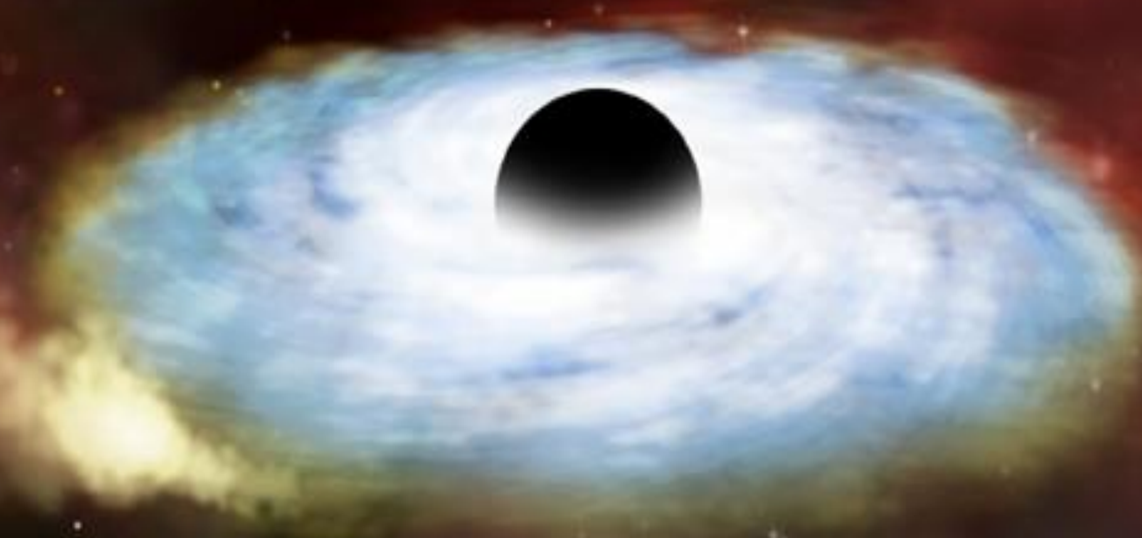
XMM-Newton: The Next Decade, May 2016

TIDAL DISRUPTION OF STARS BY SUPERMASSIVE BLACK HOLES*: HIGHLIGHTS FROM XMM & THE NEXT DECADE



)* in *quiescent*, i.e.
non-active, galaxies

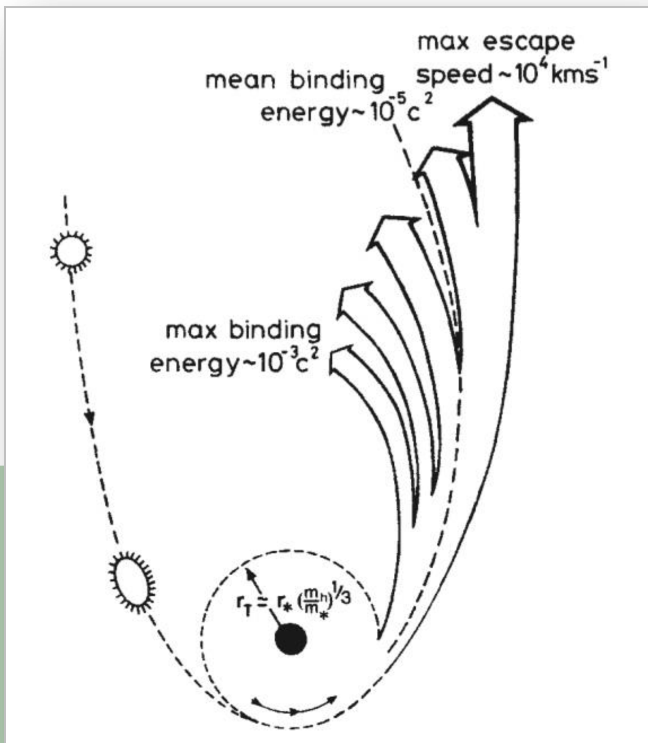
S. Komossa

tidal capture & disruption of stars

disruption at $r = r_{\rm tidal}$, with tidal radius

$r_{\rm tidal} = R_*(M_{\rm BH}/m_*)^{1/3} =$

$7\;10^{12}\,\mathrm{M}_{\mathrm{BH},6}{}^{1/3}\;(\mathrm{R}_*/\mathrm{R}_{\mathrm{sun}})\;(\mathrm{m}_*/\mathrm{m}_{\mathrm{sun}})^{-1/3}$ cm



high initial gas supply rate with

$L_{\rm peak}$ up to $L_{\rm edd}$

spectrum peaked at EUV-soft X, T~ $10^{5\text{-}6}$K
(between $r_{\rm t}$ and $3r_{\rm s}$)

$$T \simeq 8\,10^4\,(\frac{M_{\rm BH}}{M_\odot})^{\frac{1}{12}}\ \mathrm{K}\quad (\mathrm{at}\ r_t),$$

$$T \simeq 2\,10^7\,(\frac{M_{\rm BH}}{M_\odot})^{-\frac{1}{4}}\ \mathrm{K}\quad (\mathrm{at}\ 3\,r_S)$$

