X-RAY TRANSIENTS MONITORED BY THE ALL-SKY MONITOR ON RXTE: A TABULATION

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ABSTRACT We present a tabulation of 46 transient x-ray sources monitored with the All-Sky Monitor (ASM) on the Rossi X-ray Timing Explorer (RXTE). They fall into four broad categories: short (∼1 d), intermediate, and long (> 500 d) duration of outbursts, and long period binary systems that flare up at periastron (e.g., Be systems). The mixture of outburst/quiescent cycles and low-level persistent emission in a few systems could indicate conditions are near the limit for stable mass flow in the accretion disk. The two short-time-scale systems, CI Cam and V4641 Sgr, are within 1 kpc of the sun, and hence many more such systems may await discovery.

KEYWORDS: X-rays: stars

1. ASM SKY SURVEY

The All-Sky Monitor (ASM; Levine et al. 1996) on RXTE has been monitoring the entire sky for new (uncataloged) transient x-ray sources while also recording the intensities of the known sources. The current catalog contains about 325 source positions of which about 180 have yielded positive detections on some occasion. The monitoring has been reasonably continuous except for times when the sun is relatively close to a source and except for a period of ∼7 weeks shortly after launch when the detectors were turned off due to a temporary breakdown problem. The detected sources include many well known persistent sources as well as a substantial number of transient sources. Some of these are recurrent and others are in their first known outburst. Most of the latter were discovered in the RXTE era, either with other satellites, e.g. CGRO and BSAX, or with RXTE. Some were discovered prior to the launch of RXTE.

Of the 180 positive detections, approximately 150 reached 15 mCrab on at least some occasion and 30 are detected at levels 2 to 15 mCrab in averages over long periods, up to 6 months. For sources with known positions, the detection threshold (3 sigma) away from the galactic center is about 30 mCrab in a single sweep of the ASM cameras across the source. A sweep usually consists of four 90-s integrations or “snapshots” as the cameras step across the source. The one-day threshold (typically 5 – 8 sweeps) can reach down to ∼ 10 mCrab.

The data are routinely searched for new (i.e., not in the ASM catalog) sources with a cross-correlation search of the entire FOV. Confidence in the detection of
a new persistent source arises through multiple detections that yield crossed lines of position. In one day, a 50-mCrab source is solidly established. Fainter sources to about 7 mCrab can be retrieved from cross-correlation maps that integrate one week of data. These thresholds apply to positions reasonably removed from bright sources.

The list of detections include about 50 sources we call “transients”. Another 23 objects are extragalactic (14 Sy1 and QSOs, 4 BL Lacs, and 5 clusters). About 40 objects exhibit periodicities in the ASM data from the spin period of X Per (837 s) to the 164-d precession period of SS 433.

2. TRANSIENT DETECTIONS

We have collected a list of the 46 brighter transients monitored with the ASM (Table 1). We further tabulate comments about the sources in Table 2. The criterion for inclusion on this list is that the source be known to have been below Uhuru/HEAO-1 thresholds (few mCrab) for sustained periods and that the source was found in a bright state of at least 25 mCrab, as measured by the ASM. The fainter objects omitted include, for example, some of those detected in the galactic plane scans with the sensitive PCA instrument on RXTE (Valinia, Kinzer, & Marshall 2000) or from observations with the Wide-Field Camera on BeppoSAX (Jager et al. 1997).

The tabulated sources are divided into several groups that depend on the temporal character of their variability:

1. two sources with very short outbursts (hours to a few days),
2. transients of intermediate durations which have are further divided into
   (a) the thirteen monitored with the ASM in the process of their first known
       outburst (which may have occurred before the launch of RXTE) and
   (b) nineteen that are known to be recurrent,
3. six sources with very long outbursts (> 500 d), and finally
4. six periodic systems that typically flare up when the compact object in an
   elliptical orbit approaches periastron.

The definition of a transient can be rather elusive. For example, the existence of long-duration transients (Table 1C) suggests that there may be no clear boundary between transients and persistent sources. Conversely, the close binary sources X 2129+47 and X 1755–338, long considered to be persistent sources, have disappeared both optically and in X rays (see, e.g., refs in van Paradijs 1995). Neither of these sources have been detected with the ASM to levels of a few mCrab since the Dec. 1995 launch.

