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Downstream structures and ion dynamics at a rippled quasi-parallel shock: 2-D hybrid simulations

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At a quasi-parallel shock, upstream fast magnetosonic waves are always excited by interaction of the incoming flow and reflected particles from the shock front. These waves can be brought back and grow their amplitude, and finally, they merge with the shock front and become large-scale ripples. On some parts of the ripples, incident particles are directly transmitted into downstream and result in the generation of downstream high-speed jets, and the corresponding parts of shock front will not be dissipated and form downstream large-scale magnetic structures. On the other hand, in the shock front, these upstream waves can be mode converted into Alfvén waves and oblique slow waves that are strongly damped, while the highly oblique slow waves can last till downstream due to their lower damping rate. These highly oblique slow waves are the so-called kinetic slow waves which will lead to downstream filamentary structures of number density and average velocity of particles.