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What is HESS J1943+213?

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The Discovery

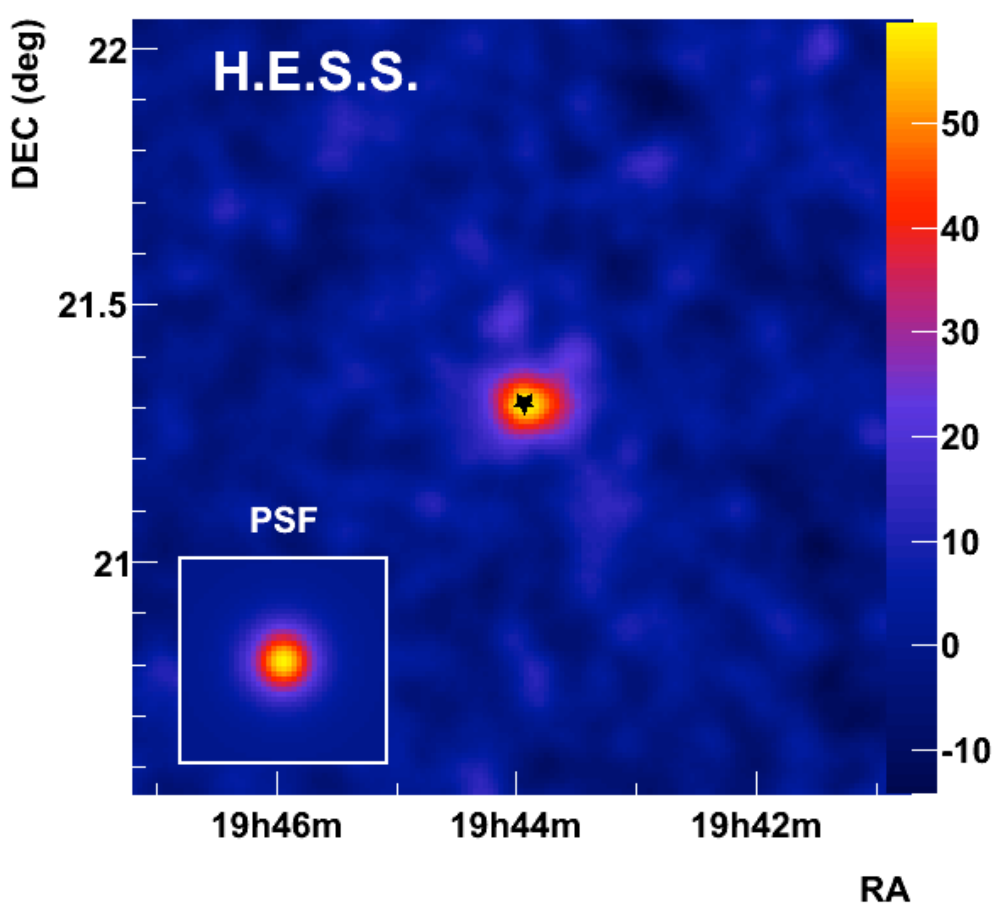
A new VHE point-like source has been detected in the H.E.S.S. Galactic Plane scan data. It coincides with an unidentified hard X-ray source IGR J19443+2117. We discuss the possible source association with an active galactic nucleus, a gamma-ray binary or a pulsar wind nebula. These are the three known types of sources that appear point-like in VHE observations.

