



## **Effects of ripples along a quasi-parallel shock front on the ion dynamics and structure evolution: 2-D hybrid simulations**

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At a quasi-parallel shock, upstream background magnetic fields are nearly parallel to the shock normal so that reflected particles from the shock front can easily move far upstream and excite upstream fast magnetosonic waves by interaction with incident particles. The excited waves will be brought back and result in the formation of large scale ripples when they interact with the shock front. Under the rippled quasi-parallel shock condition, the ion dynamics become different along the shock front. At some positions, particles can be directly transmitted into downstream and form the high-speed jets (HSJs), and the corresponding parts of shock front will not be dissipated by reflecting and accelerating the incident particles and last till far downstream as large scale filamentary magnetic structures. While at other positions, incident particles can be partially reflected back to upstream and become reflected ion beam which will interact with upstream waves. The interaction bring the generation of new shock fronts in the immediately upstream, and they will be convected back to the shock front and lead to its reformation or cyclic transformation between a relative plane shock front and a rippled shock front.