Ionization Instability OF RADIO FREQUENCY discharge at arbitrary boundary conditions

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For the first time discharge ionization instability in the field of a plane electromagnetic wave has been described by Gil'denburg and Kim [1]. Later it was shown [2] that in a spatially limited microwave low pressure discharge, this instability leads not only to a change in the spatial structure of the plasma, but also to the appearance of resonances. The resonance is observed at the electron density when the plasma size becomes equal to several half-waves of the standing surface waves excited at the plasma boundary. The development of the instability leads to a partial transfer of energy from the plane wave to surface wave and caused electron density inhomogeneous spatial distribution in the discharge. Exact solution, obtained in [3], takes into account both the excitation of vortex and potential fields. Comparison of calculations with experiment showed their qualitative agreement [4]. However, the model, described in [2, 3], uses model Neumann boundary condition, which are valid for the electromagnetic field, but not for electrons density and temperature. In this work, we used the real boundary conditions that mean the appearance of concentration and the heat-conduction boundary layers at the ends of the plasma in addition to the Debye sheath. Since such perturbations are also accompanied by disturbances of the electromagnetic field, the boundary conditions to which the surface wave is satisfied also change. Accounting for these perturbations leads to the following results.

Changes of the value of the electron density in the discharge, corresponding to the resonance is observed (\*). There may be additional resonances associated with the excitation of surface waves [5], propagating along the space-charge sheath at the plasma boundary with the face electrodes (\*\*). The highest amplitude will have the resonance for which the maximum length of a surface wave (\*\*\*). Near the intersection of lateral and face plasma boundaries the energy exchange between surface waves propagating along the lateral and face boundaries takes place (\*\*\*\*).

The instability growth rate and the new stationary states observed in the discharge, taking into account these processes are calculated. In addition we take into account the effect of field amplification in the plasma resonance on the discharge power characteristics.

References

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