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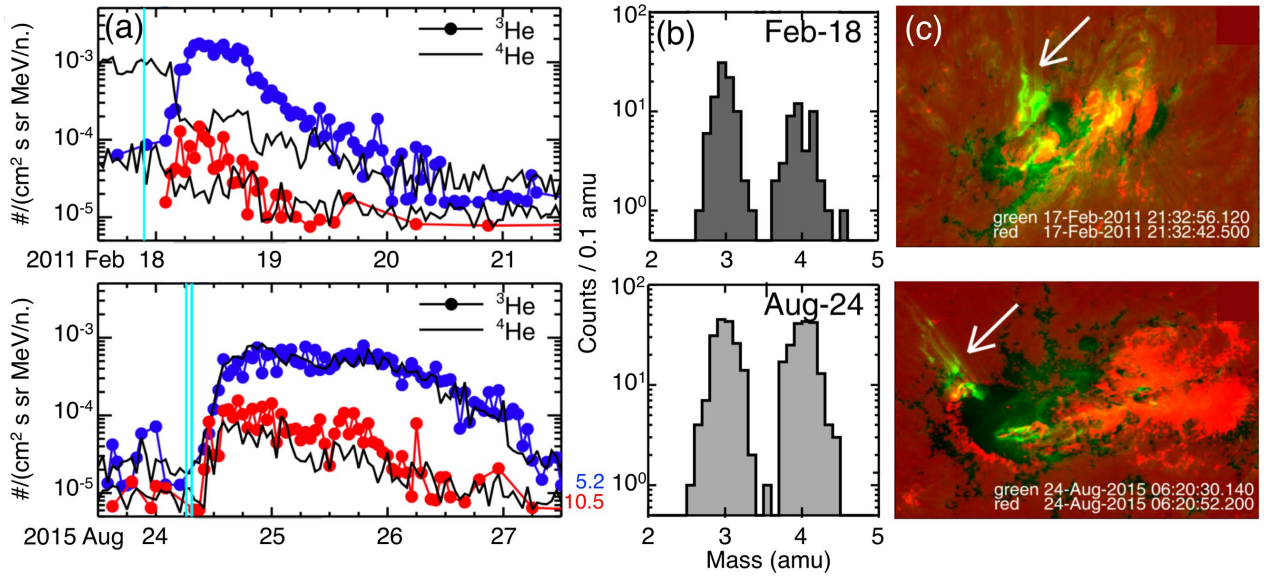
^{3}He-Rich Solar Energetic Particles from Sunspot Jets

Solar sources of suprathermal (<1 MeV/nucleon) ^{3}He-rich solar energetic particles (SEPs) have been commonly associated with jets originating in small, compact active regions at the periphery of near-equatorial coronal holes (ACE News #96, #169). Sources of relatively rare, high-energy (>10 MeV/nucleon) ^{3}He-rich SEPs remain unexplored although these events were detected for the first time at 10–100 MeV/nucleon ~50 years ago.

We have examined two of the most intense ^{3}He-rich (^{3}He/^{4}He > 1) SEP events of the solar cycle 24 (2008 through 2017) measured on the Advanced Composition Explorer (ACE) at energy >10 MeV/nucleon on 2011 February 18 and 2015 August 24 (panels a, b). Although ^{3}He shows high intensities, Z >2 ions, including Fe, were below the measurable level at energy >10 MeV/nucleon in the Solar Isotope Spectrometer (SIS) for both events. The ACE Ultra-Low-Energy Isotope Spectrometer (ULEIS) confirms that at low energies (~0.5 MeV/nucleon) both events are Fe-rich (Fe/O >1). The events are accompanied by type-III radio bursts, but type-II emission is missing, as is typically the case for suprathermal ^{3}He-rich SEPs.

The corresponding solar sources were analysed using high-resolution, extreme-ultraviolet (EUV) imaging and photospheric magnetic field observations on the Solar Dynamics Observatory (SDO). We find the sources of these events are associated with jets originating at the boundary of large sunspots with complex and less common βγδ magnetic configuration (panel c). Thus, details of the underlying photospheric field (such as sunspot area and magnetic field distribution) apparently are important to produce ^{3}He to high energies in the examined events. For further details see Bučík et al. ApJL 869, L21, 2018 (https://doi.org/10.3847/2041-8213/aaf37f).



(a) *1-hr ACE/SIS 5.2 and 10.5 MeV/nucleon ^{3}He, ^{4}He intensities. The upper (lower) black curve shows the lower (higher)-energy ^{4}He intensities. The colors correspond to the two ^{3}He energies. Solid vertical lines mark the event-associated type-III radio bursts.* ***(b)*** *He-mass histograms at 10.5 MeV/nucleon.* ***(c)*** *Two-color composite images at start time of the type-III bursts. The SDO/AIA 304 Å EUV images correspond to green and the SDO/HMI line-of-sight magnetic field (scaled to ±200 G) to red/black. The arrows point to the event-associated jets.*

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