3. THE TABULATION

The tabulation describes each transient in terms of the outburst profile shape, the peak flux, the hardness ratio, the first date of outburst, the rise and decay times
and finally the duration. The light curves exhibit much more richness than these few parameters indicate. Sample X-ray light curves for six neutron-star systems are shown in Fig. 1 and for six black hole systems in Fig. 2. Plots on expanded time-scales reveal even more detailed structure than is evident in these figures.

3.1. Description of data in Table 1

**Column 1:** Source name. Sources are listed in RA order within each category. Satellite prefixes are given for objects discovered in the past two decades, but longer-known objects are designated with the prefix “X”.

**Column 2:** Type indicates black hole candidate or neutron star system.

**Column 3:** Outburst profiles are categorized as fast-rise-slow-decay (frsd), symmetric, or irregular.

**Column 4:** The peak count rate is given in mCrab. Note that 1 Crab is 75 ASM cts/s at 1.5–12 keV.

**Column 5:** The hardness ratio HR2 is the ratio of counting rate in the 5–12 keV band to that in the 3–5 keV band.

**Column 6:** The start date (MJD) is the date of the first positive detection at the onset of an outburst, or the onset of the first outburst in Table 1D. “pre-XTE” indicates the source was first detected above threshold when RXTE observations began after launch. MJD conversions are:

- 1996 Jan. 0.0 = MJD 50082.0
- 1997 Jan. 0.0 = MJD 50448.0
- 1998 Jan. 0.0 = MJD 50813.0
- 1999 Jan. 0.0 = MJD 51178.0
- 2000 Jan. 0.0 = MJD 51543.0

**Columns 7, 8, 9:** The rise and decay times and the durations are approximately the total time for the full rise, the exponential time constant for the decay, and the total duration above threshold, respectively. Some outbursts are still in progress (IP) at this date (2000 Feb. 28).

3.2. Description of Table 2

The notes give descriptive features of the light curves and hardness ratios that complement the tabulated values and also reference recent cogent results. They are not meant to be complete; refereed publications are favored as are later works as they ease entry into the literature. Results from before the RXTE era may be found in the reviews by van Paradijs (1995) and Bradt & McClintock (1983). References to earlier catalogs may also be found in these works. The references to the table are coded based on the author and source names.

4. HIGHLIGHTS OF THE TABULATION

The nature of a given source is well correlated with the ASM hardness ratio, HR2 as follows: neutron-star low-mass binaries have HR2 = 1.0–1.5, pulsars (neutron-
star high-mass binaries) have HR2 = 2–4, and black-hole candidates exhibit large temporal variations of HR2 from extremely soft to higher values (0.3–1.5).

The outburst profiles exhibit several types of wave forms as indicated in the table. Similarities exist from source to source and from outburst to outburst in one source. However, there are substantial differences also. In general, the profiles should shed light on the disk accretion instabilities that give rise to the episodes of high accretion luminosity.

One notable effect is the presence of long (∼1 year) marginally-on states after a major outburst, e.g. in 1630–47 and 1608–522, and “failed” outbursts in Aql X–1. These states may indicate that the conditions for outburst are marginal. In fact, Aql X–1 lies on the on the thermal-viscous disk-instability boundary (van Paradijs 1996).

The range of detected outburst durations is extremely wide as noted above. The listed intermediate outbursts range from about ∼10 to ∼200 days. The two fast x-ray novae (CI Cam and V4641 Sgr) were only recently discovered. These two objects are both quite close to the sun, at distances inferred from 21 cm absorption profiles of 1.0 and 0.5 kpc respectively. It is thus possible that infrequent such outbursts from other sources could have been missed because of the intermittency of coverage or limited solid angles of past and present x-ray monitoring missions. The long-duration transients are by definition “quasi-persistent”. These too may help reveal the factors that lead to instability.

5. FUTURE WORK

The ASM instrument continues to operate with most of its initial capability, so another 1–3 years or more of useful data are expected. The archival ASM data have recently been reprocessed with improved a posteriori calibrations, increased temporal coverage, and improved analysis algorithms. With these we may retrieve additional transients. The final data base should be useful for the determination of rates of transients, the nature of accretion processes, and possibly may reveal new distinctions between neutron stars and black holes.