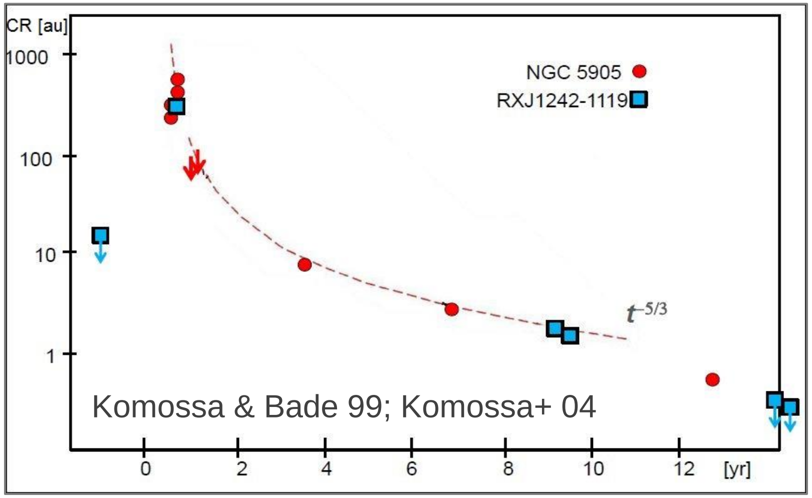
matter return rate dm/dt ~ $t^{-5/3}$

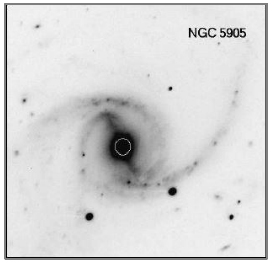
→ lightcurve: decline ~ $t^{-5/3}$ in X-rays

event rate $10^{-4...-5}$ /yr /galaxy

previous multi-wavelength observations of TDEs

soft X-rays: several *ROSAT* events





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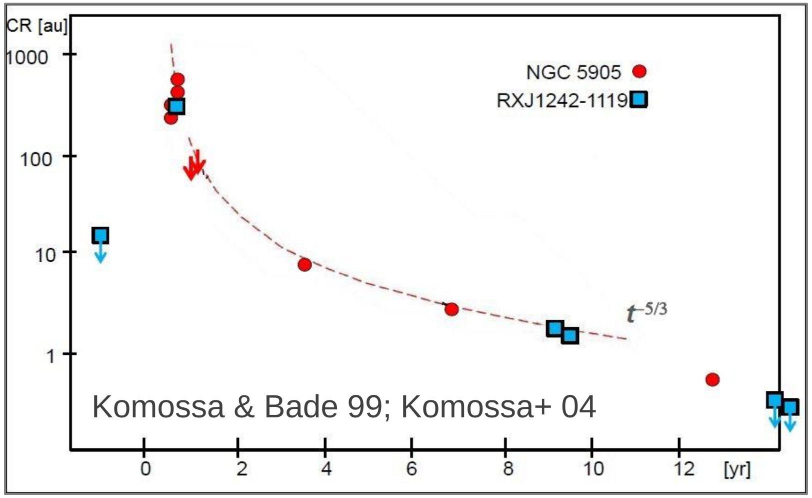
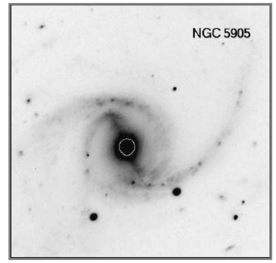
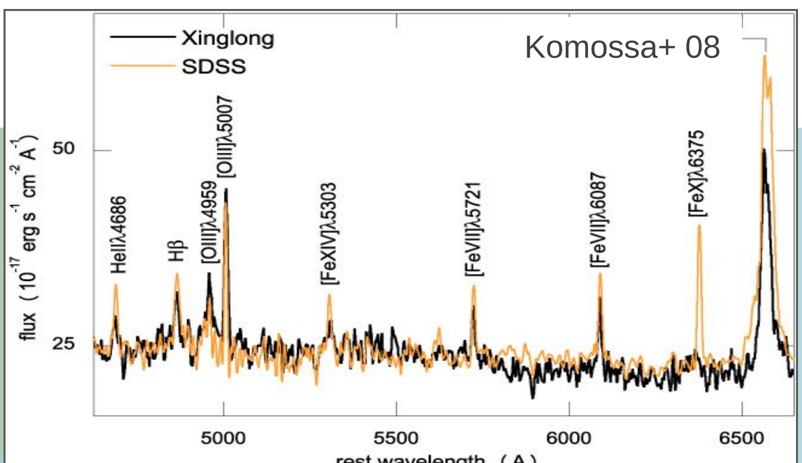
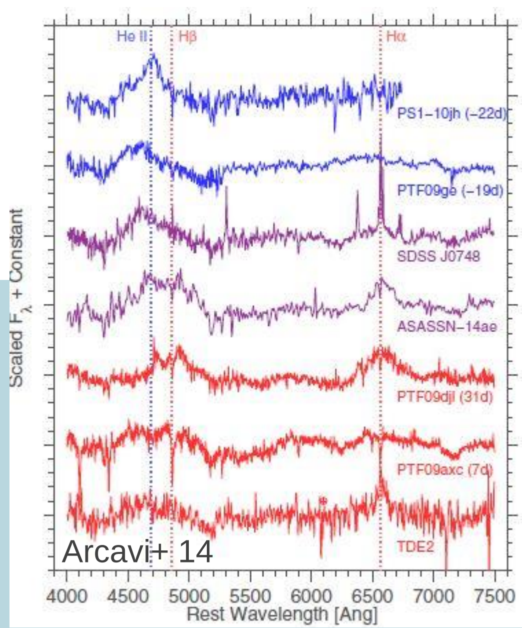




