



## **Injection of protons at the Earth's bow shock: global results of hybrid-Vlasov and test-particle modelling**

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An important source of cosmic rays and energetic particles, diffusive shock acceleration (DSA) requires seed particles to be injected into the process through interactions with a collisionless plasma shock. Theoretical and numerical results have shown the injection problem to be complex, especially in the quasi-parallel shock regime where shock geometries are perturbed and time-varying. We investigate the generation of suprathermal beam ion populations upstream of the Earth's bow shock using a combination of hybrid-Vlasov modelling and test-particle simulations. Our results expose injection dependencies on global, local and temporal scales, facilitating improved interpretation of space mission observations. We compare analytical theories with both hybrid-Vlasov results and additional test-particle modelling, which allows more analysis of per-particle injection process history.