The Study of Extended Gamma-ray Sources based on FERMI LAT Data

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Outline

- Shell Type SNR RX J1713-3946
- Spatial Fit
- Spectral Fit
- Model Fit and Conclusion
RX J1713-3946

- Best studied VHE gamma sources (Aharonian, et.al, 2008)

- D=1kpc, r=10pc

- Very young(1600 years)(Wang et al.1997)

- Shell Structure and possible origin of cosmic rays

- Multi-wavelength Observation
Fermi Count Map (E > 10 GeV)
Spatial Fit

- Binned Analysis using the Fermi Science Software (E>10GeV)

- Ring or Broken Ring Template

- Vary the Position, Shape and Size of the Template to get a best fit result
Results

- Ring Template
  \((0.1\text{degree} < r < 0.8\text{degree})\)
- \(TS = 86\), Imply a significance Of more than \(9\ \sigma\)
Hot Spot as Point Sources

The TS value for point source 1, 2, 3 is 7.17, 6.92 and 5.46 respectively, which is much smaller than the TS value for the Ring template.
Spectral Fit

- Use binned likelihood analysis in the energy range [200:300000] MeV and a power law spectrum

\[ \frac{dN}{dE} = N_0 \left( \frac{E}{1\text{MeV}} \right)^{-\gamma} \]

- Divide the energy range [200:300000] MeV into 8 bins, fit the flux of each energy bin
The index is 1.8, which is very similar to the HESS results.
Model Fit

- Hadronic Model

\[ F_p(E) = N_0 E^{-\gamma} \exp(-E/E_c) \]

\[ n_{ISM}, E_c, \gamma, W_p \]

- Leptonic Model

\[ F_e(E) = N_0 E^{-\gamma} \exp(-E/E_c^2) \]

\[ E_c, \gamma, W_e \]
Results

- **Hadronic Model**

  \[ n_{ISM} = 1.0 \text{cm}^{-3}, E_c = 70 \text{TeV}, \]
  \[ \gamma = 1.72, W_p = 1.67 \times 10^{50} \text{erg}, \chi^2 = 11.6 \]

- **Leptonic Model**

  \[ E_c = 46 \text{TeV}, \gamma = 2.42, \]
  \[ W_e = 2.9 \times 10^{48} \text{erg}, \chi^2 = 25.3 \]
Previous Results
Hess & Suzaku Data (Tanaka, et.al, 2008)

- Hardronic Model

\[ n_{\text{ISM}} = 1.0 \text{cm}^{-3}, E_c \sim 100 \text{TeV}, \]
\[ \gamma = 1.7, W_p = 1.6 \times 10^{50} \text{erg} \]

- Leptonic Model

\[ \gamma = 2, W_e = 1.4 \times 10^{47} \text{erg} \]
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*Disfavor a Leptonic Model, But Far from drawing a Conclusion!*
Nonlinear DSA

(V.N.Zirakashvili, F.A. Aharonian 2009)
Systematic Errors?

Counts Map and Residual Map in the energy band (400MeV--1GeV)
Summary

- Hadronic Model is favored by recent analysis

- Detailed Non-linear Diffusive Acceleration should be considered

- Systematic Errors should be considered carefully and maybe different position of the source should be fitted separately.
Thanks!