1. Introduction

Soft gamma repeaters are astrophysical sources which exhibit long periods of quiescence, often spanning years, punctuated by periods of intense bursting activity during which many brief (durations < 1 s) and intense (luminosities $L \sim 1 - 10^3 L_{\text{Edd}}$) bursts are emitted by the source (Norris et al. 1991). Besides the burst emission, SGRs are also characterized by steady - also referred to as "quiescent" - emission. Believed to be neutron stars, the mechanism(s) for both the steady and bursting X-ray emission is still not well understood (Thompson & Duncan 1995).

SGR 1806-20 is the most prolific SGR, and it has been studied in the X-ray (Sonobe et al. 1994), optical (van Kerkwijk et al. 1995), infrared (Kulkarni et al. 1995), and radio (Kulkarni et al. 1994) bands. The source became active again during the Fall of 1996, emitting many powerful bursts that were first detected with BATSE (Kouveliotou et al. 1996). A target of opportunity observation by the Rossi X-ray Timing Explorer (RXTE) was initiated on November 5, 1996. The data analyzed here were taken during that 50 ks observation, which spanned the time interval starting at 10:53:20 UT (5/11/96) and ending at 10:52:00 UT (6/11/96). In addition, followup RXTE data were taken during the time interval 06:45:20 UT (15/7/97) to 09:06:24 (15/7/97), in which the source was not bursting.
2. Spectral Analysis: RXTE data

The pointed instruments aboard RXTE are the Proportional Counter Array (Jahoda et al. 1996) and the High Energy X-ray Timing Experiment (rotschild et al 1998). Only data from the PCA is used in this work, however, because the relatively faint quiescent emission from SGR 1806–20 was not detected by the HEXTE on the short timescales discussed here. The PCA instrument consists of 5 collimated Xenon proportional counter detectors with a total net area of 7000 cm$^2$ and an effective energy range of 2 – 60 keV. The instrumental background for the PCA is determined from modeling of both the internal background of the detectors and the background due to cosmic X-ray flux and charged particle events.

A 2 – 60 keV lightcurve of the SGR 1806–20 RXTE TOO observation was extracted using standard FTOOLS 4.0 routines, and is shown in Figure 1. Spectra were extracted from two data stretches, of approximately equal duration, which contain no detectable burst emission from the SGR. These regions, denoted “A” and “B”, are marked by the dotted lines in Figure 1. In addition, a spectrum of approximately equal duration (column “C” in Table 1) was extracted from the July data, during which the source did not burst. Background spectra were generated for all three intervals using the standard background tool PCABACKEST.

The PCA data from the RXTE observations were fit to specific functional forms over the energy range 2.5 – 20.0 keV using XSPEC 10.00. The fitted shapes were of the form $N_H \times$ continuum + gaussian line, where $N_H$ is the neutral hydrogen photoelectric absorption column density (Morrison & McCammon 1983). Raymond-Smith, thermal bremsstrahlung, and power law functional forms were used for the continuum spectral shape, but the power law form produced (by far) the best fit to the data. The spectral parameters for the Fe line in the three RXTE fits were consistent with a constant line normalization, centroid energy, and linewidth, with values of $(5.1 \pm 0.3) \times 10^{-4}$ Photons cm$^{-2}$ s$^{-1}$, $6.65 \pm 0.02$ keV, and $0.37 \pm 0.03$ keV, respectively, for these parameters. Assuming these constant Fe line parameters, which are due to emission from the galactic ridge (Yamauchi & Koyama 1993), the best-fit RXTE spectral parameters for the three data intervals are given in Table 1. The spectral fit results indicate that the SGR 1806–20 steady emission is roughly consistent with a constant spectral shape and normalization throughout periods of both intense bursting and relative quiescence.

3. Conclusion

Through analysis of RXTE TOO data, we have determined that the persistent emission from SGR 1806–20 is consistent with a constant spectral shape and
Fig. 1. The $2 - 60$ keV RXTE/PCA lightcurve of the SGR 1806–20 TOO observation. The vertical dotted lines denote the spectral accumulation intervals A and B. The background has not been subtracted, and the time resolution is 0.5 s.

Intensity both during and away from the active bursting periods. The spectrum is best-fit by a nonthermal power law shape, with thermal bremsstrahlung and Raymond-Smith functional forms producing much worse fits to the RXTE data. The mean power law spectral index obtained by RXTE is $2.30 \pm 0.02$, which is consistent with the ASCA value of $\alpha = 2.2 \pm 0.2$ (Sonobe et al. 1994).

The nonthermal nature of the SGR 1806–20 quiescent spectrum supports the idea that the X-ray emission is due to a compact synchrotron nebula, or plerion, that derives its power from either a rapidly spinning-down pulsar (Kulkarni et al. 1994) or energetic particles ejected in the SGR bursts (Tavani 1994). The lack of an iron line in the SGR spectrum (Sonobe 1994) and short term time variability argue against the source being a low luminosity X-ray binary system (White, Nagase, & Parmar 1995), although a more extensive monitoring campaign is necessary to rule out this hypothesis.
Table 1. RXTE SGR 1806–20 quiescent spectral fit results

| Parameter            | A          | B          | C          |
|----------------------|------------|------------|------------|
| Flux$^1$             | 7.75 ± 0.16| 7.83 ± 0.18| 8.05 ± 0.16|
| Photon Index         | 2.29 ± 0.03| 2.27 ± 0.03| 2.33 ± 0.03|
| $N_H^2$              | 2.9 ± 0.3  | 3.2 ± 0.3  | 3.1 ± 0.3  |
| $\chi_\nu^2$        | 0.63       | 0.61       | 0.65       |
| $\nu$                | 44         | 44         | 44         |
| Livetime$^3$         | 3300       | 2600       | 3600       |

$^1$2 – 10 keV power law flux (10$^{-11}$ ergs cm$^{-2}$ s$^{-1}$)
$^2$ Neutral hydrogen absorption (10$^{22}$ H Atoms cm$^{-2}$)
$^3$ Instrumental livetime for spectral fit (seconds)

Acknowledgements. We thank NASA for support under grants NAS5-30720 (D.M. and R.E.R.), NAG5-2560 (S.D. and C.K.), and NAG5-4878 (JvP)

References

Jahoda, K. et al. 1996, EUV, X–ray, and Gamma–Ray Instrumentation for Astronomy VII, SPIE Proceedings, eds: O. H. V. Sigmund and M. Gumm, 2808, 59
Kouveliotou, C. et al 1996, IAUC, 6501
Kulkarni, S. R. et al. 1994, Nature, 368, 129
Kulkarni, S. R. et al. 1995, ApJ, 440, L61
Morrison, R. and McCammon, D. 1983, ApJ, 270, 119
Norris, J. P. et al. 1991, ApJ, 366, 240
Rothschild, R. E. et al. 1998, ApJ, 496, in press
Sonobe, T. et al. 1994, ApJ, 436, L23
Tavani, M. 1994, ApJ, 431, L83
Thompson, C. & Duncan, R. C. 1995, MNRAS, 275, 255
van Kerkwijk, M. H. et al. 1995, ApJ, 444, L33
White, N. E., Nagase, F., and Parmar, A. N. 1995 in X–ray Binaries, eds. W. H. G. Lewin, J. van Paradijs, and E. P. J. van den Heuvel (Cambridge University Press: Cambridge), 1
Yamauchi, S. and Koyama, K. 1993, ApJ, 404, 620
