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Properties and evolution of foreshock bubbles

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Upstream of Earth's bow shock, foreshock is filled with backstreaming particles. When backstreaming foreshock ions encounter a solar wind discontinuity, a foreshock bubble (FB) could form. Foreshock bubbles can globally disturb Earth's bow shock and cause significant geoeffectiveness. Recently, FBs are found to be able to accelerate particles implying important role in shock acceleration. Because FBs are very large (5-10 RE), their effects are typically more significant than other types of foreshock transients (e.g., hot flow anomalies). Therefore, it is important to further understand the characteristics of FBs. In this presentation, we introduce how FBs form from interaction between foreshock ions and rotational discontinuities or tangential discontinuities. From 3-D hybrid simulations and multi-point THEMIS observations, we show the spatial structure (including FB core, FB sheath, FB shock, FB foreshock, and their scales), and evolution of FBs (including fast expansion, thickness changes of FB sheath, density and temperature evolution inside FB core, and lifetime). We also briefly present very recent results on particle acceleration by FBs and discuss their potential effects on space weather, bow shock, and foreshock.