STRONG BURSTS FROM THE ANOMALOUS X-RAY PULSAR 1E 1547.0−5408 OBSERVED WITH THE INTEGRAL/SPI ANTI-COINCIDENCE SHIELD

S. Mereghetti1, D. Götz2, G. Weidenspointner3,4, A. von Kienlin5, P. Esposito1,5, A. Tiengo1, G. Vianello1, G. L. Israel6, L. Stella6, R. Turolla7,8, N. Rea9, and S. Zane8

1 INAF-Istituto di Astrofisica Spaziale e Fisica Cosmica Milano, via E. Bassini 15, I-20133 Milano, Italy; sandro@iasf-milano.inaf.it
2 CEA Saclay, DSM/IRFU/Service d’Astrophysique, Orme des Merisiers, Bât. 709, F-91191 Gif-sur-Yvette, France
3 Max-Planck-Institut für extraterrestrische Physik, Giessenbachstrasse, Postfach 1312, D-85741 Garching, Germany
4 MPI Halbleiterlabor, Otto-Hahn-Ring 6, 81739 Muenchen, Germany
5 INFN-Istituto Nazionale di Fisica Nucleare, Sezione di Pavia, via A. Bassi 6, 27100 Pavia, Italy
6 INAF-Osservatorio Astronomico di Roma, via Frascati 33, I-00040 Monteporzio Catone, Italy
7 Università di Padova, Dipartimento di Fisica, via Marzolo 8, I-35131 Padova, Italy
8 Mullard Space Science Laboratory, University College London, Holmbury St. Mary, Dorking Surrey, RH5 6NT, UK
9 Astronomical Institute “Anton Pannekoek,” University of Amsterdam, Kruislaan 403, 1098SJ, Amsterdam, The Netherlands

Received 2009 March 2; accepted 2009 March 10; published 2009 April 16

ABSTRACT

In 2009 January, multiple short bursts of soft gamma rays were detected from the direction of the anomalous X-ray pulsar 1E 1547.0−5408 by different satellites. Here we report on the observations obtained with the Anti Coincidence Shield (ACS) of the SPI instrument on INTEGRAL during the period with the strongest bursting activity. More than 200 bursts were detected at energies above 80 keV in a few hours on January 22. Among these, two remarkably bright events showed pulsating tails lasting several seconds and modulated at the 2.1 s spin period of 1E 1547.0−5408. The energy released in the brightest of these bursts was of a few $10^{43}$ erg, for an assumed distance of 10 kpc. This is smaller than that of the three giant flares seen from soft gamma-ray repeaters (SGRs), but higher than that of typical bursts from SGRs and anomalous X-ray pulsars.

Key words: gamma rays: bursts – gamma rays: observations – pulsars: individual (1E 1547.0−5408) – stars: neutron

1. INTRODUCTION

The soft gamma-ray repeaters (SGRs) are a small group of high-energy sources that emit short (less than 1 s) bursts of soft gamma-rays with peak luminosities up to $10^{41}$ erg s$^{-1}$ during sporadic periods of activity. Much more rarely they emit giant flares, releasing up to $10^{46}$ erg. SGRs are thought to be magnetars, i.e., isolated neutron stars whose persistent and bursting emission is powered by extremely high magnetic fields, $B > 10^{14}$–$10^{15}$ G (Thompson & Duncan 1995, 1996). In recent years bursts similar to those of SGRs have also been detected from members of another class of sources, the anomalous X-ray pulsars (AXPs; Gavriil et al. 2002; Kaspi et al. 2003; Israel et al. 2008). Evidence is accumulating that there might not be any physical reason to distinguish among these two groups of neutron stars, with their different classification reflecting only the way they were originally discovered. A recent review of AXPs and SGRs is given in Mereghetti (2008).

The source discussed here, 1E 1547.0−5408, was discovered almost 30 years ago (Lamb & Markert 1981), but it attracted little attention until it was proposed as a possible AXP on the basis of new X-ray and optical studies (Gelfand & Gaensler 2007). The source is transient, and it is located in the supernova remnant G 327.24−0.13. The discovery of radio pulsations with period $P = 2.1$ s and period derivative $P' = 2.3 \times 10^{-11}$ s$^{-1}$ confirmed the AXP classification (Camilo et al. 2007).

