**R008-13**
**C 会場 ：11/27　 AM1 （9:00-10:15）**
**9:30～9:45**

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# Investigating wave generation mechanisms driven by shock-reflected electrons at quasi-perpendicular shocks

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Diffusive shock acceleration (DSA) is the primary mechanism for generating high-energy particles in supernova remnant shocks. Still, it faces challenges in efficiently accelerating low-energy particles, known as the injection problem. Stochastic shock drift acceleration presents a promising solution, suggesting that whistler waves in the shock transition region are essential for accelerating low-energy electrons (Amano et al., 2022). However, the origins of waves in the transition region remain elusive. Non-Maxwellian electron velocity distributions, generated by mirror reflection at quasi-perpendicular shocks, such as Maxwellian ring-beam distributions, serve as potential free energy sources to create plasma waves (S. M. Khorashadizadeh et al., 2019; Karlicky, 2006).

In our study, we focus on the electron distribution in the upstream and transition regions of shocks, where positive gradient regions resembling ring-beam distributions can potentially generate whistler waves. We are currently developing a method to calculate the linear growth rate of instabilities driven by such distributions. Initially, we estimate the electron distribution based on the model upstream and downstream distributions, incorporating shock structure under the assumptions: (1) immobile ions, (2) incoming upstream electron distribution as Maxwellian, (3) downstream electron distribution as a flat-top distribution, and (4) cross-shock potential approximately 20% of the ion inertial energy. According to the shock drift acceleration model (Wu, 1984), some upstream electrons bounce back by the magnetic forces, creating a "loss cone". Additionally, some downstream electrons can leak into the upstream region. With these assumptions, we can estimate the electron velocity distribution in the shock transition region via Liouville mapping.

Then we proceed to calculate the linear dispersion relation for the distribution. Typically, the standard linearized Vlasov-Maxwell solver is applied to solve the linear dispersion relation for relatively simple analytic velocity distributions, such as bi-Maxwellian or Maxwellian ring-beam distributions (Umeda et al., 2012). However, solving the dispersion relation for our model distribution by the standard method is challenging due to its complexity. To address this, we use the semi-analytical method proposed by Kennel & Wong (1967) to calculate the growth/damping rate of waves. This method applies to arbitrary velocity distributions, provided the growth/damping rate is significantly smaller than the frequency's real part.

By combining these, we can investigate the wave generation mechanisms and resulting particle acceleration for arbitrary shock parameters. We validated our method by comparing dispersion relations derived from our semi-analytical approach with those obtained from fully numerical simulations of Maxwellian distributions under conditions of parallel propagation. In future work, we will compare our theoretical analyses with simulations to explore the dependence of growth or damping rates on shock parameters and investigate the mechanisms of whistler wave generation in shock regions.