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Origin of the very high energy gamma-ray emission from the Crab nebula

LHAASO has detected gamma-ray emission from the Crab Nebula up to PeV energies. We show here that our recent model for electron acceleration at pulsar wind termination shocks can fit well both the inverse Compton and the synchrotron emission from the Nebula. Integrating individual particle trajectories in a model of the magnetic field and flow pattern near the shock, we find that drift motion on the shock surface maintains either electrons or positrons on Speiser orbits in a ring-shaped region close to the equatorial plane of the pulsar, where they are accelerated up to multi-PeV energies by the first-order Fermi mechanism. We calculate the inverse Compton emission from these electrons, and demonstrate that the observed > TeV gamma-ray emission from the Crab Nebula can be well reproduced for reasonable parameters of the Crab pulsar wind and turbulence levels in the nebula. Comparing to the LHAASO observations of the Crab Nebula, we can place novel constraints on parameters of the Crab pulsar wind that are still poorly known.

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