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Table 1. RXTE ASM: Transients above 25 mCrab

| Source Name   | Type  | Profile | Peak mCrab | ASM HR2 | Start Date | Rise Days | Decay Days | Duration Days |
|---------------|-------|---------|------------|---------|------------|-----------|------------|---------------|
| A. Fast X-ray Novae: Decay $\tau < 1$ day |
| XTE J0421+560 | bhc?  | frsd   | 1885       | 0.8–2.2 | 50903      | 0.3       | 0.5        | 7.7           |
| SAX J1819.3-2525 | bhc  | irr     | 12200      | 0.8–2.1 | 51436      | 0.2       | 0.01       | 0.6           |
| B. Intermediate-Duration X-ray Transients (Nonperiodic) |
| Recent Initial Outbursts |
| XTE J0111-733 | ns    | irr?    | 50         | 3.2     | 51119      | –         | –          | 53            |
| XTE J1550-564 | bhc   | frsd    | 6800       | 0.3–1.6 | 51062      | 4.2       | 11         | 246           |
| XTE J1723-376 | ns    | irr?    | 100        | 1.5     | 51108      | –         | –          | 182           |
| GRS 1737–310  | bhc?  | frsd?   | 26         | 1.8     | 50497      | –         | –          | 46            |
| GRS 1739–278  | bhc   | frsd    | 805        | 0.6     | pre XTE    | 12        | 9          | >400          |
| XTE J1739–285 | ??    | frsd?   | 193        | 1.4     | 51471      | 6         | 22         | ~50           |
| XTE J1748–288 | bhc   | frsd    | 485        | 1.4     | 50966      | 1.4       | 15         | 63            |
| SAX J1750.8-2900 | ns  | frsd    | 117        | 1.3     | 50515      | <1        | 9          | 28            |
| XTE J1755–324 | bhc   | frsd    | 188        | 0.3     | 50653      | 3         | 30         | 104           |
| XTE J1855+034 | ns    | sym     | 26         | 3.2     | 50842      | –         | –          | 28            |
| XTE J1859+226 | bhc   | frsd    | 1045       | 0.4–1.4 | 51460      | 10        | 29         | IP            |
| XTE J2012+381 | bhc   | frsd    | 209        | 0.3     | 50956      | 3.5       | 32         | 182           |
| XTE J2123–058 | ns    | frsd    | 84         | 1.2     | 50987      | <1        | 31         | 52            |
| Known Recurrent Transients |
| EXO 0748–676  | ns    | frsd    | >50        | 0.9     | pre XTE    | –         | 40         | –             |
| X 1246–588   | ns?   | sym?    | 35         | 1.0     | 51271      | –         | –          | IP            |
| X 1354–644   | bhc   | sym     | 52         | 1.3     | 50744      | 70        | 40         | >85           |
| X 1608–522   | ns    | frsd    | ??         | 1.1     | pre XTE    | –         | 15         | –             |
| X 1630–472   | bhc   | irr     | 336        | 1.1     | 50153      | 17        | 16         | 150           |
| X 1658–298   | bhc   | irr     | 3138       | 0.6     | 50198      | 15        | 140        | 484           |
| GRO J1655–40 | bh    | irr     | 3138       | 0.6     | 50198      | 15        | 140        | 484           |

Continued Next Page.
Table 1. (continued) RXTE ASM: Transients above 25 mCrab

| Source Name | type | profile | peak mCrab | ASM HR2 | start date | Rise days | Decay days | Duration days |
|-------------|------|---------|------------|---------|------------|-----------|------------|---------------|
| X 1704+241  | ns?  | sym     | 33         | 1.3     | 50707      | 110       | 35         | 160           |
| RX J1709.5–266 | ns | frsd    | 210        | 0.9     | 50448      | <50       | 50         | 86            |
| X 1711–339  | ns?  | sym     | 50         | 1.2     | 51016      | 10        | 20         | 280           |
| X 1730–333  | ns   | frsd    | 377        | 1.5     |            |           |            |               |
| GRO J1744–28 | ns | frsd    | 1291       | 2.5     | pre XTE    | –         | 65         | >120          |
| X 1803-245  | ns?  | frsd    | 740        | 1.2     | 50904      | 20        | 25         | 75            |
| SAX J1808.4–3658 | ns | frsd    | 108        | 0.9     | 50333      | 8         | 8          | 19            |
| GS 1843+009 | ns   | frsd    | 79         | 1.1     | 50911      | 4         | 12         | 21            |
| XTE J1856+053 | bhc | sym     | 75         | 0.4     | 50189      | 20        | 10         | 27            |
| X 1908+005  | ns   | sym     | 515        | 1.0     |            |           |            |               |
| KS 1731–260 | ns | frsd    | 356        | 1.1     | pre XTE    | –         | –          | >1500         |
| X J1946+274 | mult |         | 80         | 2.6     | 51055      | –         | –          | 85            |
| EXO 2030+375 | ns | mult    | 25         | 1.6     |            | –         | –          | 20            |

