Electromagnetic ion cyclotron instabilities driven by an artificial ion beam in the magnetosphere

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We present results of linear calculation and two-dimensional hybrid simulations of electromagnetic ion beam instabilities in the direction parallel to the static magnetic field. In this time we adopted two cases to investigate the ion cyclotron instabilities driven by an ion beam with finite pitch angle. The common conditions for the two cases are that there is a weak ion beam drifting relative to the background ion population. Whereas, the difference of the two cases is the perpendicular velocity distribution of ion beam as initial condition. The artificial ion beam case is regarded as a nongyrotropic plasma and the other one is initialized as a ring distribution. In both cases for the relatively low pitch angle the ion beam instability takes place and the parallel right-handed resonant modes play an important role. The growth-rates are nearly coincided with the linear growth-rates of nongyrotropic plasma. Under this condition the result of both cases are nearly the same regardless of the different perpendicular velocity distribution in details. However, at the sufficiently high pitch angle of ion beam, the parallel left-handed resonant modes grow, especially at the pitch angle close to 90 degrees, the left-hand cyclotron waves are the only growing mode at the parallel propagation direction. Although the effects of the two cases are the same qualitatively, the quantitative differences for the two cases cannot be ignored. We maintain that the present work can be regarded as a basement to perform simulations of interaction between the background thermal plasma and the heavy ion beam injected from an ion engine.