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Energetic Electrons as Evidence for a Bow Shock at Ceres

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In late June 2016 when Dawn was in its Survey orbit around Ceres, the +Z Phoswich scintillator aboard GRaND (Gamma Ray and Neutron Detector) recorded a solar energetic particle event superimposed with distinctive spikes in its counts. The spikes appeared as Dawn crossed into the southern hemisphere on the dayside of the planet and reappeared twice at the same location on consecutive orbits after the solar event had ceased. The spike pattern was absent from the measurements of the Bismuth Germanate (BGO) scintillator. This suggests the radiation responsible for the bursts in the exterior phoswich scintillator and any of their by-products were fully absorbed by materials surrounding the BGO. The source particles causing the enhancements were likely swift electrons that penetrated directly into the phoswich or associated bremsstrahlung produced in surrounding materials. The phoswich detection threshold for electrons is 20 keV and energy deposition during spike events cut off at about 100 keV, providing an energy range for the electrons if the spikes are produced by bremsstrahlung. Electrons in planetary environments are known to reach such high energies via fast-Fermi acceleration at a bow shock. We investigate if the fast-Fermi acceleration process, which would imply a temporary bow shock at Ceres, can explain the energies and fluxes of the spikes detected by GRaND's +Z Phoswich scintillator.