Consequences of electron reflection back upstream in oblique shocks

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1 Context

- Astrophysical shocks have a finite width approximately equal to the larmor radius of an upstream ion.
- Thermal electrons have larmor radii much smaller than this, thus require pre-acceleration, or injection, to cross the shock and undergo diffusive shock acceleration.
- If the shock is oblique, electrons can be reflected and carry energy back upstream. This region is called the electron foreshock, and its properties could drive turbulence and modify the upstream population.

2 Methods

- We use 2D3V particle-in-cell simulations using code developed from TRISTAN. We generate a single shock by reflecting incoming plasma from a conducting wall.
- We investigate the effect of the obliquity angle, θ_{Bn} on the size and properties of the electron foreshock.

3 Main Results

- We find a higher proportion of incident electrons are reflected back upstream for smaller θ_{Bn}. Around 5% of electrons are reflected for $\theta_{Bn} = 30°$, but only $\sim 0.03\%$ for $\theta_{Bn} = 63°$.
- These reflected electrons generate electrostatic waves in the electron foreshock region upstream. The physical size of these is a few electron skin lengths, making them comparable to Buneman waves.
- Preliminary analysis indicates that these waves are themselves capable of accelerating and reflecting upstream electrons further away from the shock, preventing them from reaching it and compromising injection.

4 More Information

- **Poster** - Main points and figures of current work.
- **Proceedings** - Summary of work so far with more technical details.
- **Flash Talk** - An animation showing how an upstream electron is reflected in the foreshock.