PROCEEDINGS OF SCIENCE

Monitoring LMXBs with the Faulkes Telescopes

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The Faulkes Telescope Project is an educational and research arm of the Las Cumbres Observatory Global Telescope Network (LCOGTN). It has two 2-metre robotic telescopes, located at Haleakala on Maui (FT North) and Siding Spring in Australia (FT South). It is planned for these telescopes to be complemented by a research network of eighteen 1-metre telescopes, along with an educational network of twenty-eight 0.4-metre telescopes, providing 24 hour coverage of both northern and southern hemispheres.

We have been conducting a monitoring project of 13 low-mass X-ray binaries (LMXBs) using FT North since early 2006. The introduction of FT South has allowed us to extend this to monitor a total of 30 LMXBs (see target list, Section 4). New instrumentation will allow us to expand this project to include both infrared wavelengths (z and y band) and spectroscopy. Brighter targets (~ 16 - 18 mag.) are imaged weekly in V, R and i' bands (SNR ~ 50), while fainter ones (> 18 mag.) are observed only in i' band (SNR ~ 20). We alter this cadence in response to our own analysis or Astronomers Telegrams (ATels).

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[1] Speaker

1. Project Aims

1. To identify transient outbursts in LMXBs. LMXBs may brighten in the optical/near-infrared (OIR) for up to a month before X-ray detection. The behaviour of the optical rise is poorly understood, especially for black hole X-ray binaries. Catching outbursts from quiescence will allow us to examine this behaviour and alert the astronomical community to initiate multi-wavelength follow-up observations.

2. To study the variability in quiescence. Recent results have suggested that many processes contribute to the quiescent optical emission, including emission from the jets in black hole systems [1]. By monitoring the long-term variability of quiescent LMXBs, we will be able to provide some constraints on the emission processes and the mass fuctions.

2. GX 339-4

A target for FT South is the transient black hole binary GX339-4, which went into outburst in early 2007, followed by a steady decline in the following months. The outburst was detected at X-ray [2], OIR [3] and radio [4] wavelengths. Our observations (Figure 1) show that the source continued to decline in V, R and i' bands until ~ MJD 54585 (29 April, 2008) when the source increased in brightness to its previous brightest level. We have also noted rapid flaring in i' (Figure 2) and V bands with jumps of ~ 0.3 - 0.4 mags in periods of ~ 140 seconds [5]. Our ATel triggered multi-wavelength follow-ups with SALT, VLT, Swift and RXTE.

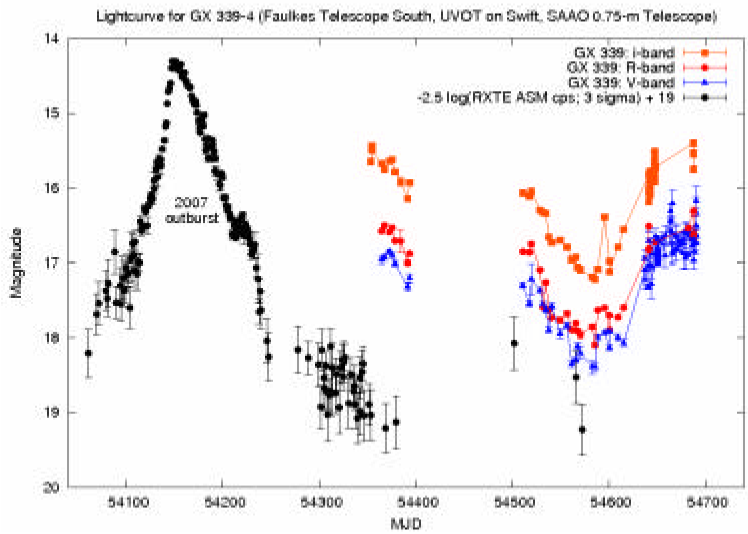

__Figure 1__ FT (orange, red, blue) and RXTE ASM data (black) of the 2007 outburst and 2008 re-flare of GX339-4. Swift UVOT V-band data are also included (blue from ~ 54650 – 54700).

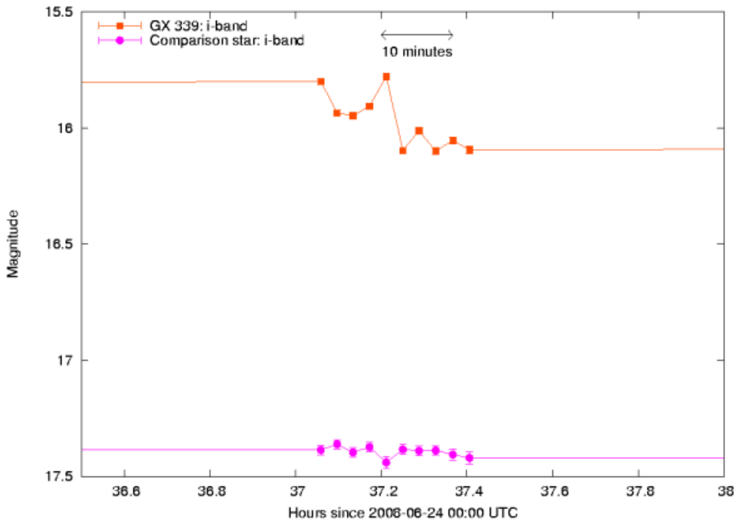

Figure 2 *Example of the rapid flaring behaviour seen in GX339-4*

3. XTE J1118+480

The bright Galactic Halo black hole system, XTE J1118+480, is monitored by several groups at different wavelengths [6] [7]. We note long-term variability over 800 days of observations. On occasion, we detect variability of ~ 0.6 mags in i'-band within a few days. In an attempt to discriminate between orbital modulation and flaring behaviour, we undertook observations in i'-band over a single orbit. This unfolded lightcurve (Figure 3) shows 0.4 mags variability in i' band over one orbit, which is known to be ~ 4.1 hours. [8]. This suggests that much of the long-term variability may be orbital in origin.