In early 2008 October 1E 1547.0−5408 showed enhanced X-ray activity, with the emission of several short bursts in a few days, accompanied by an increase in its persistent X-ray flux (G. L. Israel et al. 2009, in preparation). No further bursts were reported after that until the source started a new period of strong activity on 2009 January 22, as testified by the numerous bursts detected with Swift (Gronwall et al. 2009), Fermi/GBM

(CONNAUGHTON & BRIGGS 2009; von Kienlin & Connaughton 2009), INTEGRAL (Savchenko et al. 2009; Mereghetti et al. 2009), Suzaku (Terada et al. 2009), Konus-Wind (Golenetskii et al. 2009a) and RHESSI (Bellm et al. 2009). Here we report on observations obtained with the SPI–ACS (Anti-Coincidence Shield) instrument on board the INTEGRAL satellite that provided uninterrupted monitoring of the most active bursting period, thanks to its highly elliptical orbit.

2. RESULTS

The Anti-Coincidence Shield (ACS) of the SPI instrument (Vedrenne et al. 2003), besides serving to veto the background in the germanium spectrometer, is routinely used as a nearly omnidirectional detector for gamma-ray bursts (von Kienlin et al. 2003). It consists of 91 bismuth germanate scintillator crystals of thickness between 16 and 50 mm that provide a large effective area at $E > 80$ keV for most directions. The data used here consist of the overall light curve resulting from the OR-ed veto signals of all the ACS crystals. The time bin is 50 ms, and no energy and directional information is available.

During the burst observations of 2009 January 22, the INTEGRAL pointing direction varied by less than $\sim 10^\circ$. The change in the ACS effective area resulting from the varying instrumental direction is negligible. We therefore used for the whole analysis the instrumental response computed for the zenith and azimuth of 1E 1547.0−5408 at the time of the event with the largest fluence (burst no. 149, see below). These are $\theta = 61^\circ$ (from the SPI pointing axis) and $\phi = 322^\circ$ ($\phi = 0^\circ$ corresponds to the satellite Sun-pointing side, i.e., the direction from SPI toward the IBIS instrument). The ACS effective area as a function of energy was computed with Monte Carlo simulations based on a detailed mass modeling of the
SPI spectrometer and surrounding material, including the satellite structure and other instruments (Sturman et al. 2003). These simulations were carried out using MGPOD (Weidenspointner et al. 2005), a suite of Monte Carlo tools developed for modeling high-energy astronomy instruments. In a similar way we computed the ACS effective area for the satellite orientation corresponding to the bright burst of January 25, which was observed close to the on-axis direction ($\theta = 5^\circ$).

The light curve covering the most active period is shown in Figure 1. During the observation of the bursts, the background count rate in the ACS was stable, within 1%, at $1.23 \times 10^5$ counts $s^{-1}$. Adopting a flux threshold at $5\sigma$ above the background, 233 bursts were detected from 18:11 UT of January 21 to 4:27 UT of January 23. Their peak fluxes, over a time integration interval of 50 ms, cover the range from $\sim 10^4$ to more than $10^6$ counts $s^{-1}$, while the fluences span the range from $\sim 500$ to $\sim 2 \times 10^8$ counts. We derived the distributions of peak fluxes and fluences and fitted them using the maximum-likelihood method (Crawford et al. 1970). Assuming a power-law distribution with index $\alpha$ for the integral distributions ($N (> S) \propto S^{-\alpha}$), we obtained $\alpha = 1.03 \pm 0.08$ for the peak flux distribution, and $\alpha = 0.75 \pm 0.06$ for the fluence distribution.

The time distribution of the bursts is strongly nonuniform. Most of them are clustered in two time intervals, from 4:34 to 5:28 UT and from 6:43 to 6:51 UT on January 22. The total fluence of all the bursts detected in these two time intervals is of $\sim 1.5 \times 10^6$ and $\sim 2.8 \times 10^6$ ACS counts, respectively. We computed the phases of the onset time of each burst with respect to the neutron-star rotation, based on a phase-connected timing solution we derived from Swift/XRT data. We found that the burst onset times are not correlated with the neutron-star rotation phase.

