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Pick-up ion energization in the outer heliosphere due to bulk velocity fluctuations

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At large solar distances beyond 10 AU MHD turbulence amplitudes are decreasing and even selfgenerated turbulences by pick-up ions will not support effectively enough energy diffusion processes driven by nonlinear wave-particle interactions. This should suppress the evolution of suprathermal ion tails beyond the pick-up ion injection border, though at distances beyond 10 AU such tails have been observed by spacecraft like Voyager-1/2, Cassini, and Horizon. We want to show here that an effective process of ion energy diffusion is driven by solar wind bulk velocity fluctuations passing over co-moving ions. Describing such fluctuations as traveling MHD shocks we describe kinetically the ion processing in momentum space and can identify this with an energy diffusion process with a distance-independent diffusion coefficient. As we show this process will lead to the appearance of suprathermal ion power law tails as observed by in-situ spectral ion observations.