Contribution ID: **12** Type: **not specified**

High-energy neutrinos, cosmic rays, and gamma rays from gamma-ray bursts

Tuesday, 9 May 2017 14:48 (18 minutes)

Ultra-high-energy cosmic rays and high-energy astrophysical neutrinos are routinely detected, but their sources remain unknown. Gamma-ray bursts (GRBs) have long been considered attractive candidate sources. Recently, the lack of neutrinos detected in coincidence with known GRBs has motivated revisions of the multi-messenger emission mechanism — gamma rays, cosmic rays, neutrinos — from within the GRB jet. By embedding this revised mechanism in a simulation of multiple emission regions within the jet, we obtain a robust prediction for the minimal diffuse GRB neutrino flux, likely within the reach of the planned detector upgrade, IceCube-Gen2. Further, we show that, by looking for features in the shape of the GRB gamma-ray light curve, we can assess whether a particular burst is likely to be an intense neutrino source.

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Session Classification: Gamma Rays

Track Classification: Gamma Rays - Convenor: Reshmi Mukherjee, Columbia