Contribution ID: **65** Type: **oral**

Explaining cosmic ray antimatter with secondaries from old supernova remnants

Tuesday, 26 October 2021 15:40 (20 minutes)

Despite significant efforts over the past decade, the origin of the cosmic ray positron excess has still not been unambiguously established. A popular class of candidate sources are pulsars or pulsar wind nebulae but these cannot also account for the observed hard spectrum of cosmic ray antiprotons. We revisit the alternative possibility that the observed high-energy positrons are secondaries created by spallation in supernova remnants during the diffusive shock acceleration of the primary cosmic rays, which are further accelerated by the same shocks. The resulting source spectrum of positrons at high energies is then naturally harder than that of the primaries, as is the spectrum of other secondaries such as antiprotons. We present the first comprehensive investigation of the full parameter space of this model — both the source parameters as well as those governing galactic transport. Various parameterisations of the cross sections for the production of positrons and antiprotons are considered, and the uncertainty in the model parameters discussed. We obtain an excellent fit to recent precision measurements by AMS-02 of cosmic ray protons, helium, positrons and antiprotons, as well as of various primary and secondary nuclei. This model thus provides an economical explanation of the spectra of *all* secondary species — from a single well-motivated population of sources.

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Cosmic rays

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Session Classification: Session 3