X-RAY SYNCHROTRON EMISSION FROM 10–100 TEV COSMIC-RAY ELECTRONS IN THE SUPERNOVA REMNANT SN 1006

G. E. Allen (1), R. Petre (2) and E. V. Gotthelf (3)
(1) MIT Center for Space Research, 77 Massachusetts Avenue, NE80-6029, Cambridge, MA 02139-4307, USA, (2) NASA/Goddard Space Flight Center, Laboratory for High Energy Astrophysics, Code 662, Greenbelt, MD 20771, USA, (3) Columbia Astrophysical Laboratory, Columbia University, Pupin Hall, 550 West 120th Street, New York, NY 10027, USA.
gea@space.mit.edu/Fax: 617-253-8084

We present the results of a joint spectral analysis of *RXTE* PCA, *ASCA* SIS, and *ROSAT* PSPC data of the supernova remnant SN 1006. This work represents the first attempt to model both the thermal and non-thermal X-ray emission over the entire X-ray energy band. The thermal flux is described by a non-equilibrium–ionization model with an electron temperature $kT_{\rm e} = 0.6$ keV, an ionization timescale $n_0 t = 9 \times 10^9$ cm^{-3} s, and a relative elemental abundance of silicon that is 10–18 times larger than the solar abundance. The non-thermal X-ray spectrum is described by a broken–power-law model with low- and high-energy photon indices $\Gamma_1 = 2.1$ and $\Gamma_2 = 3.0$, respectively. Since the non-thermal X-ray spectrum steepens with increasing energy, the results of the present analysis corroborate previous claims that the non-thermal X-ray emission is produced by synchrotron radiation. We estimate the parameters of the cosmic-ray electron, proton, and helium spectra of the remnant. The results for the ratio of the number densities of protons and electrons ($R = 160$ at 1 GeV), the total energy in cosmic rays ($E_{\rm cr} = 1 \times 10^{50}$ erg), and the spectral index of the electrons at 1 GeV ($\Gamma_{\rm e} = 2.14 \pm 0.12$) are consistent with the hypothesis that Galactic cosmic rays are accelerated predominantly in the shocks of supernova remnants. Yet, the remnant may or may not accelerate nuclei to energies as high as the energy of the "knee," depending on the reason why the maximum energy of the electrons is only 10 TeV.