TeV Upper Limits for Pulsar Wind Nebulae Using H.E.S.S.

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***Abstract*. Pulsar Wind Nebulae (PWNe) form one of the most prominent groups of astronomical very high energy (VHE) γ-ray, sources with at least nine confirmed detections in the TeV energy range and several more sources which show possible associations with known PWNe observed at other wavelengths. PWNe are formed by the ejection of relativistic electrons from pulsars into the supernova remnants that surround them [4] [7]. They are seen around the most energetic young pulsars with emission in the TeV energy band dominated by inverse Compton boosted photons.**

At the start of its life, a PWN will initially expand into the surrounding supernova remnant (SNR). At these early stages in the development of the nebula it contains a young, highly energetic electron population. This results in both synchrotron and inverse Compton emission in the immediate vicinity of the pulsar and so small nebulae are seen at both keV and TeV energies. After a few thousand years of expansion, PWNe contain mostly older, less energetic electrons, with younger electron populations only being present near the source pulsar where they are replenished. The young electrons create a small synchrotron nebula around the pulsar which is visible in X-rays. In contrast, a much larger nebula, generated by the inverse Compton process, is revealed in the TeV regime.

As X-ray pulsar wind nebulae are in general quite small, it is necessary to use an X-ray instrument of good angular resolution to resolve them and properly distinguish themproperly distinguish them from their pulsar, which may appear extended due to the instrument point spread function. Of the current generation of X-ray satellites, the Chandra observatory has the best angular resolution and so we have chosen this instrument to identify PWNe for which upper limits will be calculated. Kargaltsev and Pavlov [6] provide a catalogue of known PWNe that have been detected by Chandra. However, some additional nebulae (The Eel [8] and G7.4-2.0 [3]) have been observed with Chandra and so have been added to the objects to study.

The combination of Kargaltsev and Pavlov [6] and the additional targets provides a catalogue of 57 nebulae that have been observed by Chandra. This work will provide upper limits for the 20 PWNe in the catalogue for which archival H.E.S.S. data is available.

X-ray observations of the target PWNe have been used in conjunction with the method presented in de Jager et al. [5] to obtain predictions of the γ-ray flux. Where a magnetic field strength estimate is provided in the relevant X-ray observation paper, this value is used; otherwise the equipartition method of de Jager et al. [5] is used to estimate the value of the magnetic field strength. It is also possible to use the upper limit and the X-ray flux measurement to calculate a lower limit to the magnetic field present in the nebula.

***Keywords*: VHE γ-ray sources - Pulsar Wind Nebulae - Pulsars**

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