ROTATION MECHANISMS OF DUST STRUCTURES IN STRATIFIED DISCHARGES IN INHOMOGENEOUS MAGNETIC FIELDS

Dyachkov L.G.

JIHT RAS, Moscow, Russia
dyachk@mail.ru

We consider four mechanisms leading to the rotation of dusty structures trapped in a stratified discharge under the action of an inhomogeneous magnetic field. Two of them also operate in homogeneous fields, while others are specific for inhomogeneous ones.

In a uniform magnetic field, two main rotation mechanisms operate:

1) Rotation under action of the ion drag force. This rotation is due to the ion drift in the crossing radial electric (ambipolar) E_r and axial magnetic B_z fields, as well as the radial gradient of ions pressure. In this case, the angular velocity vector $\mathbf{\Omega}_1$ is directed opposite to the magnetic field vector $\mathbf{B}$, $\Omega_1 < 0$. This mechanism prevails at relatively small magnetic fields ($B \lesssim 10^{-2}$ T).

2) Rotation together with the gas, which rotates under the action of eddy currents arising in the striation due to the temperature and density gradients of electrons. In the region of the of dust particles position in the striation $\Omega_2 > 0$. This mechanism begins to prevail with increasing B_z ($B \gtrsim 10^{-1}$ T), and rotation inversion occurs.

In an inhomogeneous magnetic field, its lines diverge (or converge), and a radial component B_r appears. Then, for each of the considered mechanisms we have a "twin":

3) Rotation by ion drag force in the crossing longitudinal electric field E_z of the discharge and the radial magnetic field B_r.

4) Rotation together with the gas, which rotates under the action of a discharge current I_z and a radial magnetic field B_r.

The rotation direction for the last two mechanisms depends on the magnetic field radial component direction. If $B_r > 0$, then $\Omega_{3,4} < 0$. However, for $B_r < 0$ the rotation direction changes, $\Omega_{3,4} > 0$.

As a result of the action of all four mechanisms, the dusty structure can rotate in one or the other direction. This largely depends on the magnitude and direction of B_r.