Tractable Approacch to kinetics of MHD waves

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Linear kinetics on magnetized plasmas can be calculated using the method of field integration along the unperturbed orbit. This calculation is notorious for its lengthy and time consuming
manipulation; it is exhausting even when applied to a simple uniform and time stationary background. The method requires detailed orbit information including gyro-motion even for large scale MHD phenomena.

One usually does not wish to pay attention to micro-scale particle orbits in investigating MHD waves, as long as it does not affect the wave properties. Unfortunately, however, the kinetic effects sometimes take place in the MHD wave propagation; Landau damping on magnetosonic waves is a good example. Therefore, it is desirable to have a simple and tractable kinetic approach other than the conventional kinetic method.

A few year ago Nakamura and Shinohara (2000) proposed a new approach to linear kinetics. Their method utilizes the conservation of phase space volumes in Vlasov equation system. Precise field integration along the orbit is not necessary, and consequently, simplification such as drift approximation is available for large scale phenomena. They have successfully applied the method to the instability of lower hybrid waves.

The aim of the present study is to provide a tractable way in kinetic approach for MHD waves based on their method. In general, what we need in calculation of MHD waves are:(1) E cross B drift; (2) polarization current; (3) pressure gradient current. The kinetic calculation of these drift/currents has been derived using the new method.

One good example of applications is the magnetorotational instability (MRI) in rotating plasmas. The importance of MRI in angular momentum transport is now fully realized and intensive investigations are going on. However, a full kinetic solution of MRI is still yet to come because the conventional method is too lengthy to apply. The approach presented here will hopefully solve this problem with reasonably acceptable amount of calculations. The basic tactics for this approach will be briefly mentioned in the talk.