the control of the spatial position, the degree of order, as well as the dynamics of plasma-dust structures. The influence of a magnetic field is also important for the understanding of the behaviour of the dust particles in the TOKAMAK wall plasma.

In a number of experiments with different types of electric discharges [1-2], it was found that in the presence of a magnetic field, the plasma-dust structures exhibit rotational motion. The direction of rotation and rotation speed depends on the induction of the magnetic field as well as other discharge parameters. But, unfortunately, there are no complete understanding of the dynamics of dust structures in the magnetic field to date.

In work [2] the inversion of the dust structures rotation on a horizontal plane was reported for the first time. The difference between our work and [2] is the absence of a narrowing channel of the diaphragm current used to stabilize strata (dust traps). By changing the discharge conditions and the electrode systems, a stable discharge of up to 27 mT without a diaphragm was achieved. We observed an interesting behavior of dust structures which was not manifested in other similar works.

The experiment was carried out in a stratified DC discharge in a discharge tube 3 cm in diameter filled with argon at a pressure of 0.22 Torr. The discharge current was 1.5 mA. These settings have created a stable strata. The magnetic field varied from 1 to 27 mT. Observations were made in three regions. The first area (I) is above the coil, the second area (II) is between the coils, and the third area (III) is under the coil. When the magnetic field was switched on, the dust particles in areas I and III had a rotational motion on the horizontal plane. Clockwise rotation and counterclockwise rotation were observed in areas I and III, respectively, while the dust structure in area II did not rotate. The dependence of the average angular velocity of dust structures on the magnetic field induction in three areas is shown in Figure 1.

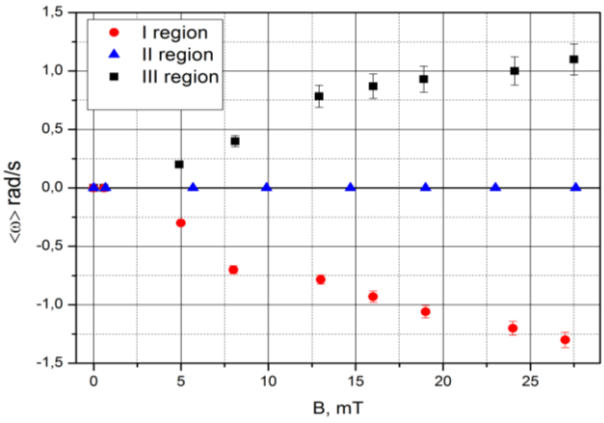

Fig. 1. Dependence of the angular velocity on the magnetic field

References

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