anomalous losses of fast ions provoked by excitating alfvén ion-cyclotron instability in a mirror trap with skew neutral beam injection

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Alfven ion-cyclotron (AIC) instability is electromagnet instability which can excite in magnetized plasmas with non-isotropic ion distribution function. In mirror traps, AIC instability is driven by inverse population of resonant ions, which have longitudinal (along mirror trap magnet field) velocity satisfying the cyclotron resonance condition , here  is ion cyclotron frequency,  and  are frequency and wave vector of unstable perturbation. Only trajectories of ions which have energy near injection energy can be inversely populated in mirror traps with skew injection of neutral beams. So longitudinal velocity of resonant ions is equal approximately to the longitudinal velocity of injected atoms. Perturbations of electric and magnet fields are standing wave near trap center and travelling waves propagating away from center at long distance. Perturbation frequency and spatial distribution of perturbations of fields can be found in linear approximation from WKB approximation [1].

The present work is devoted to investigating anomalous transport of fast ions in axisymmetric mirror trap with skew neutral beam injection. Methods developed in papers [2-3] are used for investigating ions dynamic. When condition  is satisfied (here  is the bounce frequency and brackets denote averaging over bounce-trajectory) the ion resonates. It means that phase of ion Larmour rotation changes to an integer number of  after each bounce-oscillation in the frame of reference which rotates with frequency . Distance between resonances decreases when transversal energy of ion decreases. So resonances overlap for ions having velocities  and . Resonance overlapping results in chaotic behavior and anomalous diffusion. The diffusion coefficient and margin of area of chaotic motion can be estimated analytically [4]. It allows rate of anomalous longitudinal losses to be estimated. The agreement between analytical estimates and numerical simulation of ions motion is demonstrated. It is shown that the ions with energy several times less than injection energy give main contribution to anomalous losses. It agrees with experimental results [5].

References

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