UV & optical TDEs: transient
emission lines & lightcurves





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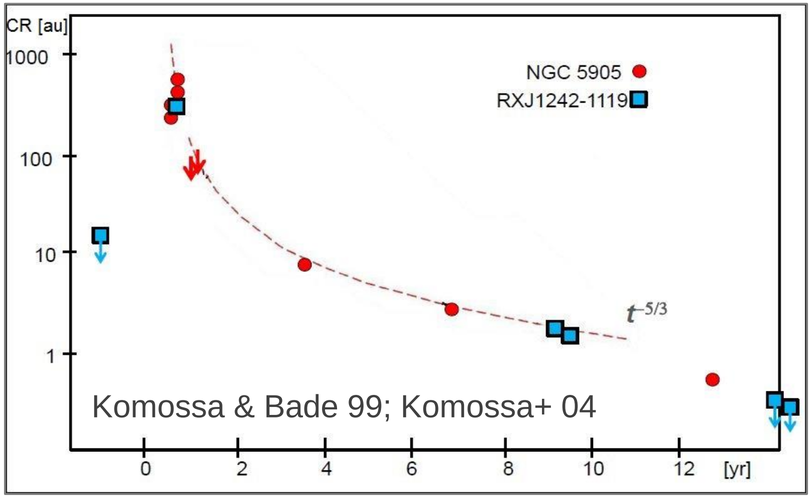
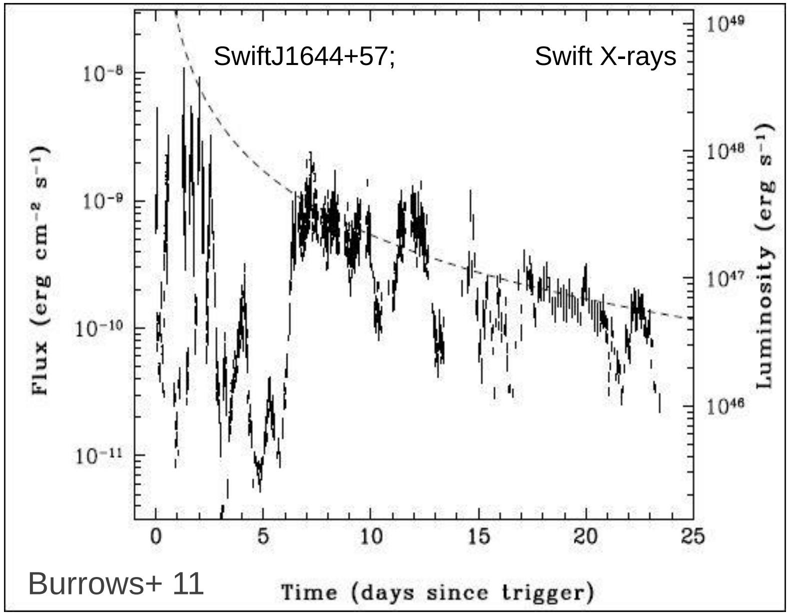


