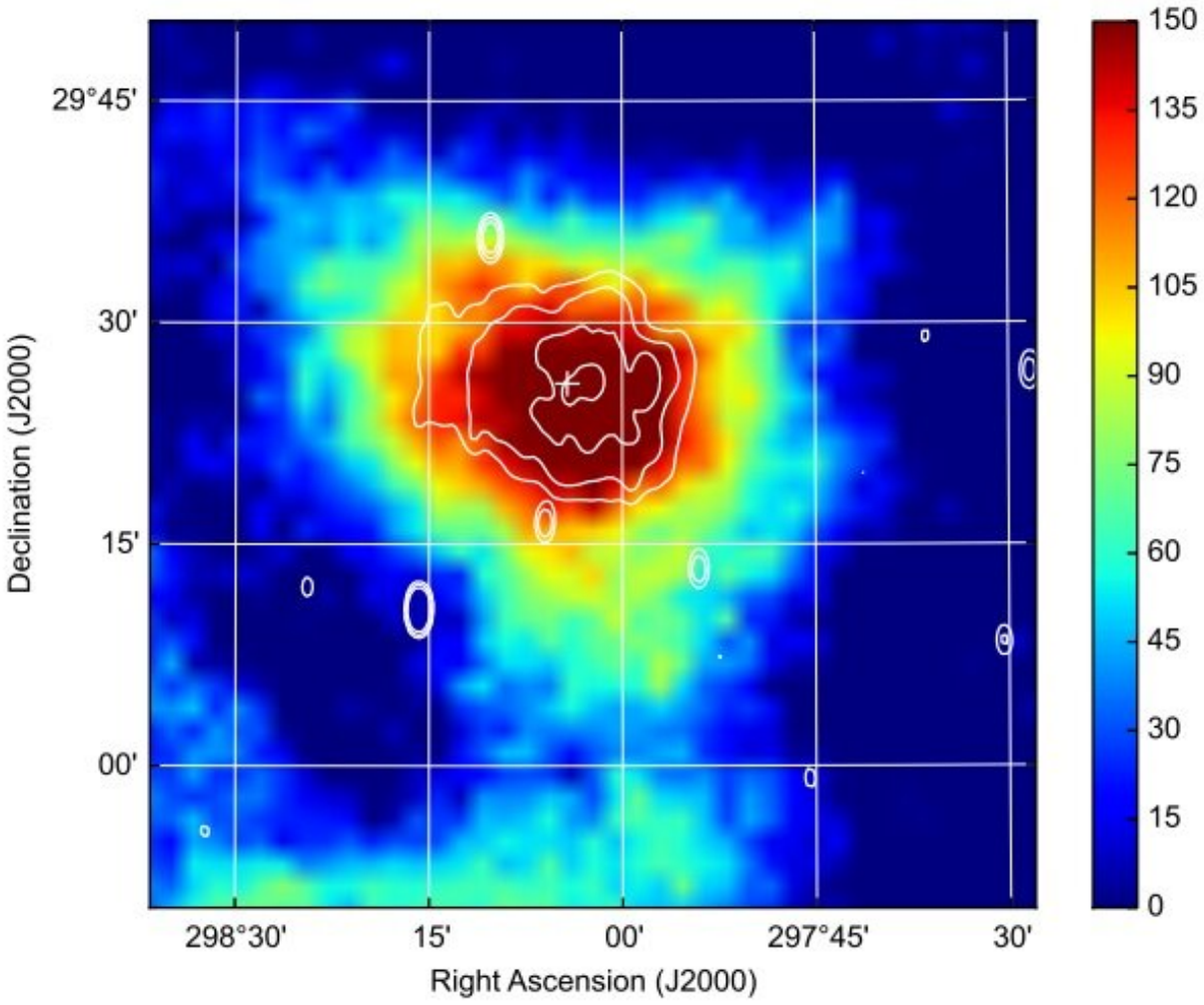
Astronomers investigate pulsar wind nebula DA 495

May 27 2019, by Tomasz Nowakowski



VERITAS image of DA 495. Credit: Coerver et al., 2019.

Astronomers have carried out a multiwavelength investigation of a pulsar wind nebula (PWN), designated DA 495, to unveil its mysterious physical nature. Results of the study, based on observations using HAWC and VERITAS ground-based observatories as well as NASA's NuSTAR spacecraft, are presented in a paper published May 17 on arXiv.org.

Pulsar wind nebulae (PWNe) are nebulae powered by the wind of a pulsar. Pulsar wind is composed of charged particles; when it collides with the pulsar's surroundings, in particular with the slowly expanding supernova ejecta, it develops a PWN.

Particles in PWNe lose their energy to radiation and become less energetic with distance from the central pulsar. Multiwavelength studies of these objects, including X-ray observations, especially using spatially-integrated spectra in the X-ray band, have the potential of uncovering important information about particle flow in these nebulae. This could unveil important insights into the nature of PWNe in general.

Discovered about half a century ago, DA 495 (G65.7+1.2) was first identified as a point source in the Dominion Astrophysical (DA) survey. Subsequent observations of this source have revealed that it is located some 3,260 light years away from the Earth, and has an extended structure and a non-thermal spectrum. These suggest DA 495 could be a Crab nebula–like supernova remnant.

However, more recent observations of DA 495, especially in X-rays and gamma-rays, provided evidence that the object is a PWN in an evolutionary state somewhere between the Crab and Vela-X nebulae. This makes it an excellent target for studies focused on investigating life cycles of PWNe.

Moreover, still very little is known about physical properties of DA 495,

which encourages scientists to conduct more observations of this mysterious object.

Recently, a team of astronomers led by Anna Coerver of Columbia University has reinvestigated DA 495 using new X-ray data from observations performed with Nuclear Spectroscopic Telescope Array (NuSTAR). The study was complemented by analysis of the archival datasets from the High Altitude Water Cherenkov Observatory (HAWC) and Very Energetic Radiation Imaging Telescope Array System (VERITAS).

"In this paper we presented new observations from NuSTAR. We combined this new analysis with recent TeV gamma-ray observations and the current radio analysis to create a broadband spectral energy distribution for DA 495," the astronomers wrote in the paper.

The research mainly confirmed previous findings regarding such parameters as photon index, neutral hydrogen absorption, blackbody temperature, and a blackbody radius. In particular, the photon index, at a level of 2.0, is typical for a PWN.

However, the astronomers found some evidence that DA 495 may not be a PWN at all. They noted that the radio and TeV emission from this object could be also explained by a thick shell containing relativistic hadrons. Such structure could be accelerated from a supernova shock interacting with some slow supernova ejecta.

"This challenges the current interpretation and requires further investigation by future TeV gamma-ray observations," the paper reads.

Therefore, these findings deepen the mystery of the physical nature of DA 495. That is why Coerver's team proposes more observations of this source, especially in radio to infrared bands and spatially resolved

gamma-rays. Such studies have the potential to provide more hints into the physical conditions and radiation mechanisms in this peculiar object.

More information: A. Coerver, et al. Multiwavelength Investigation of Pulsar Wind Nebula DA 495 with HAWC, VERITAS, and NuSTAR.arXiv:1905.07327v1 [astro-ph.HE]. arxiv.org/abs/1905.07327