The light curves of a few bursts, including that of the brightest one (burst no. 121, at 06:45:14 UT), are shown in Figure 2. The properties of the brightest events are given in Table 1. Two bursts had durations longer than the spin period of 1E 1547.0–5408 and clearly showed a modulation at 2.1 s (see Figure 3). They occurred at 6:48:04 UT (burst no. 149) and 8:17:29 UT (burst no. 176). The first burst was brighter, it started with a very bright

---

**Table 1**

| ID | Start UT Duration | Peak flux$^a$ | Fluence$^a$ | Notes |
|----|-------------------|--------------|-------------|-------|
| 28 | 2 46 57.0 1.70    | 1.83 \pm 0.04 | 1.10 \pm 0.011 |       |
| 33 | 3 13 33.2 0.35    | 3.16 \pm 0.05 | 0.643 \pm 0.006 |       |
| 35 | 3 50 38.1 1.30    | 2.22 \pm 0.04 | 0.787 \pm 0.010 |       |
| 47 | 4 39 04.9 0.95    | 5.30 \pm 0.05 | 1.099 \pm 0.009 |       |
| 71 | 4 57 29.8 0.65    | 1.08 \pm 0.04 | 0.381 \pm 0.007 |       |
| 74 | 4 58 03.0 0.20    | 1.82 \pm 0.04 | 0.234 \pm 0.004 |       |
| 80 | 5 17 44.1 0.15    | 5.23 \pm 0.05 | 0.483 \pm 0.004 |       |
| 82 | 5 17 48.2 0.55    | 1.63 \pm 0.04 | 0.521 \pm 0.007 |       |
| 85 | 5 17 51.7 0.45    | 12.57 \pm 0.07 | 1.914 \pm 0.008 |       |
| 89 | 5 18 01.7 0.20    | 3.35 \pm 0.05 | 0.339 \pm 0.004 |       |
| 92 | 5 18 32.9 0.10    | 2.97 \pm 0.05 | 0.221 \pm 0.003 |       |
| 93 | 5 18 39.5 1.00    | 3.17 \pm 0.05 | 1.442 \pm 0.009 |       |
| 95 | 5 26 27.9 0.25    | 2.34 \pm 0.04 | 0.359 \pm 0.005 |       |
| 106 | 6 38 27.9 0.25   | 1.96 \pm 0.04 | 0.265 \pm 0.004 |       |
| 108 | 6 41 02.1 1.00   | 3.95 \pm 0.05 | 2.354 \pm 0.010 |       |
| 117 | 6 44 36.4 1.75   | 2.71 \pm 0.05 | 1.928 \pm 0.012 |       |
| 119 | 6 45 00.2 0.20   | 2.20 \pm 0.04 | 0.213 \pm 0.004 |       |
| 120 | 6 45 12.3 0.20   | 1.72 \pm 0.04 | 0.184 \pm 0.004 |       |
| 121 | 6 45 13.9 1.45   | > 26.27 \pm 0.09 | > 4.587 \pm 0.013 | Brightest |
| 130 | 6 46 14.8 0.15   | 1.51 \pm 0.04 | 0.106 \pm 0.003 |       |
| 141 | 6 47 57.1 0.35   | 13.10 \pm 0.07 | 1.819 \pm 0.007 |       |
| 147 | 6 48 02.9 0.15   | 2.78 \pm 0.05 | 0.169 \pm 0.003 |       |
| 149 | 6 48 04.3 8.15   | > 22.31 \pm 0.09 | > 27.759 \pm 0.031 | Total |
| 149-s 6 48 04.3 0.30 | > 22.31 \pm 0.09 | > 2308 \pm 0.008 | Initial spike |
| 149-t 6 48 04.6 7.85 | 10.34 \pm 0.06 | 25.451 \pm 0.030 | Pulsed tail |
| 150 | 6 48 15.1 0.85   | 1.13 \pm 0.04 | 0.584 \pm 0.008 |       |
| 156 | 6 49 49.0 0.25   | 8.54 \pm 0.06 | 0.826 \pm 0.005 |       |
| 164 | 7 56 56.8 0.35   | 1.80 \pm 0.04 | 0.463 \pm 0.005 |       |
| 176 | 8 31 15.3 0.35   | 1.63 \pm 0.04 | 0.311 \pm 0.005 |       |
| 176 | 8 37 29.4 6.20   | 2.75 \pm 0.05 | 6.588 \pm 0.022 | Pulsed |
| 285 | 43 44 42.6 0.45 | 21.68 \pm 0.17 | 3.328 \pm 0.020 |       |

