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Generation process of high energy particles, far beyond the background thermal energy, has been one of the key topics in space plasma physics. Acceleration by their interaction with shock waves is the major mechanism, where a power-law spectrum is derived in the energy distribution. The standard shock acceleration theory shows that the power-law index depends on the shock compression ratio. In contrast, in-situ plasma measurements by ACE, Ulysses, and Voyager spacecraft recently identified that particles in the heliosphere have a common spectrum in the suprathermal range (the order of tens to hundreds of keV), where $f(v) \sim v^{-5}$, indicating that the shock waves do not play a dominant role in particle acceleration. The pump acceleration proposed by Fisk and Gloeckler [e.g., 2014] is one of alternative mechanisms to account for the generation of this common spectrum. In this study, we verify the validity of this pump process by performing two-dimensional hybrid simulations including interstellar pickup ions. We demonstrate several parameter sets and identify the strong dependence of acceleration efficiency on the angle between the solar wind flow direction and the magnetic field, as well as the spatial scale of compression/expansion structures in the pump process. We confirm the formation of the power-law tail in the velocity distribution of pickup ions, where the shock is not the only site of acceleration. We will discuss the diffusion property of energetic particles within the pump structures in comparison with the theoretical description.

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