hard X & radio: jetted TDEs with Swift



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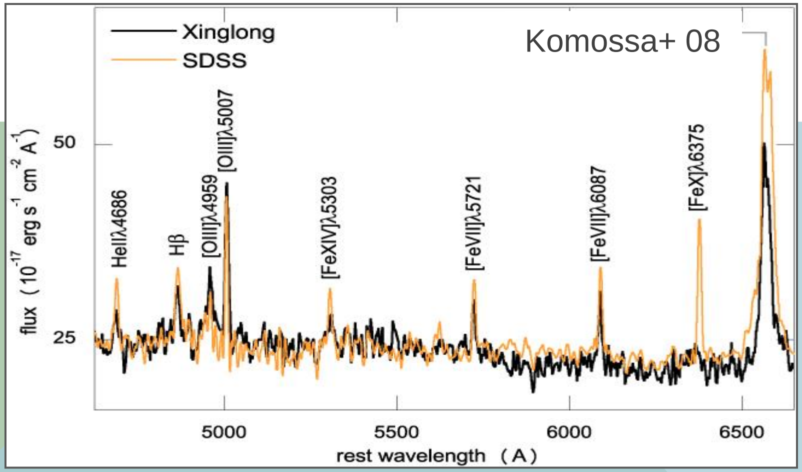

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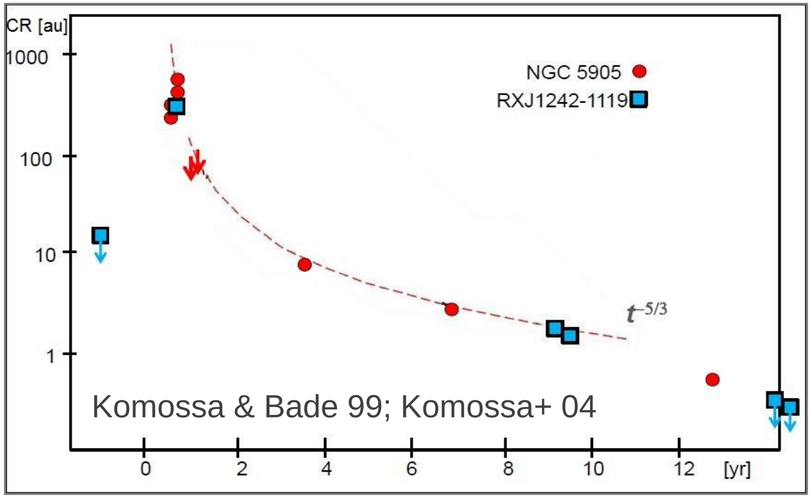

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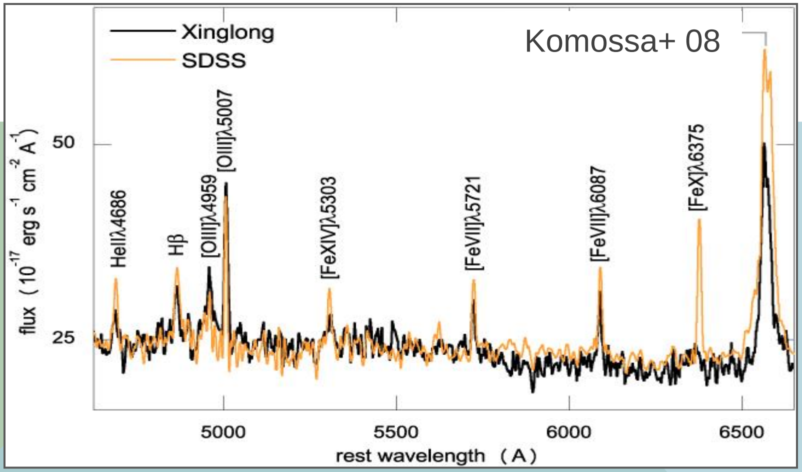

