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Spectra of Cosmic Rays escaping from star clusters

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Cosmic ray acceleration inside compact star clusters has recently received much attention, mainly because of the detection of gamma ray emission from some of such astrophysical sources. Here we focus on the acceleration of nuclei at the wind termination shock and we investigate the role played by proton energy losses and spallation reactions of nuclei, especially downstream of the shock. We show that for a rather generic choice of the mean gas density in the cavity excavated by the cluster wind, the spectrum of He nuclei is systematically harder than the spectrum of hydrogen, in a manner that appears to be qualitatively consistent with the observed and yet unexplained phenomenon of discrepant hardening. We also find that the spallation reactions of heavier nuclei are likely to be so severe that their spectra become very hard and with a low normalization, meaning that it is unlikely that heavy nuclei escaping star clusters can provide a sizeable contribution to the spectrum of cosmic rays at the Earth.

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