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Extended power laws for heliospheric KeV ions due to injection from the ACR- ion population

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Though pick-up ions are well known in the inner heliosphere, their phase-space distribution nevertheless is a theoretically unsettled problem till now. Especially the question why pick-up ions form suprathermal tails, extending to far above their primary injection energy, is not satifactorily answered. Fermi-2 velocity diffusion theories indicate that such tails to some degree should become populated, but cannot explain observations showing power-laws with an indicated velocity index of ”-5”. First we show that such power-laws cannot result from a quasi-equilibrium state between suprathermal ions and magnetohydrodynamic turbulences in mutual energy exchange. The required equilibrium if established near the shock, would require too high pick-up ion pressures enforcing a shock-free deceleration of the solar wind. Fermi-2 type energy diffusion is too ineffective in the outer heliosphere for the generation of power law shapes of the ion distribution function. As we can show, however, power-laws ranging to far above the injection threshold can be established, if the injection takes place at higher energies of the order of 100 KeV. Such an injection is in fact connected with the modulated anomalous cosmic ray (ACR) particles at the lower end of their spectrum where they again start being convected outwards with the solar wind. A quantitative calculation of the pick-up ion spectrum resulting under such conditions in fact delivers power-laws, however, with a velocity power index of ”-4” and astonishingly enough fairly distance-independent spectral intensities. These results seem to be observationally well supported by VOYAGER-1 measurements in the lowest energy channels, i.e. 50-100 KeV.