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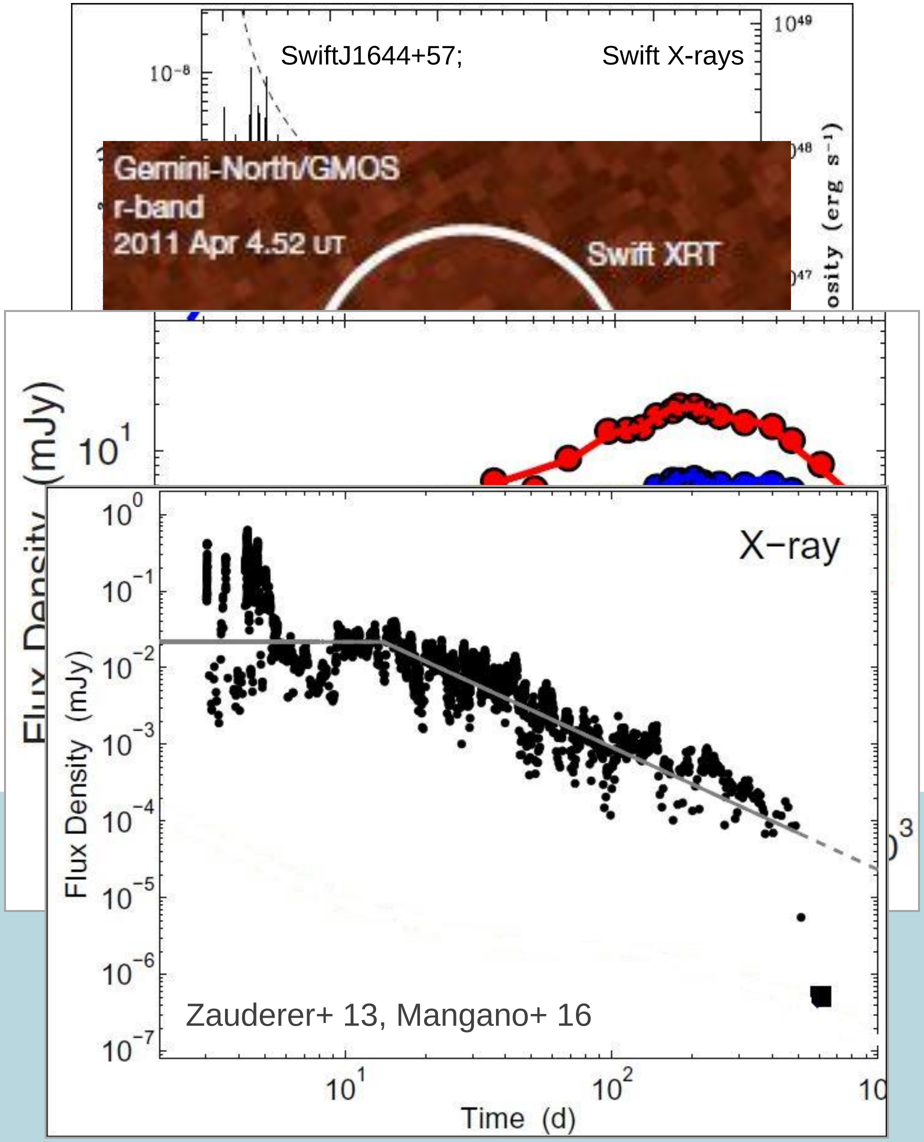

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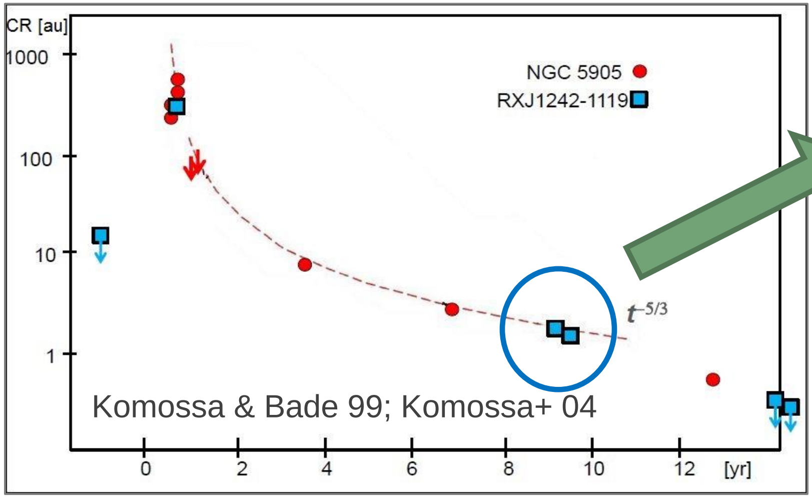
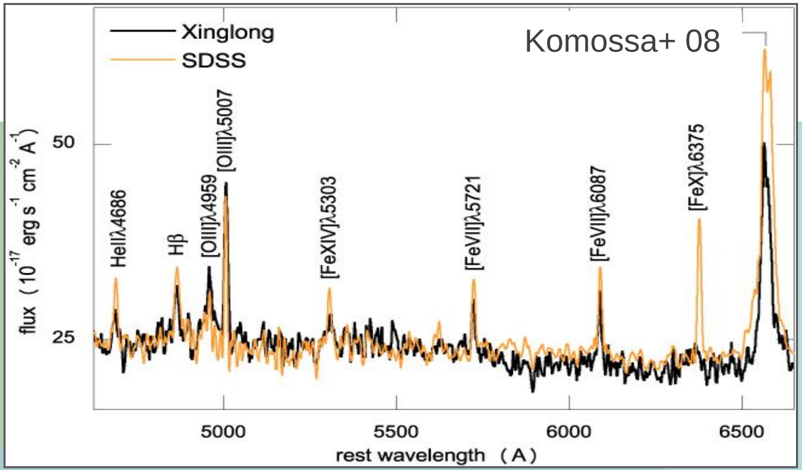


RXJ1242-1119: first XMM-Newton & Chandra follow-ups of a TDE: fading counterpart decade after maximum, spectral hardening