D. Periodic, Hard Transients

| Source Name | type | profile | peak mCrab | ASM HR2 | start date | Rise days | Decay days | Duration days |
|-------------|------|---------|------------|---------|------------|-----------|------------|---------------|
| X 0115+634  | ns   | sym     | 400        | 3.2     |            | –         | –          | 23            |
| RX J0812.4–3114 | ns | sym    | 25         | 2.0     | 50926      | –         | –          | 20            |
| X 1145–619  | ns   | sym     | 93         | 1.9     | 50166      | –         | –          | 30            |
| X 1845–024  | ns   | sym     | 25         | 2.5     | 50345      | –         | –          | 30            |
| X J1946+274 | mult |         | 80         | 2.6     | 51055      | –         | –          | 85            |
| EXO 2030+375 | ns | mult    | 25         | 1.6     |            | –         | –          | 20            |
Table 2. Notes and References for ASM Transients

A. Fast X-ray Novae: Decay $\tau < 1$ day

| Object         | Notes/References |
|----------------|------------------|
| XTE J0421+560  | (CI Cam, radio jets) |
| X-ray outburst (Smi99) | Radio jets (Hje99) |
| Rapid rise (few hours) and decay time scale 0.5 d to 2.3 d (Bel99) | Optical outburst: (Wag99, Bar98) |
| X-ray properties, unusual spectrum (Ued98, Frc98, Orr98, Rev99) | IR spectrum, dense circumstellar wind (Cla99) |
| Distance 1.0 kpc (Orl00) | |

| Object         | Notes/References |
|----------------|------------------|
| SAX J1819.3–2525 | (V4641 Sgr, radio jets) |
| Discovery: Feb 99, (Int99), Sept. 99 | Radio jets (Hje99) |
| (Smi99) | Distance 0.5 kpc (Hje99) |
| Five brief X-ray outbursts in 6 days in Sept. 99 (Smi99, Wij99, McC99) | Opt counterpart (Gar99, Gre99) |
| Rapid 1-s variability (Wij99) | Optical outburst (Stu99, Gar99) |

B. Intermediate-Duration Transients (Nonperiodic)

Recent Initial Outbursts

| Object         | Notes/References |
|----------------|------------------|
| XTE J0111–733  | (31-s pulsar in SMC) |
| Pulsations (Cha98) | Optical counterpart (Int99) |
| Hard X-ray profile and spin-up (Wil98) | |

| Object         | Notes/References |
|----------------|------------------|
| XTE J1550–564  | (bright bhc transient) |
| Acquired early in its rise (Smi98) | Optical counterpart K star at 2.5 kpc (Jai99, San99) |
| Reached 6.8 Crab brightness in brief flare (Rut98) | Hard lags in X-ray QPO and broad band var. (Cui99) |
| Detected to 200 keV with BATSE (Wil98) | |
| Evolution of spectra (Sob99) | Likely radio counterpart (Cam98) |
| QPO 0.05 — 285 Hz (Cui99, Rem99, Hom99) | |

| Object         | Notes/References |
|----------------|------------------|
| XTE J1723–376  | |
| X-ray outburst w. 816 Hz osc. (Mar99a) | X-ray position and Type I bursts (Mar99b) |

| Object         | Notes/References |
|----------------|------------------|
| GRS 1737–310   | |
| Weak X-ray outburst: (Tru99, Mar97) | BSAX intensity and position (Hei97) |
| Similarity to Cyg X–1 spectrum (Cui97) | Spectrum and distance of 8500 pc (Ued97) |

| Object         | Notes/References |
|----------------|------------------|
| GRS 1739–278   | (radio emitter) |
| Multiple X-ray sub-peaks (Asm00) | Candidate optical/IR object at radio position (Mar97) |
| X-ray outburst; black-hole candidate (Var97) | X-ray spectra variations (Bor98) |
| Radio emission (Hje96) | 5-Hz QPO (Bor98) |

| Object         | Notes/References |
|----------------|------------------|
| XTE J1739–285  | |
| X-ray outburst (Mar99) | |

