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Pulsar Wind Nebulae as seen in TeV gamma-rays and their Galactic environments

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Pulsar Wind Nebulae (PWNe) constitute the largest class of identified Galactic sources of TeV gamma-rays, as revealed by the Galactic Plane Survey with the HESS telescopes. This survey allowed a systematic study of a large number of PWNe in TeV gamma-rays, and revealed properties that could only be hinted at previously. In particular, there is a weak but significant trend for the gamma-ray luminosity to decrease with age, and seemingly to depend on Galactic location. Furthermore, older PWNe are often significantly offset from the associated pulsar, with separations considerably larger than may be explained solely by typical pulsar proper motions.

We first review the above properties of TeV-emitting PWNe, with emphasis on the observational evidence for large offsets and constraints on the associated pulsar's proper motion. We investigate possible explanations in terms of their respective Galactic environments. In particular, we consider recent models of the photon density in the Galaxy and its spiral arms, and study their possible influence, in a leptonic (inverse Compton) model, on the observed contrasts in luminosity. We also discuss an explanation of the offsets which relies, in addition to the pulsar proper motion, on density heterogeneity in the surrounding medium. We explore this scenario by means of relativistic magneto-hydrodynamic numerical simulations. Looking at individual examples, we examine publicly available multi-wavelength data to search for evidence of the required density variations.

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