Plasma maser instability in a turbulent plasma

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The problem of conversion of wave energy with a large change of frequency is important to laboratory as well as space and astrophysical plasmas. One of the attractive possibilities is offered by the plasma maser instability. The idea of the plasma maser is to use plasma nonlinearities for the amplification of waves when there is no inverted particle population.

The nonlinear interaction of a resonant mode (which satisfies the linear Landau resonance condition) with a nonresonant mode (which does not satisfy the linear and the nonlinear Landau conditions) is termed as plasma maser interaction in the literature. In principle, the plasma maser interaction allows both up-conversion and down-conversion of the energy from the resonant waves to the nonresonant waves. One important point is that the plasma maser conversion does not imply any type of restrictive conditions for frequencies and wave numbers of the waves involved.

The plasma maser interaction between resonant and nonresonant waves is strongly related to the process of resonant particle acceleration (heating). The presence of heating either makes the system nonstationary or inhomogeneous (the particle energy rises or the heated particles flow out from the acceleration region and is distributed inhomogeneously). The nonresonant field perturbates the rate of resonant particle heating (or cooling). Since the energy is continuously flowing from resonant waves to resonant particles, the presence of such disturbances of the heating process as the nonresonant waves provides a possibility to take some energy from this flux to the nonresonant waves.

Since in space and astrophysical plasmas the most of the turbulent fluctuation energy is contained in the low frequency modes, such as MHD waves, drift waves, ion sound waves etc., therefore the plasma maser has potential importance in explaining various space and astrophysical radiation phenomena.