| Object         | Notes/References |
|----------------|------------------|
| XTE J1748–288  | (radio jets, shock in ISM) |
| Single outburst w. 2-d rise (Smi98) | Spectral and QPO evolution (Rev99) |
| Detected to 100 keV (Har98) | Transient radio with jet that shocked in ISM (Hje98, Fan98) |
| QPO at 0.5 and 32 Hz (Fox98) | |

| Object         | Notes/References |
|----------------|------------------|
| SAX J1750.8–29 | Bursting transient (Nat99) |
Table 2. (continued) Notes and References for ASM Transients

| XTE J1755–324 (extremely soft spectrum) | XTE J1858+034 (221-s pulsar) | XTE J1859+226 (radio source) |
|----------------------------------------|-----------------------------|-------------------------------|
| Steep soft spectrum with hard component, Temporal/spectral evol. similar to Nova | X-ray outburst, hard spectrum Oscillations from 0.5 Hz to 5.5 Hz | X-ray outburst, hard spectrum (Rem98) Optical counterpart R = 15.1 (Gar99) |
| (Rem97) | (Tak98) | (Mar99, Dal99) |
| Hard X-ray flux (Gol99) | QPO at 0.11 Hz (Pau98) | Celestial position (Mar98) |
| XTE J1859+226 (radio source) | X-ray outburst (Rem98) | X-ray outburst (Rem98) |
| Temporal/spectral evol. similar to Nova | X-ray outburst (Rem98) | Hard initial spike and later becomes very soft, bhc (Asm00) |
| (Rem97) | (Tak98) | (Whi98) |
| QPO at 0.11 Hz (Pau98) | Optical counterpart (tentative) V = 21.3 (Hyn99) | Optical counterpart (tentative) V = 21.3 (Hyn99) |
| X-ray outburst (Rem98) | XTE J2012+381 (radio source) | Optical outbursts (Gne99) |
| X-ray outburst (Rem98) | X-ray outburst (Rem98) | Optical outbursts (Gne99) |
| Temporal/spectral evol. similar to Nova | X-ray outburst (Rem98) | Optical outbursts (Gne99) |
| (Rem97) | (Tak98) | (Whi98) |
| QPO at 0.11 Hz (Pau98) | Optical counterpart (tentative) V = 21.3 (Hyn99) | Optical counterpart (tentative) V = 21.3 (Hyn99) |
| XTE J2123–058 (high-lat. LMXB) | XTE J2123–058 (high-lat. LMXB) | XTE J2123–058 (high-lat. LMXB) |
| High galactic latitude –36.2 (Lev98) | High galactic latitude –36.2 (Lev98) | High galactic latitude –36.2 (Lev98) |
| Atoll LMXB, bursts, twin kHz (Hom99, Tom99) | Atoll LMXB, bursts, twin kHz (Hom99, Tom99) | Atoll LMXB, bursts, twin kHz (Hom99, Tom99) |
| Optical counterpart w. 6-h orbit (Tom99, Sor99) | Optical counterpart w. 6-h orbit (Tom99, Sor99) | Optical counterpart w. 6-h orbit (Tom99, Sor99) |
| Known Recurrent Transients | Known Recurrent Transients | Known Recurrent Transients |
| EXO 0748–676 (eclipsing LMXB) | EXO 0748–676 (eclipsing LMXB) | EXO 0748–676 (eclipsing LMXB) |
| Soft x-ray excess (Bri97) | Soft x-ray excess (Bri97) | Soft x-ray excess (Bri97) |
| Eclipse Timings (Her97) | Eclipse Timings (Her97) | Eclipse Timings (Her97) |
| Progressive covering of disk corona (Chu98) | Progressive covering of disk corona (Chu98) | Progressive covering of disk corona (Chu98) |
| X 1246–588 | X 1354–644 (LMXB, BW Cir) | X 1354–644 (LMXB, BW Cir) |
| Probable X-ray Burster (Pir97) | Modest outburst (Rem97) | Modest outburst (Rem97) |
| Probable ROSAT source 1RXS J124938.0–590525 (Bol97) | Detected to 200 keV (Har97) | Detected to 200 keV (Har97) |
| Quiescent luminosity (Asa96) possibly thermal (Rut99) | KHz QPO peak separation not constant (Men99b) | KHz QPO peak separation not constant (Men99b) |
| X 1608–522 (bright recurrent LMXB) | X 1608–522 (bright recurrent LMXB) | X 1608–522 (bright recurrent LMXB) |
| Sustained one-year low states after each outburst (Asm00) | KHz QPO freq. dependence on position in color diagram (Men99a) | KHz QPO freq. dependence on position in color diagram (Men99a) |
| KH3 QPO (Men98) | Quiescent luminosity (Asa96) possibly thermal (Rut99) | Quiescent luminosity (Asa96) possibly thermal (Rut99) |
| Island state kHz QPO (Yu97) | Outburst with hard spectrum (Zha96) | Outburst with hard spectrum (Zha96) |
Table 2. (continued) Notes and References for ASM Transients