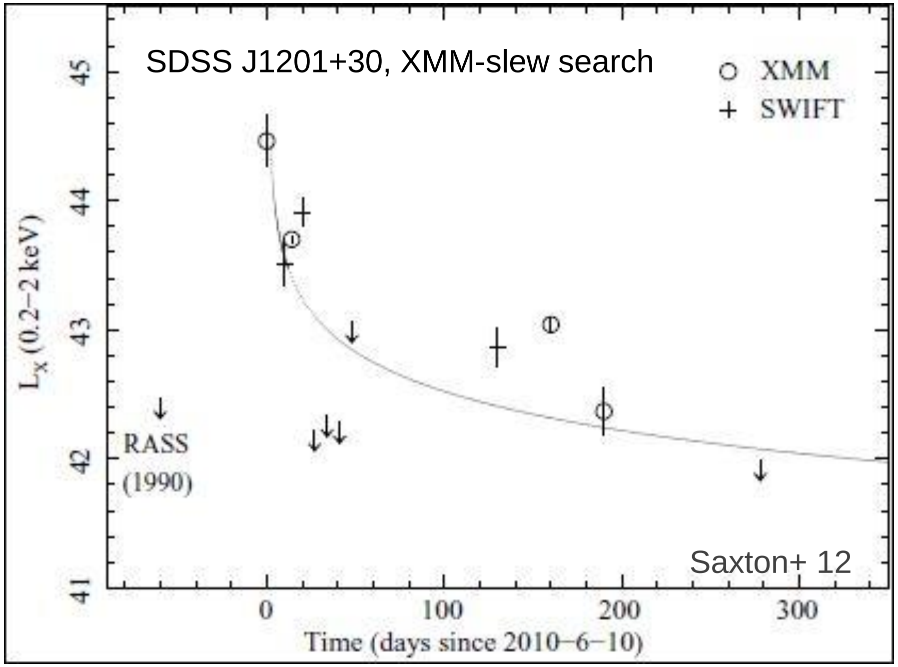
UV & optical TDEs: transient emission lines & lightcurves



X-ray TDEs: discoveries & contributions from XMM – dedicated search for new events

~ 8 events identified; overall properties very similar to previous (ROSAT) X-ray TDEs:

- extreme X-ray softness near maximum
- high peak luminosities, up to few 10^{44} erg/s
- decline by typ. factors ~ > 100 (ROSAT: > 1000-6000)
- (optically) quiescent galaxies



→ important probes of accretion physics in early stages of TDE evolution (spectroscopy & lightcurve evolution)

[Esquej+ 07,08, Cappelluti+ 09, Maksym+ 10,13, Lin+ 11,15, Saxton+ 12, 14,16—in prep., review: Komossa 15]

X-ray TDEs: discoveries & contributions from XMM – dedicated (archival) search for events

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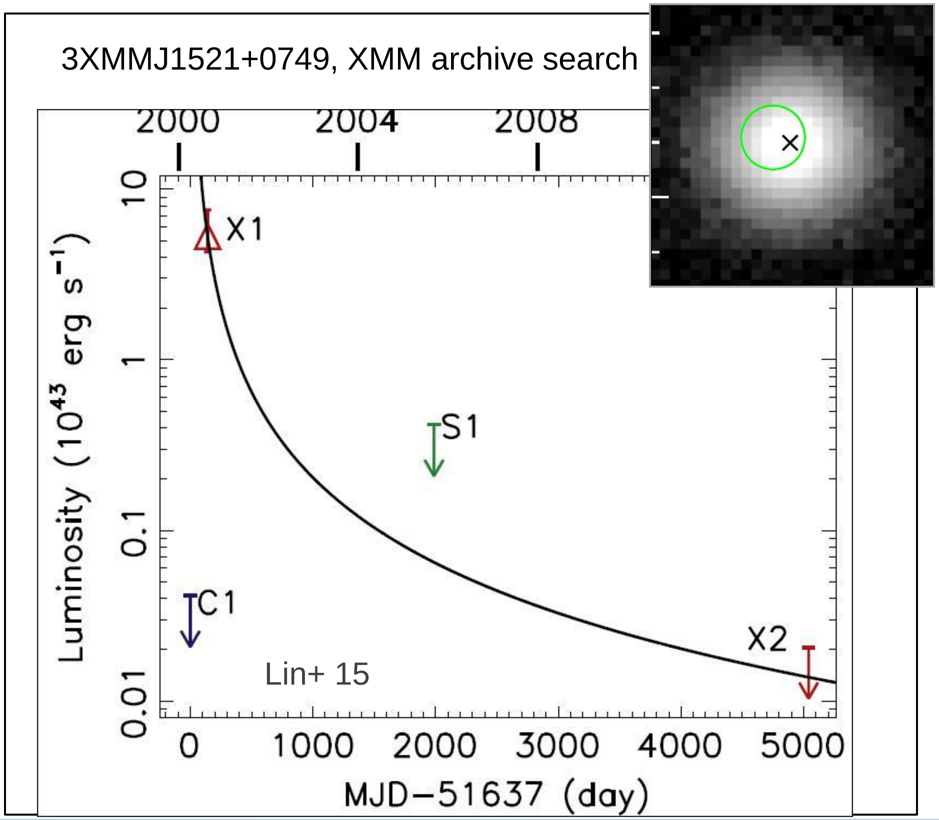


