

The 4 June 2011 Solar Neutron Event at MESSENGER,

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Evidence for solar flare neutrons were first detected during an M2 flare on 31 Dec. 2007 at about 0.5 AU [Feldman et al., 2010]. The interpretation of the solar-flare association of the detected neutrons was disputed based on the fact that the neutrons at MESSENGER occurred during a Solar Energetic Particle (SEP) event that engulfed MESSENGER [Share et al., 2011]. This criticism is problematic because comparison with cosmic-ray-generated background neutrons on the spacecraft showed that the putative solar neutrons were a factor of 5 times larger than what was estimated to be generated by the SEP ions interacting with spacecraft material. Here we report the observation of a fast neutron ($0.5 \text{ MeV} < E_n < 8 \text{ MeV}$) event on 4 June 2011 where SEP particles were absent and coincident neutron-generated gamma-rays were observed. These combined observations strongly argue for a solar origin of the detected neutrons. Common properties of the detected fast neutron events are: 1) they occur far from any planetary body, 2) they are long-duration events (longer than about 0.5 hours), 3) neither are associated with a gamma-ray impulse at the initiation of neutron acceleration at the Sun, 4) they are associated with an X-ray impulse, an EUV impulse, and/or multiple type-3 electron events. These long duration neutron events are closely similar to the delayed EUV events seen in Fe XVI 335 line intensity, as reported by Wood et al. [Ap. J., 2011]]. A potential explanation of all these characteristics is that the neutrons are generated high in the corona by energetic ions accelerated by merging magnetic fields in a new class of long-duration solar flare events.