| Source | Notes and References |
|--------|-----------------------|
| X 1630–472 (bright recurrent bhc, 184 Hz, radio source) | Three outbursts w. intervals of 700 d and 450 d (Asm00) Double-peaked and flat-topped profiles (Asm00) Sustained (1 year) low state after 2nd outburst (Asm00) Historical outbursts behavior (Kuu97) Absorption dips (Kuu98) Evolution of spectral components (Oos98) QPOs 0.06 – 14 Hz (Die90) QPO 184 Hz (Rem99) Radio and Hard X-rays (Hje99) |
| GRO J1655–40 (rel. radio jets; 300 Hz QPO) | Black hole, radio jets, “microquasar” (Tin95) Mass 6 – 7 $\text{M}_\odot$ (Oro97a, Sha99) Optical turn-on precedes X-ray by 5 d (Oro97b) Low freq. QPOs; 300 Hz when source hard (Rem99) Spectral evolution (Men98, Tom99, Sch99) Echo mapping (X-ray to optical) (Hyn98) |
| X 1658–298 (X-ray burster) | Recovery by BSAX and X-ray burst (Hei99) |
| X 1704+241 (HD 154791) | Peculiarities in M Giant spectrum (Gau99) |
| RX J17095–26 | Hard X-ray outburst (Mar97) Possible radio counterpart (Hje97) X-ray bursts (Coc98) |
| X 1711–339 | Recovered Ariel-5 and SAS-3 source (Rem98) |
| X 1730–333 (Rapid Burster) | Seven outbursts w. intervals 210 d (Asm90) Outbursts last 5 weeks w. two phases: Type I thermonuclear bursts followed by Type II accretion bursts (Gue99) |
| GRO J1744–28 (bursting pulsar) | Hard X-ray pulsations 0.47 s (Fin96) Pulsar phase changes associated with bursts (Kos98 and refs therein) QPOs (Zha96, Kom97) Super-Eddington fluxes imply beaming (Gil96) Propeller effect (Cui97) HEXE/Mir-Kvant observations (Bor97) Hard X-ray bursts with Konus and Mir-Kvant (Apt98, Ale98) X-ray properties from BATSE and ASCA (Woo99, Nis99) |
| X 1803–245 (XTE J1806–246) | X-ray outburst (Mar98) QPOs (Rev99, Wij99) Possible burst source (Mul98) |
| SAX J1808.4–36 (401-Hz accreting pulsar) | X-ray outburst (Int98) 401-Hz pulsations and 2-h orbit (Wij98a, Cha98) Soft phase lags (Cui98, Vau98) Renewed activity Feb. 00 (vdK00, Wac00) Broad-band power spectrum (Wij98b) Optical counterpart (Roc98) Transient radio emission (Gae99) X-ray spectrum (Gil98, Hei98) |
Table 2. (continued) Notes and References for ASM Transients