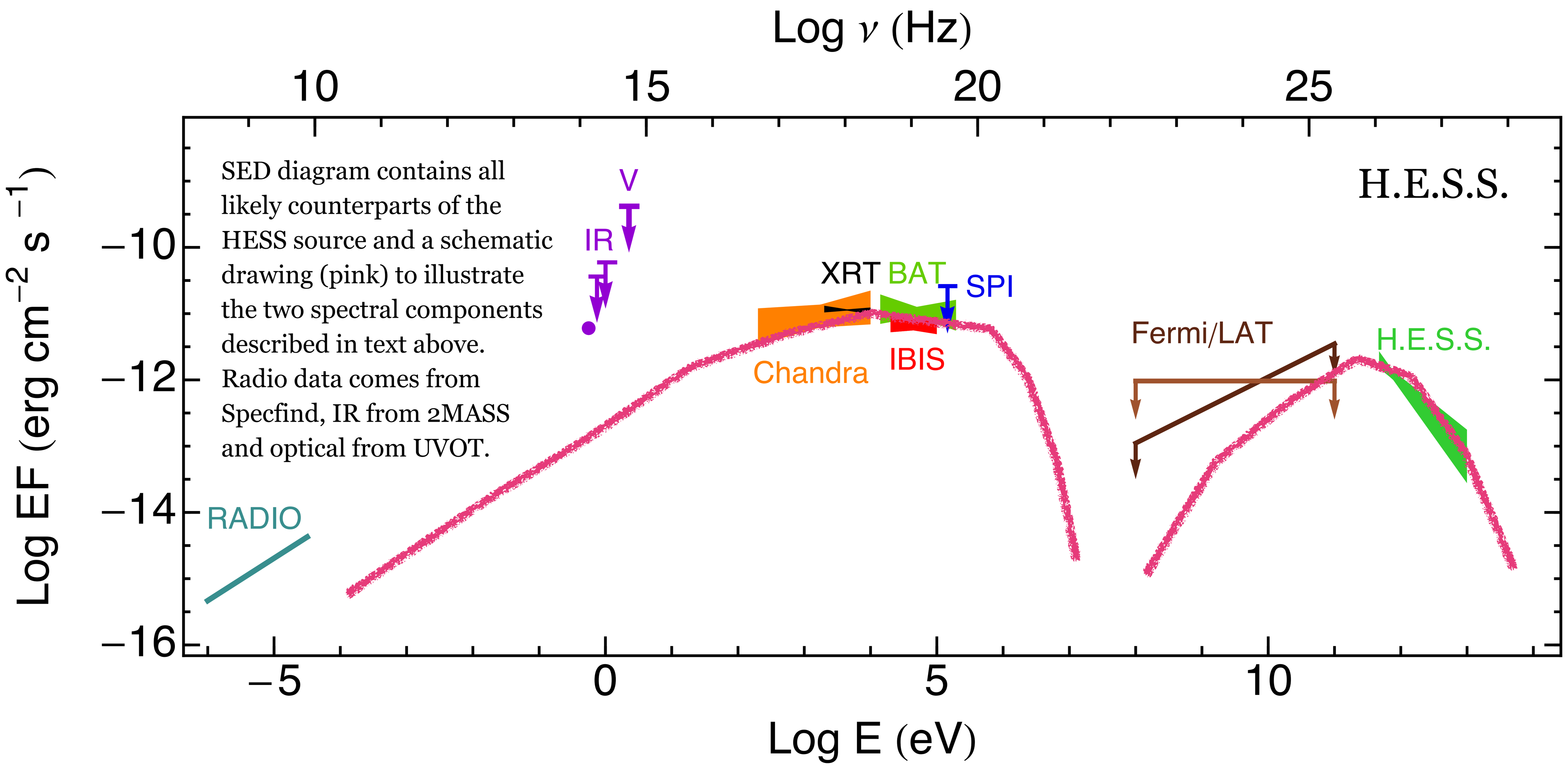
The Clues

HESS J1943+213 was detected at the significance level of 7.9σ (post-trials) at RA (J2000) = 19h 43m 55s, Dec(J2000) = +21d 18' 8". The source has a soft spectrum with photon index $\Gamma = 3.1 \pm 0.3_{stat} \pm 0.2_{sys}$ and a flux above 470 GeV of $(1.3 \pm 0.2_{stat} \pm 0.3_{sys}) \times 10^{-12}$ cm^{-2} s^{-1}. There is no Fermi/LAT counterpart down to a flux limit of 6×10^{-9} cm^{-2} s^{-1} in the 0.1–100 GeV energy range (95%, for an assumed power-law model with a photon index $\Gamma = 2.0$).

The source has very likely counterparts in Radio, IR and X-rays. The observations from radio to VHE gamma-rays are unresolved and do not show any significant variability. SED diagram of HESS J1943+213 (shown below) is apparently composed of two components, a low energy one most likely of synchrotron origin and high energy one due to synchrotron self-Compton or external inverse Compton. Such two component SED is characteristic to all three considered classes of sources.

H.E.S.S. Excess map





Gamma-ray binary?

The few sources in the Galactic Plane that appear point-like in VHE, are often associated with gamma-ray binaries such as e.g., LS 5039 or PSR B1259-63. With five known systems, our knowledge of these sources as a class is limited. The radio, X-ray and VHE spectral properties of HESS J1943+213 and its possible counterpart are compatible with what is known to date about gamma-ray binaries. However...

The classification as HMXB appears less likely given the absence of a massive star. A faint flux of the infrared counterpart attributed to a massive star and assuming a similarity of the source SED with the known binaries, implies too large distance (>25 kpc) and in consequence too high X-ray luminosity. A secondary less constraining argument against the binary hypothesis is the absence of an orbital modulation.

Pulsar wind nebula?

When the wind ejected from a rotation-powered pulsar is confined by the pressure of the surrounding medium (supernova remnant or compressed interstellar gas), a PWN is created. If HESS J1943+213 was a PWN, it would be very young ~10^3 yr, and it would contains a pulsar with a spin-down power $\dot{E}$~10^{38} erg s^{-1}, similar to the Crab Nebula (Mattana et al. 2009).

The main argument against the PWN scenario is the soft VHE gamma-ray spectrum, which is unusual when compared with the spectra of a large sample of TeV PWN (Kargaltsev & Pavlov 2010). The young age of HESS J1943+213 in the PWN scenario is consistent with it being unresolved for H.E.S.S.. However, all the unresolved VHE PWNe are extended in X-rays. The unresolved X-ray emission as observed by Chandra weakens the PWN scenario.

Blazar?

The SED peaking in X-rays and in VHE gamma-rays is characteristic to HBL BL Lacerta type blazars. HBL objects are the best candidates for VHE sources. In fact, the class constitutes the majority of the current population of VHE AGN.

There are no arguments against the AGN hypothesis. On the contrary, it is strongly supported by the radio, optical and X-ray properties being well within the parameter region (set by the broad band spectral indices and logarithmic flux ratios, e.g., Costamante & Ghisellini 2002, Plotkin et al. 2010) in which high-frequency peaked BL Lac objects and TeV AGN are found. The infrared counterpart is compatible with an elliptical galaxy at z>0.14, which would also explain the soft VHE spectrum as attenuation of the intrinsic spectrum on the extragalactic background light.

The Answer

HESS J1943+213 seems to be one of the most extreme HBL objects detected, with a peak of synchrotron frequency well beyond 10 keV.

Please send comment & questions to aszostek@slac.stanford.edu

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