Discovery of the Extended X-ray Emission from the Dark Accelerator HESSJ1614-518

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Outline

- HESS unID object: HESSJ1614-518
- Suzaku observation of HESSJ1614-518
  - Discovery of an extended X-ray counterpart
  - Other two X-ray objects
  - Discovery of extended soft X-ray emission
- Discussion
- Summary
TeV γ-ray object: HESSJ1614-518

Discovered by the Galactic plane survey with the H.E.S.S. telescope. (Aharonian et al. 2005, 2006)

Brightest object: $F(1-10\text{TeV})=1.8\times10^{-11}\text{ erg/s/cm}^2$
Suzaku Observation

Normal mode without the speced-row charge injection

TeV image and XIS FOV

2006/9/15 45ks

2006/9/15 53ks

offset
Discovery of three X-ray objects

srcA, srcB: extended, srcC: point like
Comparison with the HESS image

Src A is spatially coincident with the TeV gamma-ray.
Spectral Analysis

Definition of spectral regions and a background.

(The offset observation is not used as a background. Explain later.)
Spectrum of src A

3-10keV

Red: BI
Black: FI

Featureless = non-thermal

\( \Gamma = 1.73 \pm 0.33 \)

\( NH = 1.21 \pm 0.5 \times 10^{22} \text{ cm}^{-2} \)

\( F(2-10\text{keV}) = 5.3 \times 10^{-13} \text{ erg/cm}^2/\text{s} \)
Discussion: Src A

Src A is a plausible counterpart to HESSJ1614

If the origin of the TeV emission is the inverse Compton of the CMB by high-energy electrons, the magnetic field must be too small.

- **Src A**
  - $B = 10 \mu G$
  - $B = 1 \mu G$
  - $B = 0.1 \mu G$

**H.E.S.S.**

- $F(1-10\text{TeV})/F(2-10\text{keV}) = 34$
  - One of the largest ratios.

**Other Suzaku results**
- HESSJ1616-508: $>55$ (Matsumoto et al. 2007)
- HESSJ1804-216: $\sim 25$ (Bamba et al. 2007)
Discussion: src A

- No counterpart in other wavelengths.
- $NH \sim 1.2e22 \text{ cm}^{-2}$
  - $D \sim 10 \text{ kpc (c.f. NH (HI survey) } \sim 2e22 \text{ cm}^{-2})$
  - $Lx(2-10\text{keV}) \sim 6e33 \text{ erg/s}$
  - Photon index $= 1.7$
  - Harder than the canonical SNR values (2.5-3.0)
  - Non-thermal brems. emission from loss-flattened electron distribution? (e.g., $\gamma$ Cygni; Uchiyama et al. 2002)
  - Old SNR? (Yamazaki et al. 2006)
  - PWN?
Spectrum of srcB

Featureless = Non-thermal?
Extremely soft!

\[ \Gamma = 3.60 \pm 0.23 \]
\[ \text{NH} = 1.24 \pm 0.1 \times 10^{22} \text{ cm}^{-2} \]
\[ F(2-10\text{keV}) = 3.6 \times 10^{-13} \text{ erg/cm}^2/\text{s} \]
Discussion: src B

- Spatially coincident with 2MASS J16140610-5152264
  - The origin of the object is not clarified.
- Previously detected with Swift XRT in March 2006: variable?
  - F(2-10keV): Swift 1.4e-13 erg/s/cm² (Landi et al. 2007)
    Suzaku 3.6e-13 erg/s/cm² (large err.)
- Extremely large photon index (3.6)
- NH ~ 1.2e22 cm⁻²
  - Same as that of src A.
  - Physically related to HESSJ1614?
  - Src A= offset PWN and src B = pulsar?
    (e.g. PSRJ1809-1917 associated with HESSJ1809-193
    has a large photon index of 3.2+/-0.4; Kargaltsev & Pavlov 2007)
Spectrum of src C

0.4-3 keV

Thermal spectrum

Counts s^{-1} keV^{-1}

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Red: BI
Black: FI

kT=0.63\pm0.1 keV

Abundance=0.18\pm0.5 solar

NH=0.28\pm0.2 e22 cm^{-2}

F(2-10 keV)=7.6e-15 erg/cm^{2}/s

Probably the foreground B9V star HD145703

Dec. 12, 2007
Suzaku 2007
Diffuse soft X-ray emission

TeV image

Blank region as a background

Offset region. No X-ray and gamma-ray objects.

Blank-Offset

Red: BI

Black: FI

$\Gamma = 2.4$ or $kT = 2.7\, \text{keV}$

$NH = 0.1 \times 10^{22} \, \text{cm}^{-2}$

BI spectrum
Summary

- Discovery of three X-ray objects.
  - **Src A**
    - Extended and spatially coincident with HESSJ1614.
      - Plausible counterpart to HESSJ1614.
    - $F(1\text{-}10\text{TeV})/F(2\text{-}10\text{keV}) = 34$
      - It is difficult to explain the ratio in terms of high-energy electrons.
    - Photon index = 1.7
      - Different from the SNR values.
  - **Src B**
    - Column density suggests that src B may also be physically related to HESSJ1614. Pulsar?
  - **Src C** … foreground star
- Discovery of the extended soft X-ray emission.
他波長イメージ

SUMSS 843MHz survey

CO map