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# Observation of thundercloud-related gamma rays and neutrons in Tibet

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During the 2010 rainy season in Yangbajing (4300 m above sea level) in Tibet, China, a long-duration count enhancement associated with thunderclouds was detected by a solar neutron telescope and neutron monitors installed at the Yangbajing Cosmic Ray Observatory. The event, lasting for  $\sim 40$  min, was observed on July 22, 2010. The solar neutron telescope detected significant  $\gamma$ -ray signals with energies  $> 40$  MeV in the event. Such a prolonged high-energy event has never been observed in association with thunderclouds, clearly suggesting that electron acceleration lasts for 40 min in thunderclouds. In addition, Monte Carlo simulations showed that  $> 10$ -MeV  $\gamma$  rays largely contribute to the neutron monitor signals, while  $> 1$ -keV neutrons produced via a photonuclear reaction contribute relatively less to the signals. This result suggests that enhancements of neutron monitors during thunderstorms are not necessarily a clear evidence for neutron production, as previously thought.

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