05pA02

新しい種類の高エネルギー粒子駆動型測地的音響モードのシミュレーション研究

Simulation study of a new kind of energetic particle driven geodesic acoustic mode

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The relation between energetic particle distribution and frequency of energetic particle driven geodesic acoustic mode (EGAM) in the large helical device plasmas are investigated using MEGA which is a hybrid simulation code for a magnetohydrodynamics fluid interacting with energetic particles. Two cases are compared with each other. For the first case, the energetic particle distribution is slowing down type as follows:

$$f(v) = 1/(v^3 + v_c^3),$$

where v is particle velocity and v_c is critical velocity. This function is plotted with dashed curve in Fig. 1(a). In this case, the EGAM frequency is in proportion to the square root of the plasma temperature as shown in Fig. 1(b), dashed curve and triangles[1]. The results are consistent with experimental observation[2]. For the second case, all the other conditions are same with case 1 but the charge exchange is considered. The distribution is written as follows:

$$f(v) = C \cdot e^{-I(v)},$$

$$I(v) = \int_0^v \frac{3u^2 - u^2\tau_s/\tau_{cx}(u)}{u^3 + v_c^3} du,$$

where C is an integration constant, τ_s is slowing down time which is 8 s for the present work, $\tau_{cx}(v)$ is charge exchange time and $\tau_{cx}(v_{NBI})$ is 0.78 s. This function is plotted with solid curve in Fig. 1(a), and the mode frequency is plotted with solid curve and circles in Fig. 1(b). The frequency is independent of temperature, and this trend is consistent with experimental observation under other conditions. The results reveal that the distribution function is modified by charge exchange, and the modified distribution causes temperature independence. It is a new property, and it means the existence of a new kind of EGAM. Detailed properties of the new EGAM are still under investigation.

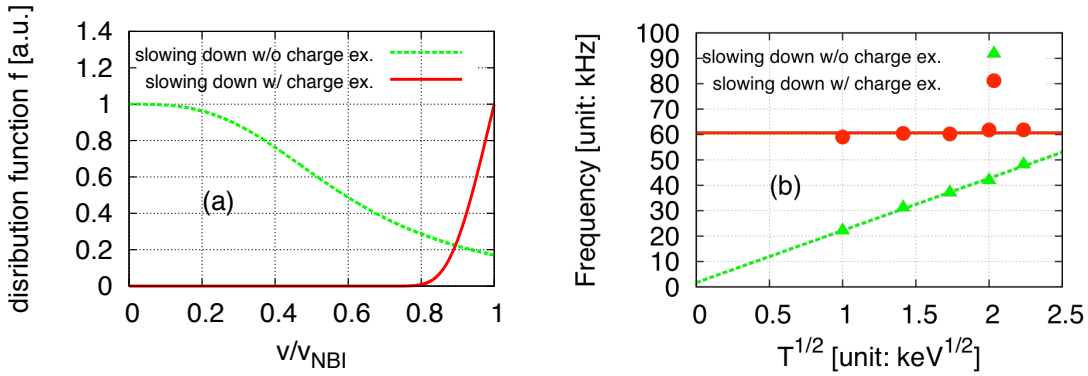

Figure 1. (a) The distribution function without (dashed) and with (solid) charge exchange and (b) the relation between mode frequency and square root of temperature without (dashed and triangle) and with (solid and circle) charge exchange.

[1] H. Wang and Y. Todo, Phys. Plasmas **20** (2013) 012506.
[2] T. Ido, A. Shimizu, M. Nishiura *et al*, Nucl. Fusion **51** (2011) 073046.