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Electromagnetic drift waves in the magnetotail - electron bouncing and ion cyclotron effects

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Drift waves are known to propagate extensively in inhomogeneous plasmas like the solar corona or planetary magnetospheres. Due to density or temperature gradients electrostatic drift waves propagate perpendicular both to the ambiant magnetic field and to the gradient. They become unstable when dissipative processes such as collisions or electron Landau damping are included. Hence these waves may play an essential role in the destabilization process of the magnetotail before a substorm. Fruit et al. 2017 proposed a kinetic model for these electrostatic instabilities in resonant interaction with trapped bouncing electrons : the linearized Vlasov equation is solved for electrostatic fluctuations with period of the order of the electron bounce period (a few seconds) and the dispersion relation is obtained through the quasineutrality condition. The particle motion is restricted to its first Fourier component along the magnetic field in order to allow for a complete time integration of the non local perturbed distribution functions. The inclusion of electron bounce effects has substantially enhanced the growth rate of the instability compared to the classical slab geometry in which electrons travel freely along straight lines of force.

Encouraged by these results an electromagnetic study of the drift-Alfvén instability including electron bounce effects has been developed (Tsareva et al., JPP 2019, submitted). It confirms the importance of the bounce motion to drive an instability with e-folding times of the order of a few tens of seconds as observed during substorm onsets. One weakness of the present study is to neglect the ion cyclotron effects. When the wavelength of the mode is of the order of a fraction of the ion Larmor radius, the frequency is of the order of the ion cyclotron frequency. The computed growth rate - a little to high in these range of parameters - may not be correct within the frame of our present assumptions. We propose to reconsider the problem with the addition of ion cyclotron effects.