Fundamental and Second Harmonic Cyclotron Heating of Sloshing Ions in a Straight Field Line Mirror

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Sloshing ions, the energetic ions with a velocity distribution concentrated to certain pitch-angle, play an important role in plasma confinement in mirrors. They are normally produced in mirror traps with neutral beam injection. They also could be generated by ion-cyclotron heating. In the present report, two alternative radio-frequency heating scenarios to sustain a sloshing ion population in a newly proposed mirror device, the straight field line mirror, are examined. The first ~~one~~ consists in the ion cyclotron heating in two-ion species plasma using longitudinal wave conversion and fundamental harmonic heating of deuterium ions in tritium plasma. This scheme provides efficient ion heating for high deuterium "minority" concentration without substantial power deposition to the electrons. The second scenario is based on second harmonic heating of deuterium ions.

The study uses numerical 3D calculations for the time-harmonic boundary problem for Maxwell's equations. For the radio-frequency heating in both schemes, a simple strap antenna is used. Calculations show that it has low antenna Q and operates in the regime of global resonance overlapping. For fundamental harmonic heating scenario only a small portion of the wave energy transits through the cyclotron layer and penetrates to the central part of the trap. The power deposition is peaked at the plasma core. Calculations show that this scenario is prospective for practical implementation in large mirror devices. The first results of the numerical calculations for second harmonic heating are reported.