Notes. $^a$ In the range 25 keV–2 MeV, assuming a thermal bremsstrahlung spectrum with $kT = 40$ keV.

---

**Notes.** Due to the burst brightness, which saturated the ISGRI telemetry, it was not possible to obtain also a measure of the peak flux and fluence.

---

10 While dead time and saturation effects in the ACS crystals and electronics are negligible (less than 1%) below a few $10^5$ counts s$^{-1}$, the results for fluxes above this level should be considered as lower limits.

11 Due to the burst brightness, which saturated the ISGRI telemetry, it was not possible to obtain also a measure of the peak flux and fluence.
Figure 2. SPI–ACS light curves of a few bursts observed on 2009 January 22. See Table 1 for their properties.

Figure 3. SPI–ACS light curves of the two longest bursts seen from 1E 1547.0−5408 on 2009 January 22. Note that the initial spike of the 6:48:04 UT burst was probably brighter than shown in the figure, due to the non-negligible instrumental dead time at high count rates.

The initial spike of burst no. 149 reached a peak count rate of $1.5 \times 10^8$ counts s$^{-1}$ ($\Delta T = 50$ ms) and was surpassed in intensity only by burst no. 121 that occurred about three minutes earlier. In both cases, only lower limits to the flux can be derived, due to the nonlinearity of the ACS response at such high count rates. The latter are reported in Table 1, again for an assumed $kT = 40$ keV thermal bremsstrahlung spectrum. However, it is likely that these bursts had significantly harder spectra. In fact, the initial spikes observed in giant flares from other three SGRs had spectra significantly harder than those of the pulsating tails. Evidence for harder spectra was also reported in other bright bursts from 1E 1547.0−5408 observed with Konus/Wind on January 25 and 29 (Golenetskii et al. 2009b, 2009c). For example, an exponentially cut off power law with photon index $\Gamma = -1$ and $E_{\text{cut}} = 400$ keV, results in 25 keV–2 MeV fluxes and fluences about 30% smaller than those reported in Table 1. Extrapolating this spectrum, gives lower limits to the peak luminosity of $6 \times 10^{42}$ $d_{10\,\text{kpc}}$ erg s$^{-1}$ ($E > 1$ keV) for bursts no. 121 and no. 149, respectively.

3. DISCUSSION

The strong activity shown by 1E 1547.0−5408 on 2009 January 22, with the emission of hundreds of bursts in a time span of a few hours, resembles similar episodes observed in the past from other SGRs and AXPs (see, e.g., Kaspi et al. 2003; Israel et al. 2008; Götz et al. 2006). The peak of the bursting rate occurred around 6:48 UT, when more than 50 bursts were recorded in 10 minutes. The high fluence emitted in this short time interval is most likely responsible for the expanding dust scattering halos discovered in Swift/XRT X-ray images obtained about one day later (Tiengo et al. 2009). We can exclude the presence of other periods of comparably high bursting rate in the few preceding days, except for the time interval from 4:30 to 14:30 UT of January 20, when INTEGRAL was at perigee.