| ASM Transients | Notes and References |
|----------------|----------------------|
| **GS 1843+009 (30-s pulsar)** | 100-d flare followed by weak activity (Asm00) X-ray recovery, 30-s pulse period, and spectrum (Wil97, Tak97) |
| **XTE J1856-053 (bhc)** | X-ray outburst (Mar96) Hard X-ray flux (Bar96) Soft spectrum (Asm00) |
| **X 1908+005 (Aql X–1; bright recurrent transient)** | Five strong and two failed outbursts (Asm00) Low-energy phase lags (For99) Optical counterpart clarified: V = 21.6, late K (Che99) Propeller effect (Cam98) KHz oscillations change freq after burst (Yu99) |
| **GS 2138+568 (Cep X–4(?), 66-s pulsar)** | Be star optical counterpart: (Bon98) X-ray pulse profile changes (Muk00) Spindown rate (Wil99) |
| **SAX J2103.5+4545 (359-s pulsar)** | Faint transient, 359-s pulsar (Hul98) Second outburst (Bay00) |
| **C. Long Duration Transients (Duration > 500 d)** | **X 1210–64 (quasi-persistent)** | On until 50763 (Asm00) Uhuru and OSO–7 source |
| **KS J1716–389 (100-d dipper)** | Galactic center source (Ale95) Quasi persistent source with periodic dips (Rem99) On until MJD 50763 (Asm00) Periodicity ~ 100 d (Wen99) |
| **KS 1731–260 (524 Hz during bursts)** | KHz QPO at 524 Hz during burst (Smi97) Two KHz QPO at 898 and 1159 Hz (Wij97) ROSAT observations, celestial position, persistent source? (Bar98) |
| **GRS 1758–258 (bright hard galactic center source)** | Radio jets, x-ray spectral var. and similarity to 1E 1740.7–2942 (Smi97) ASCA spectrum, soft excess (Mer97) Optical candidates (Mar98) Long-term monitoring (Mai99, Kuz99) |
| **GS 1826–238 (burster)** | Bursts at reg. intervals (Ube97) Spectrum and distance from bursts (Int99) Possibly steady accretor since 1988 (Ube97, Int99) |
| **GRS 1915+105 (microquasar)** | Superluminal jets (Mir94, Fen99) Ten distinct accretion states, some oscillatory (Gre97, Mun99) Variable low freq. QPOs and persistent 67 Hz when spectrum hard (Mor97) Coincident X-ray, IR and radio outbursts (Poo97, Elk98, Mir98) Disk emptying episodes (Bel97, Poo97, Fer99) Hard phase lags for 67 Hz QPO (Cui99) Interplay between QPOs and spectral components (Mun99, Mar99, For99) |
### Table 2. (continued) Notes and References for ASM Transients

**D. Periodic, Hard Transients**

| **X 0115+634 (P = 24-d, 3.61 s)** | 24-d orbital period (Asm00) |
| ~ 8 maxima detected through 2/00 (Asm00) | Four cyclotron lines, (Hei99, San99) |
| Major outburst Feb. 99 (Asm00) | Optical counterpart reclassified (Ung99) |
| Mini outbursts May – July 96 at multiples of | |

| **RX J08124–3114 (P = 81.4 d, 32 s)** | Orbital period 80 d (Cor00) |
| ~ 7 maxima detected through 2/00 (Asm00) | X-ray pulsar 31.9 s (Rei99) |
| Optical counterpart is Be star LS992 | |
| (Mot97) | |

| **X 1145–619 (P = 189 d, 292 s)** | Multiwavelength observations, 13-yr review |
| ~ 4 maxima detected through 2/00 (Asm00) | (Ste97) |
| Outburst (Cor96) | |

| **X 1845–024 (P = 242 d, 95 s)** | BATSE outbursts w. 242-d period (Fin99) |
| (= GRO J1849–03 = GS1843–02) | GRO source identified as |
| ~5 maxima detected through 2/00 (Asm00) | Ariel–5/SAS–3/Ginga source (Sof98, Fin99) |

| **X J1946+274 (= 3A 1942+274; P = 80 d, 16-s)** | Pulsar, P = 16 s, (Smi98) |
| ~ 7 maxima detected through 2/00 (Asm00) | Orbital period 80 d, (Cam99) |
| First detections since 1976 (Asm00) | |

| **EXO 2030+375 (P = 46 d, 42 s)** | Thirteen outbursts at 46-d intervals, orbit from pulse phases (Sto99) |
| ~30 maxima detected through 2/00 (Asm00) | Spectra at low luminosities (Rei99) |
| Pulse period dependence on luminosity (Rey96) | |
| Timing properties (Rei98a) | |
| Long-term variability and IR spectroscopy (Rei98b) | |

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FIGURE 1. RXTE/ASM light curves for six neutron-star binary-system transients for the period early January 1996 through mid August 1999. The data points represent 1-day averages of the 10 – 20 (typical) daily measurements in the 1.5–12 keV band. 75 ct/s corresponds to 1.0 Crab. MJD 50082 = 1996 Jan. 0.0.
FIGURE 2. RXTE/ASM light curves for six black-hole binary-system transients. GX 339–4 shows a transient bright soft state; it is not listed as a transient in Table 1. See also caption to Fig. 1.