Extragalactic science using MAXI + Swift

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(+some slides from the MAXI team)
Sky views from MAXI

Zenithal View

Horizontal View

FOV Crossing Time for Each Source
>45 sec

FOV Crossing Intervals
Horizon to Zenith: 20 minutes
Zenith to Horizon: 70 minutes

One-orbit (90 minutes)
Coverage
85 - 95 %
Sensitivity and targets

Galactic Objects
- Crab
- LMC, SMC

Extra Galactic Objects
- Galaxies / QSOs
- Clusters of Galaxies

Key:
- 1 orbit
- 1 day
- 1 Week
- 6 months
Example MAXI AGN (preliminary)

Cen A

Mkn 421

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Motivation for AGN Variability Studies

• MAXI+Swift make a good team
• MAXI on-line light curves + alerts
• Follow-up with Swift etc.
• Many open questions:
  - How often do AGN change state?
  - What drives variability – test disk reprocessing and reflection models
  - Does PDS correlate with L?
  - Are there periodic phenomena? (Yes! Gierlinski et al (2008) REJ1034+396; a~1hr QPO)
  - Compare AGN and X-ray binaries

Imagine AGN as a large binary system where the “donor” is a galaxy

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AGN observations

PDS 456 (O’Brien, Reeves et al.)

Fig. 9. The current observations of PDS 456, shown as νFν spectra, where we have plotted the data compared to a ratio with an absorbed (NH = 2 × 10^{21} cm^{-2}) power-law of Γ = 2 at a mean 2 keV flux level of 5 × 10^{-12} erg cm^{-2} s^{-1}. Shown are RXTE PCA (black, 1998), XMM-Newton (2001, green), Suzaku XIS (2007, red), Chandra/HETG (2003, blue) and ASCA (1998, orange dotted). Strong variability is seen below 10 keV, from RXTE and XMM at high fluxes, down to Chandra and ASCA at the lowest/hardest observations. Note the 6 keV (observed) Fe K-shell absorption in the XMM, 2001, Suzaku, 2007 and RXTE 1998 observations. A summary of all these observations is shown in Table 1.
Galactic flares – tidal disruption events

- Passing star disrupted by central BH
- Fast rise, “soft” X-ray flare, decays over many weeks-months roughly as $t^{-5/3}$ (but see later)
- Peak luminosity up to $\sim 10^{45}$ erg s$^{-1}$
- Expected rate $\sim 10^{-4} – 10^{-5}$ yr$^{-1}$ per galaxy
- Unique probe of accretion physics – but needs very good light curve (cf. very poor at present)
Galactic flare rates

- MAXI SSC can detect bright tidal disruption events out to ~100 Mpc (if the sensitivity and localisation as claimed).

- Expected rate is low: 1-2 events per year. Once a candidate is found, trigger Swift for confirmation (i.e. Core of nearby galaxy) and then full follow-up.
Lodato et al. (2009, MNRAS, 392, 332) : different stars disrupt in different ways – due to the effective gravity of the star vs. the gravitational pull of the SMBH.

Changes the light curve and when curve decay rate reaches “canonical” $t^{-5/3}$ rate

Model using a polytropic index, $\gamma$, where larger $\gamma$ means more uniform density.
Gezari et al. (2009)
GALEX observations

Comparison with Lodato model

SEDs cf. Galaxy+BB models
Summary

• MAXI can locate and monitor extragalactic objects such as AGN, tidal events etc. Follow-up with Swift etc.

• Both projects have set up subject teams to coordinate what to do following an alert (AGN, Nova-CV, “new”...)

• MAXI alert system under test; due “soon” (December?)

• Ideal time to combine “wide-area” facilities such as MAXI, Swift etc. so as to MAXImise science (many all-sky facilities coming, e.g. LOFAR, panSTARRS)

• See MAXI talk tomorrow by Tomida