→ important probes of accretion physics

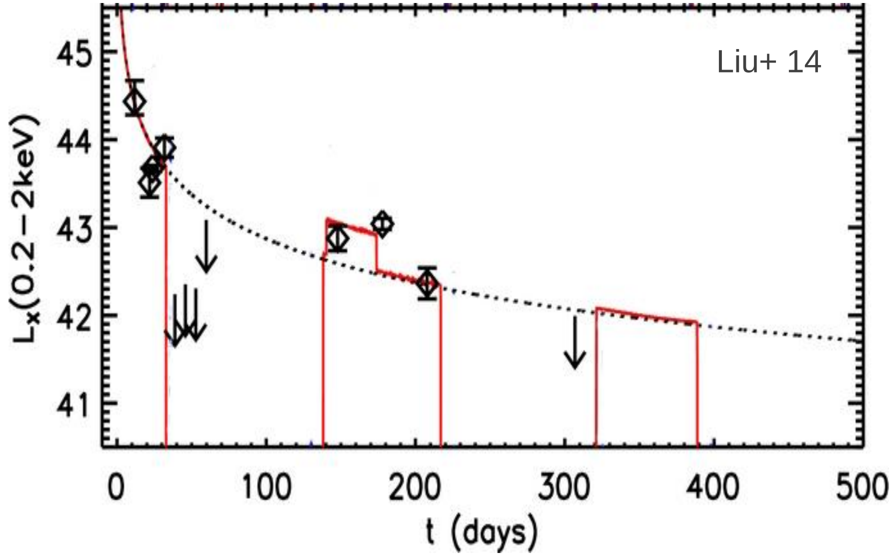
X-ray TDEs: discoveries & contributions from XMM – first TDE in candidate milli-pc SMBBH

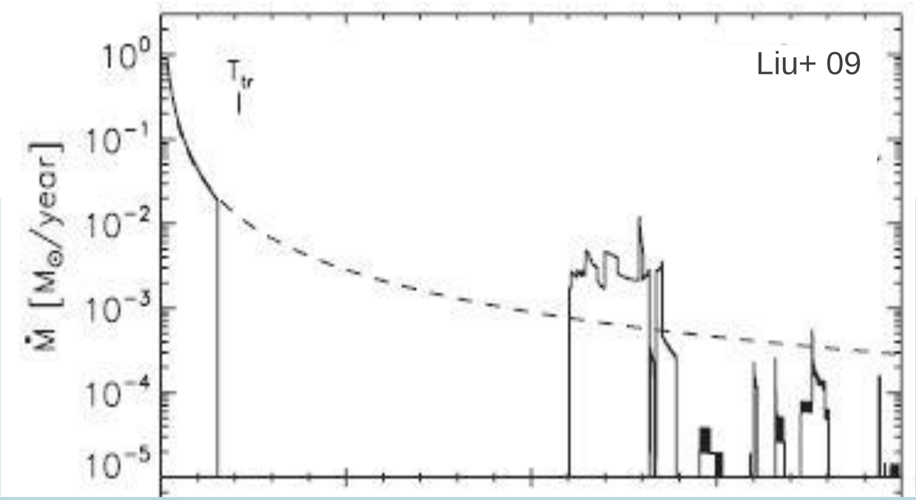
- characteristic dips in lightcurve predicted by SMBBH model of Liu,Li&Chen 2009, where 2nd BH perturbs stream of stellar material, temporarily interrupting accretion process

- a 0.6 milli-pc SMBBH with $M_{BH} = 10^{6-7}\ M_{sun}$, and mass-ratio q=0.1 reproduces the lightcurve well

→ new discovery route for compact binary SMBHs, and in *quiescent* galaxies

[Liu, Li, Komossa 14]