We intend to repeat these observations when the system is next visible in order to better constrain the ephemeris and to determine the orbital variability in V and R wavebands.

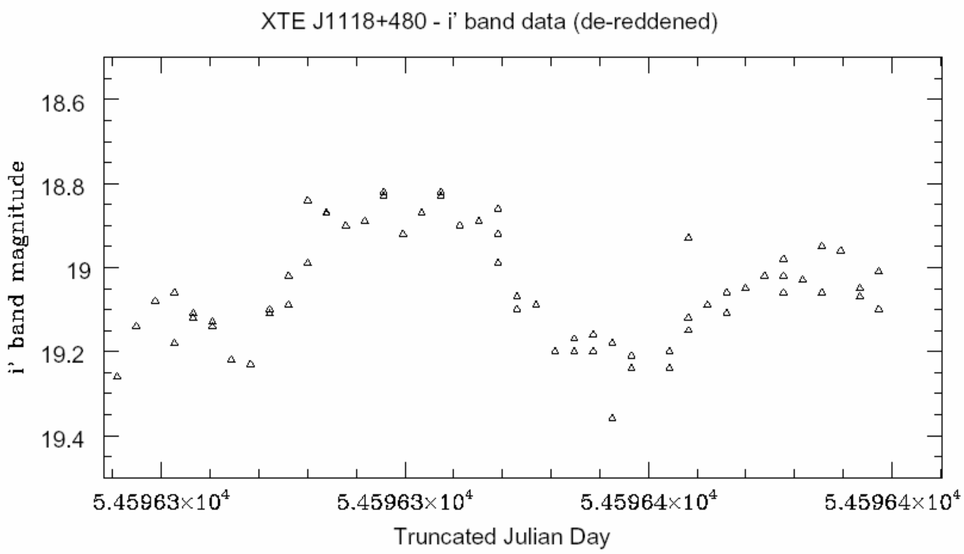

Figure 3 *FT unfolded i' band data of the black hole system, XTE J1118+480*

4. Targets

System	Type	Orbital Period
IGR J00291+5934 (N)	MSXP	2.46 hours
GRO J0422+32 (N)	BH	5.092 hours
4U 0614+09 (N)	Atoll, MQ	50 minutes
A 0620-00 (N)	BH	7.75 hours
XTE J0929-314 (S)	MSXP	0.73 hours
GRS 1009-45 (S)	BH	6.84 hours
XTE J1118+480 (N)	BH, MQ	10.38 hours
GRS 1124-68 (S)	BH	4.08 hours
GS 1354-64 (S)	BH, IMXB	61.07 hours
Cen X-4 (S)	NS	15.1 hours
4U 1543-47 (S)	BHC, IMXB	26.8 hours
XTE J1550-564 (S)	BH, MQ	37.25 hours
4U 1608-52 (S)	Atoll	12.89 hours
4U 1630-472 (S)	BH, MQ	~ 1 day
XTE J1650-500 (S)	BH, MQ	7.63 hours
GRO J1655-40 (S)	BH, IMXB, MQ	62.88 hours
GX 339-4 (S)	BH, MQ	42.14 hours
H 1705-250 (N)	BH	12.51 hours
GRO J1719-24 (N)	BHC	14.7 hours
XTE J17464-3213 (S)	BHC	none
SAX J1808.4-3658 (S)	MSXP	2.014 hours
XTE J1814-338 (S)	MSXP	4.275 hours
V4641 Sgr (S)	BHC	2.8 days
XTE J1859+226 (N)	BHC, MQ	9.16 hours
HETE J1900.1-2455 (S)	MSXP	1.39 hours
Aql X-1 (N)	Atoll	18.95 hours
4U 1957+11 (N)	BHC	9.33 hours
GS 2000+25 (N)	BH	8.26 hours
V 404 Cyg (N)	BH	155.4 hours
XTE J2123-058 (N)	Atoll	5.96 hours

N = FTN target
S = FTS target
Atoll = Atoll source neutron star LMXB
MSXP = Millisecond X-ray Pulsar
BH = Black Hole
BHC = Black Hole Candidate
IMXB = Intermediate-Mass X-ray Binary
MQ = displaying ‘microquasar-type’ behaviour

5. Online Microquasar Database

We are producing an interactive online resource of 'microquasar-type systems' with links to ADS, Simbad, etc. in a similar way to the open cluster database, WEBDA, or the galaxy database, NED. This will be an educational and research resource, which we will encourage researchers to contribute to.

It will contain fully-referenced data such as alternate names, luminosities, mass functions, distances, orbital periods, inclinations, finder charts and optical and X-ray lightcurves.

6. Acknowledgements

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We acknowledge Craig Markwardt and the RXTE team for the PCA bulge scan data, which appears in Figure 2.

7. References

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