On January 22 1E 1547.0−5408 also emitted a few bursts remarkable for their luminosity and duration, including one (no. 149) showing a bright and short spike followed by a
pulsating tail. The burst was preceded by a short precursor, but, considering the high rate of bursts, it is not clear whether this was physically related to the bright burst. These features of the light curve are typical of giant flares from SGRs (Mazets et al. 1979; Hurley et al. 1999; Palmer et al. 2005; Mereghetti et al. 2005; Hurley et al. 2005). Therefore, despite the uncertainties due to the poorly constrained distances and possible spectral differences, it is interesting to compare the energetics of the 1E 1547.0–5408 burst no. 149 with that of the three historical giant flares from SGRs. Some properties of such events are summarized in Table 2, where also a few other peculiar bursts and flares from SGRs and AXPs are listed for comparison.

It is evident that the energy released in the pulsating tails of the giant flares of SGR 0526–66, SGR 1900+14, and SGR 1806–20 was much higher than the value of a few $10^{43}$ erg we derived for 1E 1547.0–5408 (unless its distance is much larger than 10 kpc). However, the difference is mainly due to the shorter duration of the 1E 1547.0–5408 pulsed tail. In fact the tails following the three historical giant flares lasted a few minutes, but their average luminosity ($\sim 3 \times 10^{43}$–$10^{45}$ erg s$^{-1}$) was not too different from that observed in the pulsating tail of 1E 1547.0–5408 ($\sim 3 \times 10^{42} d_{10 \text{kpc}}^2$ erg s$^{-1}$).

Comparison of the initial spikes’ energetics is more difficult, since the effects of saturation and spectral uncertainties could be larger. However, also in this case, it is clear that the initial spike of burst no. 149 involved a significantly smaller energy than those of the giant flares. From the point of view of the total energy, this event was more similar to the intermediate flares or to some of the brightest bursts observed in other SGRs, such as the 1998 October 28 and the 2001 July 2 events from SGR 1900+14, but owing to its shorter duration it reached a higher peak luminosity. Another notable difference with respect to the three giant flares is that the latter had very short rise times (Mazets et al. 1999b; Schwartz et al. 2005), while the initial spike of burst no. 149 showed a slow rise to the peak, that could be resolved in four ACS time bins (50 ms each).

We note that the characteristic timescales over which bursts develop can give information on the location of the energy source and on the mechanisms responsible for their triggering (Thompson & Duncan 1995; Lyutikov 2006). Instabilities in the magnetosphere, where the Alfvén velocity is close to the speed of light, can develop on short timescales. Longer timescales are expected for the release of energy stored in the neutron-star crust.

### Table 2

| Source Date | Date | Fluence (erg cm$^{-2}$) | Notes$^a$ | Duration (s) | Energy$^b$ (erg) | Spectrum$^c$ (keV) | Ref.$^d$ |
|-------------|------|-------------------------|----------|-------------|-----------------|--------------------|--------|
| 2009 Jan 22 | 121-B | $> 4.6 \times 10^{-5}$ (>25 keV) | 1.45 | $> 4 \times 10^{42}$ | $kT \sim 40^f$ | M99 |
| 2009 Jan 22 | 149-IHS | $> 1.8 \times 10^{-5}$ (>25 keV) | 0.3 | $> 5 \times 10^{41}$ | $kT \sim 400^f$ | M99 |
| 2009 Jan 22 | 149-PT | $2.5 \times 10^{-5}$ (>25 keV) | ~8 | $2 \times 10^{43}$ | $kT \sim 40^f$ | M99 |
| 2009 Jan 22 | 176-PT | $6.6 \times 10^{-5}$ (>25 keV) | 6.2 | $6 \times 10^{42}$ | $kT \sim 40^f$ | M99 |

### Notes.

$^a$ IHS = Initial Hard Spike, PT = Pulsed Tail, B = burst.

$^b$ In the range $E > 3$ keV, assuming the indicated distances, and isotropic emission (when needed, the spectrum has been extrapolated to lower energy).

$^c$ Temperature of bremsstrahlung ($kT$) or blackbody ($kT_{BB}$) spectra.

$^d$ References: A01: Aptekar et al. (2001); G04: Guidorzi et al. (2004); H05: Hurley et al. (2005); I01: Ibrahim et al. (2001); L03: Leners et al. (2003); M99: Mazets et al. (1999b); M99B: Mazets et al. (1999a); O04: Olive et al. (2004); W05: Woods et al. (2005).

