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A new branch of geodesic acoustic modes driven by fast ions

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A new branch of geodesic acoustic modes (GAMs) driven by the magnetic drift motion of fast ions is presented. An effective ion heating mediated by the new branch is expected. Strong ion Landau damping is attributed to the eigenfunction of the new branch, which has steep poloidal gradients. The analysis is based on a gyrokinetic model. The gyrokinetic equation for the fast ions has two kinds of resonances in accordance with the transit motion and the magnetic drift, which induces two unstable branches to appear. In a limit that the transit frequency is much larger than the magnetic drift frequency, a branch with the transit frequency of the fast ions appears, which has been investigated in previous studies. In this study, we focus on a limit that the magnetic drift resonance is dominant. The magnetic drift resonance is poloidally inhomogeneous, which is a typical feature. A dispersion relation of the GAMs that includes the magnetic drift resonance is derived, keeping the contributions from modes with arbitrary poloidal mode numbers. If one truncates the poloidal mode number at one, the previous theory is reproduced. The new branch is obtained, whose frequency is close to the magnetic drift frequency of the fast ions. The growth rate of the unstable branch takes the maximum when the magnetic drift frequency agrees with the ordinary GAM frequency. The poloidal eigenfunction has bump structures and phase shift, where the resonance is strong. The steep poloidal gradients, associated with the bump structure, increase the effective parallel wavenumber, which leads to an effective ion heating via Landau damping. The phase shift of the eigenfunction indicates particle and energy transfers.

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