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The Crab Pulsar: An Old Friend Full of Surprises¹

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The Crab pulsar and its nebula have been astrophysical standards for several decades. The Crab nebula is the brightest known pulsar wind nebula and the “crab” is a widely used flux unit. In 2011 Fermi and AGILE telescopes reported powerful gamma-ray flares from the nebula, with up to 30 fold increase over the quiescent flux. The flares challenge traditional models of acceleration in pulsar wind nebulae, since they seem to violate a fundamental limit on maximum acceleration energy in these models, and their short timescales indicate they originate from regions much less than an arc second in size. New models and simulations suggest that Doppler boosting or shock-driven reconnection at the pulsar wind termination shock may be able to overcome some of these limitations, but there are still questions to be resolved. This same year, the ground-based Air-Cherenkov telescopes MAGIC and VERITAS detected, for the first time, pulsed very high-energy gamma rays up to 400 GeV from the pulsar. No existing models had predicted such emission but new models for inverse Compton radiation from electron-positron pairs are rapidly developing, which imply a high multiplicity of pairs reaching at least these energies.

¹The Fermi-LAT Collaboration