$^e$ Assumed value.

$^f$ Strong hard to soft spectral evolution.

$^g$ Fit with two blackbodies.
The differences mentioned above suggest that burst no. 149 is not of the same nature of the giant flares. Most likely this event, and the other bright bursts observed from 1E 1547.0−5408, are just “normal” SGR bursts with extreme properties. This is also supported by the fact that their peak fluxes and fluences are in agreement with the distributions of these quantities derived from the other bursts.

The second pulsed burst from 1E 1547.0−5408 (no. 176) did not start with a bright short spike. The lack of such a feature could be related to the lower fluence of this burst (a factor ∼4 smaller than that of burst no. 149) or simply to the initial spike being beamed in a different direction from ours. A similar situation occurred in the flare observed from SGR 1900+14 on 2001 April 18 (Guidorzi et al. 2004). It is not surprising that pulsations are seen in all the bursts with a sufficiently long duration. 1E 1547.0−5408 has the shortest period among SGRs and AXPs, and long bursts are rare. In other objects of this class pulsating tails could only be seen after particularly energetic events. The pulsating tails in 1E 1547.0−5408 could be due to magnetically trapped fireballs, similar to the case of giant flares, even if the mechanism responsible for the initial energy injection is different. Alternatively, they could result from localized regions on the neutron-star crust, possibly heated by the same mechanisms that produced the burst. In the latter case their modulation would not be expected to maintain phase coherence across different bursts. We could not find strong evidence for a phase difference between the pulses of bursts no. 149 and no. 176, based on a backward extrapolation of the preliminary timing solution derived with Swift/XRT (Israel et al., in preparation).

4. CONCLUSIONS

Thanks to the high sensitivity and uninterrupted coverage provided by the SPI–ACS instrument, we could characterize the statistical properties of the bursts emitted by 1E 1547.0−5408 in the few hours when the source displayed the most pronounced activity during its recent reactivation. The source is still active (Golenetskii et al. 2009d; Kouveliotou et al. 2009), but with a much lower bursting rate compared to that seen on 2009 January 22.

We showed that, despite the apparent similarity to giant flares, the bright and pulsed bursts observed from 1E 1547.0−5408 involved a smaller energy and are most likely related to ordinary bursts. The total fluence measured from the 125 bursts emitted from 4:30 to 7:00 UT is 5.2 × 10^{-4} erg cm^{-2} (25 keV–2 MeV). A fraction of the soft X-rays associated with these bursts was forward-scattered along a somewhat longer path by interstellar dust grains, and detected in the form of expanding rings by several X-ray satellites about a day later. Detailed modeling of these data will allow us to constrain the distance of 1E 1547.0−5408 (A. Tiengo et al. 2009, in preparation).

The properties of the bursts from 1E 1547.0−5408 are typical of sources classified as SGRs. Indeed, if this AXP had not been previously known from X-ray and radio observations, it would have been named as a new SGR following the January 22 bursts. This underlines once more that the distinction between these two classes of neutrons stars is not based on physical properties of the sources, which are most likely explained by the same model.

INTEGRAL is an ESA project with instruments and Science Data Centre funded by ESA member states (especially the PI countries: Denmark, France, Germany, Italy, Switzerland, Spain), Czech Republic, and Poland, and with the participation of Russia and the USA. The SPI anticoincidence system is supported by the German government through DLR grant 50.0G.9503.0. The Italian authors acknowledge the partial support from ASI (ASI/INAF contracts I/088/06/0 and AAE TH-058). P.E. thanks the Osio Sotto city council for support with a G. Petrocchi fellowship. D.G. acknowledges the CNES for financial support. N.R. is supported by an NWO Veni Fellowship. S.Z. acknowledges support from STFC.

