

Discovery of the X-ray emission from the unidentified TeV object HESS J1741–302

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ABSTRACT

HESS J1741–302 is one of the unidentified TeV gamma-ray objects along the Galactic plane. Because HESS J1741–302 is extended and very faint, HESS J1741–302 may be related to the diffuse TeV emission from the Galactic center ridge. This object was observed with the Suzaku XIS, and an X-ray counterpart to HESS J1741–302 was discovered. Furthermore, a new X-ray object, Suzaku J1740.5–3014, was discovered in the vicinity of HESS J1741–302. Spectral and temporal analysis suggests that the object is a cataclysmic variable.

KEY WORDS: X-rays: individual (HESS J1741–302) — gamma rays: observations — ISM: cosmic rays

1. Introduction

HESS J1741–302 is one of the unidentified TeV gamma-ray objects discovered along the Galactic plane with the H.E.S.S. telescope (Tibolla et al. 2008; Tibolla 2009). This object is extended and very faint; the preliminary analysis of the H.E.S.S. data suggests that the energy flux in the 1–10 TeV energy band is $F(1–10 \text{ TeV}) \sim 2 \times 10^{-12} \text{ erg cm}^{-2} \text{ s}^{-1}$ ($\sim 1\%$ of the Crab nebula) (Tibolla et al. 2009). Thus this object may be physically related to the diffuse TeV gamma-ray emission from the Galactic center ridge (Aharonian et al. 2006), the origin of which has not been clarified. Therefore HESS J1741–302 was observed with the Suzaku XIS (Koyama et al. 2007) twice; the observed regions are shown in Fig. 1 together with the TeV gamma-ray image obtained with the H.E.S.S. telescope. In this paper, uncertainties are given at the 90% confidence level.

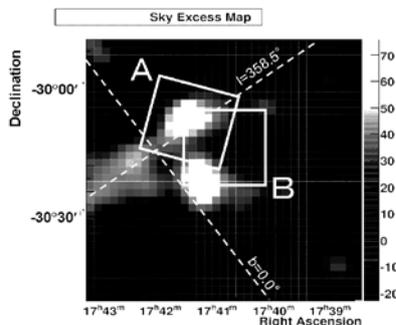


Fig. 1. TeV gamma-ray image of HESS J1741–302. The boxes marked as A and B show the fields of view of the Suzaku XIS.

2. Suzaku Results

2.1. Region A

The region A in Fig. 1 was observed on Feb. 24, 2009 for 45 ks. X-ray images in the 0.4–2.0 keV band and in the 2.0–10.0 keV band are shown in Fig. 2. An X-ray object is found at the center of the high-energy band image. The location of the object is $(\alpha, \delta)_{J2000} = (17\text{h}41\text{m}26\text{s}, -30\text{d}06\text{m}51\text{s})$. Fig. 2 (c) shows the X-ray contour in the 2.0–10.0 keV band with the TeV gamma-ray image. The X-ray object is spatially coincident with one of the gamma-ray peaks of HESS J1741–302, and hence the object is the X-ray counterpart of HESS J1741–302.

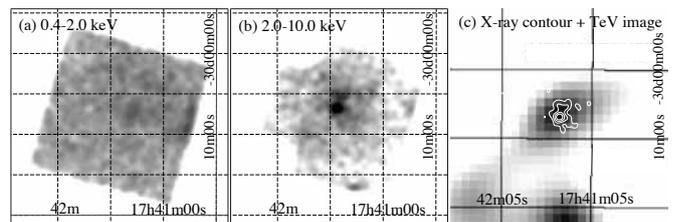


Fig. 2. X-ray images of the region A obtained with the Suzaku XIS (XIS0+XIS3) in the 0.4–2 keV (a) and in the 2–10 keV band (b). (c) X-ray contour in the 2–10 keV band is overlaid on the TeV gamma-ray image.

Fig. 3 shows the X-ray spectrum of the X-ray counterpart of HESS J1741–302. The spectrum was fitted with a power-law model modified by an interstellar absorption. Free parameters are the photon index (Γ) and the normalization of the power-law model, and the absorption column density (N_{H}). The best-

fit parameters are $\Gamma = 1.13 \pm 0.60$ and $N_{\text{H}} = (3.95 \pm 2.70) \times 10^{22} \text{ cm}^{-2}$. The large column density suggests that the object is really at the Galactic center region. The observed X-ray flux in the 2–10 keV band is $F(2\text{--}10 \text{ keV}) = 3.2 \times 10^{-13} \text{ erg s}^{-1} \text{ cm}^{-2}$. The flux ratio is $F(1\text{--}10 \text{ TeV})/F(2\text{--}10 \text{ keV}) \sim 6$. The large ratio may suggest the hadronic origin of the TeV gamma-ray emission of HESS J1741–302.

