Evidence of a Curved Cosmic-Ray Electron Spectrum in the Remnant SN 1006

Glenn E. Allen, (MIT/MKI), John C. Houck (MIT/MKI), and Steven J. Sturmer (USRA, NASA/GSFC)

Abstract

A joint spectral analysis of Chandra X-ray data and HIRFL radio data indicates that the high-frequency cutoff of the electron energy spectrum of SN 1006 is consistent with a curved electron spectrum for high energies, beyond the radio band. The results of the joint spectral analysis and the expected radio flux densities of SN 1006 are consistent with a possible detection of a curved electron spectrum, which is a result of nonthermal electrons undergoing a change in energy. The estimated spectral curvature is consistent with the expected slope of the linear relationship between the index and curvature parameters.

Table 1. Best-Fit Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value (Units)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Index (Γ)</td>
<td>3.0 ± 0.1</td>
</tr>
<tr>
<td>Curvature (δ)</td>
<td>1.5 ± 0.3</td>
</tr>
</tbody>
</table>

Assumptions

1. The electron density is described by a function of the form

\[ \rho = \frac{\rho_0}{(1 + \alpha \nu^2)^{\delta}} \]

where \( \rho_0 \) is the electron density, \( \nu_0 \) is the lowest frequency, \( \alpha \) is the spectral index used by Ellison et al. (2000), and \( \delta \) is the observed spectral curvature.

2. The model is a linear function of the logarithm of the momentum. This enables us to show, for the first time, that the electron spectral index is a linear function of the logarithm of the momentum.

3. The model is a linear function of the logarithm of the momentum. This enables us to show, for the first time, that the electron spectral index is a linear function of the logarithm of the momentum.

4. The model is a linear function of the logarithm of the momentum. This enables us to show, for the first time, that the electron spectral index is a linear function of the logarithm of the momentum.

Conclusions

1. We performed a joint spectral analysis of Chandra X-ray and HIRFL radio data for SN 1006, which indicates that the electron spectral index is consistent with a possible detection of a curved electron spectrum.

References