REFERENCES

Aptekar, R. L., et al. 2001, ApJS, 137, 227
Bellini, E., Smith, D. M., & Hurley, K. 2009, GCN Circ. 8857, http://gcn.gsfc.nasa.gov/gcn3/8857.gcn3
Camilo, F., Ransom, S. M., Halpern, J. P., & Reynolds, J. 2007, ApJ, 666, L93
Connaughton, V., & Briggs, M. 2009, GCN Circ. 8835, http://gcn.gsfc.nasa.gov/gcn3/8835.gcn3
Crawford, D. F., Jauncey, D. L., & Murdoch, H. S. 1970, ApJ, 162, 405
Gavioli, F., Kaspi, V. M., & Woods, P. M. 2002, Nature, 419, 142
Gelfand, J. D., & Gaensler, B. M. 2007, ApJ, 667, 1111
Golenetskii, S., et al. 2009a, GCN Circ. 8851, http://gcn.gsfc.nasa.gov/gcn3/8851.gcn3
Golenetskii, S., et al. 2009b, GCN Circ. 8858, http://gcn.gsfc.nasa.gov/gcn3/8858.gcn3
Golenetskii, S., et al. 2009c, GCN Circ. 8863, http://gcn.gsfc.nasa.gov/gcn3/8863.gcn3
Golenetskii, S., et al. 2009d, GCN Circ. 8913, http://gcn.gsfc.nasa.gov/gcn3/8913.gcn3
Götz, D., et al. 2006, A&A, 445, 313
Gronwall, C., et al. 2009, GCN Circ. 8833, http://gcn.gsfc.nasa.gov/gcn3/8833.gcn3
Guidorzi, C., et al. 2004, A&A, 416, 297
Hurley, K., et al. 1999, Nature, 397, 41
Hurley, K., et al. 2005, Nature, 434, 1098
Ibrahim, A. I., et al. 2001, ApJ, 558, 237
Israel, G. L., et al. 2008, ApJ, 685, 1114
Kaspi, V. M., et al. 2003, ApJ, 588, L93
Kouveliotou, C., et al. 2009, GCN Circ. 8915, http://gcn.gsfc.nasa.gov/gcn3/8915.gcn3
Lamb, R. C., & Markert, T. H. 1981, ApJ, 244, 94
Lebrun, F., et al. 2003, A&A, 411, L141
Lenters, G. T., et al. 2003, ApJ, 587, 761
Lytovtov, M. 2006, MNRA, 367, 1594
Mazets, E. P., Golentskii, S. V., Ilinskii, V. N., Aptekar, R. L., & Guryan, I. A. 1979, Nature, 282, 587
Mazets, E. P., et al. 1999a, ApJ, 519, L151
Mazets, E. P., et al. 1999b, Astron. Lett., 25, 635
Mereghetti, S. 2008, A&AR, 15, 225
Mereghetti, S., et al. 2009, GCN Circ. 8841, http://gcn.gsfc.nasa.gov/gcn3/8841.gcn3
Mereghetti, S., et al. 2005, ApJ, 624, L105
Olive, J.-F., et al. 2004, ApJ, 616, 1148
Palmer, D. M., et al. 2005, Nature, 434, 1107
Savchenko, V., et al. 2009, GCN Circ. 8837, http://gcn.gsfc.nasa.gov/gcn3/8837.gcn3
Schwartz, S. J., et al. 2005, ApJ, 627, L129
Strumberg, S. J., et al. 2003, A&A, 411, L81
Terada, Y., et al. 2009, GCN Circ. 8845, http://gcn.gsfc.nasa.gov/gcn3/8845.gcn3
Thompson, C., & Duncan, R. C. 1995, MNRA, 275, 255
Thompson, C., & Duncan, R. C. 1996, ApJ, 473, 322
Tiengo, A., et al. 2009, GCN Circ. 8848, http://gcn.gsfc.nasa.gov/gcn3/8848.gcn3
Ubertini, P., et al. 2003, A&A, 411, L131
Vedrenne, G., et al. 2003, A&A, 411, L63
von Kienlin, A., et al. 2003, A&A, 411, L299
von Kienlin, A., & Connaughton, V. 2009, GCN Circ. 8838, http://gcn.gsfc.nasa.gov/gcn3/8838.gcn3
Weidenspointner, G., Harris, M. J., Sturmer, S., Teegarden, B. J., & Ferguson, C. 2005, ApJS, 156, 69
Woods, P. M., et al. 2005, ApJ, 629, 985