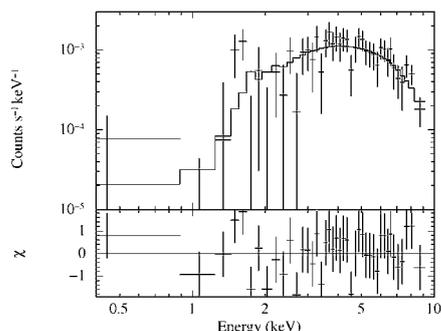


Fig. 3. X-ray spectrum of the X-ray counterpart of HESS J1741–302. The solid line shows the best-fit absorbed power-law model. Although the FI (XIS0+3) and BI (XIS1) spectra are simultaneously analyzed, only the FI spectrum are shown for esthetic reasons.

2.2. Region B

The region B in Fig. 1 was observed on Oct. 4, 2008 for 54 ks. Fig. 4 shows the X-ray image of the region B. A bright point source is conspicuous in both the low- and high-energy images. The location of the object is $(\alpha, \delta)_{\text{J2000}} = (17\text{h}40\text{m}35\text{s}, -30\text{d}14\text{m}16\text{s})$. Thus this object is designated as Suzaku J1740.5–3014. The other objects in the low-energy image are probably foreground stars. There is the pulsar PSR B1737–30, the location of which is $90''$ away from Suzaku J1740.5–3014. Although the pulsar is a candidate for an “engine” of the TeV emission of HESS J1741–302 (Tibolla et al. 2008), no significant X-rays were found from the pulsar.

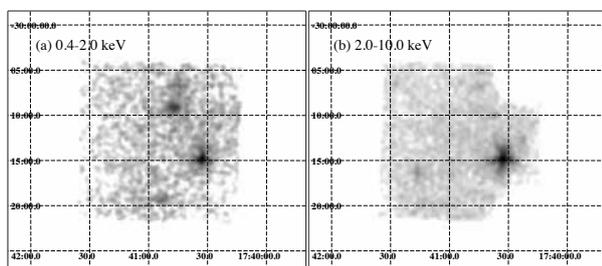


Fig. 4. X-ray images of the region B obtained with the Suzaku XIS (XIS0+XIS3) in the 0.4–2.0 keV band (a) and in the 2.0–10.0 keV band (b).

Fig. 5 is the X-ray spectrum of Suzaku J1740.5–3014. Three lines at $\sim 6 \text{ keV}$ can be seen clearly. Then the spectrum was fitted with an absorbed power-law model

plus three Gaussian lines. The best-fit parameters are $\Gamma = 0.83 \pm 0.13$ and $N_{\text{H}} = (1.62 \pm 0.34) \times 10^{22} \text{ cm}^{-2}$. The observed flux is $F(2\text{--}10 \text{ keV}) = 2.2 \times 10^{-12} \text{ erg cm}^{-2} \text{ s}^{-1}$. The center energies and equivalent widths of the three lines are $6.39 \pm 0.03 \text{ keV}$ and 172 eV , $6.66 \pm 0.02 \text{ keV}$ and 186 eV , and $6.95 \pm 0.03 \text{ keV}$ and 172 eV , respectively. Thus these lines are attributed to the $K\alpha$ lines from neutral (or low ionized) iron, FeXXV and FeXXVI.

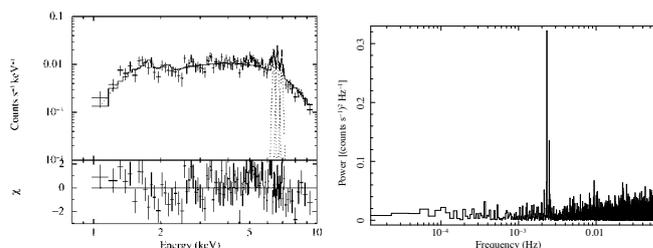


Fig. 5. X-ray spectrum of Fig. 6. Power spectrum of Suzaku J1740.5–3014(XIS0+3) and the best-fit model. 1–9 keV band.

The light curve of Suzaku J1740.5–3014 in the 1–9 keV band was analyzed, and the FFT analysis revealed a clear peak at $\sim 2.3 \times 10^{-3} \text{ Hz}$ (Fig. 6). Then an accurate period of $432.1 \pm 0.1 \text{ s}$ was found with the folding technique.

The spectrum and the light curve suggest that Suzaku J1740.5–3014 is a magnetic cataclysmic variable, especially an intermediate polar. See Uchiyama et al. (2009) for more details about Suzaku J1740.5–3014.

3. Conclusions

Two regions of HESS J1741–302 was observed with the Suzaku XIS. In one region, an X-ray counterpart spatially coincident with one of the TeV gamma-rays emission peaks was discovered. The ratio of the TeV flux to the X-ray flux is ~ 6 , and the low value may support the hadronic origin of the TeV gamma-ray emission. In the other field, a new object Suzaku J1740.5–3014 was discovered. The spectrum and the light curve suggest the object is a cataclysmic variable.

References

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