Dissipative Instability of Overlimiting Electron Beam In No Uniform Cross-Section System

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Streaming instabilities are the most frequently encountered plasma instabilities e.g. well known beam-plasma instability. Their physics is elaborated and it may seem that one fail to encounter a variety of that with new physics. This investigation presents new type of beam-plasma instability. It realizes under high beam current and in presence of high level of dissipation in no uniform cross-section system. Mechanisms of beam-plasma instability under very high beam current are of special interest. Traditional concepts of physical nature of beam-plasma instability are not applicable to such systems [1]. In this case beam inner degrees of freedom and its space charge play an important role. The instability is due not to induced radiation of the system proper waves, but either to aperiodic modulation of the beam density in system with negative dielectric constant or to excitation of beam space charge wave with negative energy. The last variety of beam instability realizes in system, which are no uniform in cross-section. The threshold current is limiting vacuum current for given system.

Apart from increasing of beam current, another physical phenomenon also leads to excitation of the beam wave with negative energy. Dissipation of high-level leads not to suppression of the beam instability, but transforms it to that of dissipative type. Dissipation serves as a channel of energy withdrawal and leads to excitation of beam wave with negative energy.

Present investigation considers superposition of the two processes that lead to excitation of the beam wave with negative energy. It causes instability of new type – dissipative instability of overlimiting electron beam. As expected, it has more critical (as compared with dissipative instability of underlimiting electron beam), inverse proportional dependence of the growth rate on dissipation. The influence of dissipation on excitation of the beam wave with negative energy and transition of instability to that of dissipative type as the level of dissipation increases are elaborated in detail. An approach is developed that enables to investigate space-time evolution of large variety electron beam instabilities. For underlimiting beams analogous approach was also developed [2], available for systems of arbitrary geometry. Influence of dissipation on other type of overlimiting electron beam instability is investigated in [3].

References

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