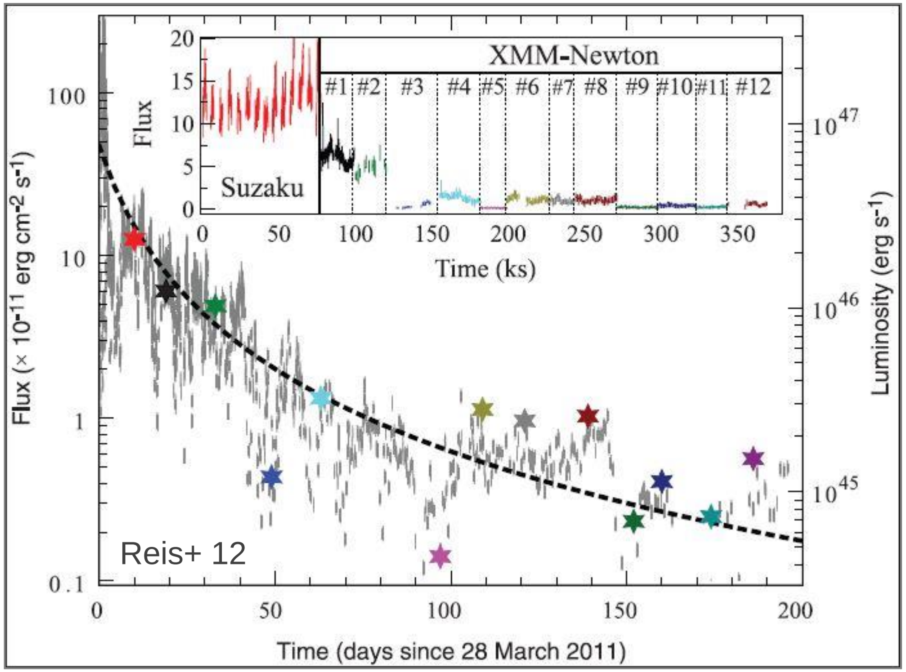


X-ray TDEs: discoveries & contributions from XMM – 'relativistic' TDE SwiftJ1644+57

- J1644+57 discovered with Swift BAT March 2011
  $L_{x,isotropic} = 10^{45} – 4\ 10^{48}$ erg/s
  rapid variability, Δt ~ 100s
  z_{host} =0.35, optically inactive

➔ rapid onset of a powerful jet, following tidal disruption

- evidence for 200s QPO in first XMM follow-up in hard X-rays (2-10 keV)
  → from inner disk ?



[Bloom+ 11, Burrows+ 11, Levan+ 11, Zauderer+ 11, *multi-λ follow-ups:* Aliu+11, Berger+ 12, Wirsema+ 12, Saxton+ 12, Reis+ 12, Aleksic 13, Zauderer+ 13, Castro-Tirado+ 13, Gonzales-Rodriguez+ 14, Levan+ 16, Mangano+ 14, 16]

X-ray TDEs: discoveries & contributions from XMM – SwiftJ1644+57

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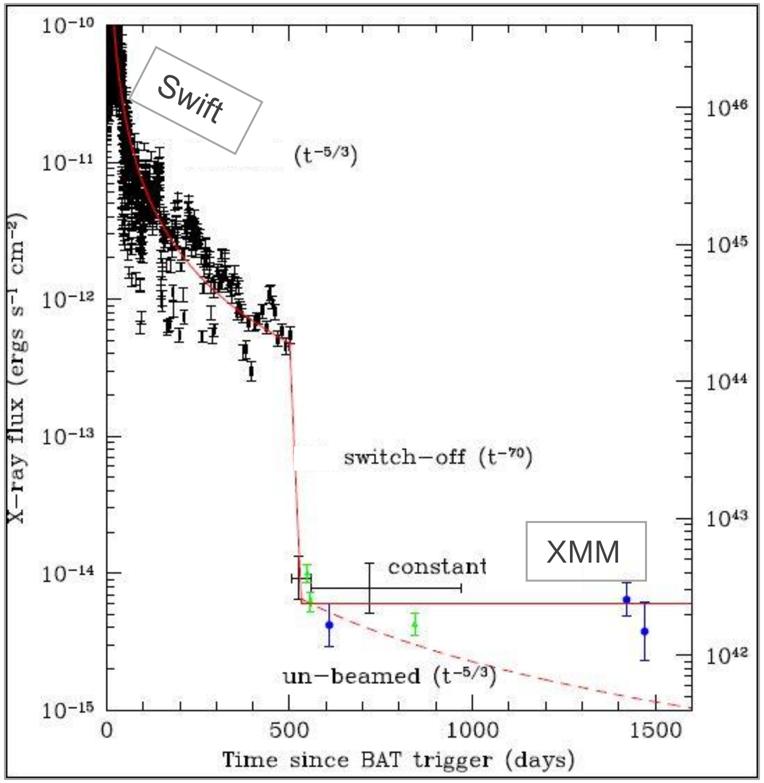
- late-time X-rays remain faint, ~constant, at $L_{x,low} = 5\ 10^{42}$ erg/s, with hard (Γ=1.9) spectrum → no forward shock from outer jet, nor LLAGN, but most likely, from viscously spread disk & corona
  → new probe of jet/disk coupling & jet-environment interactions



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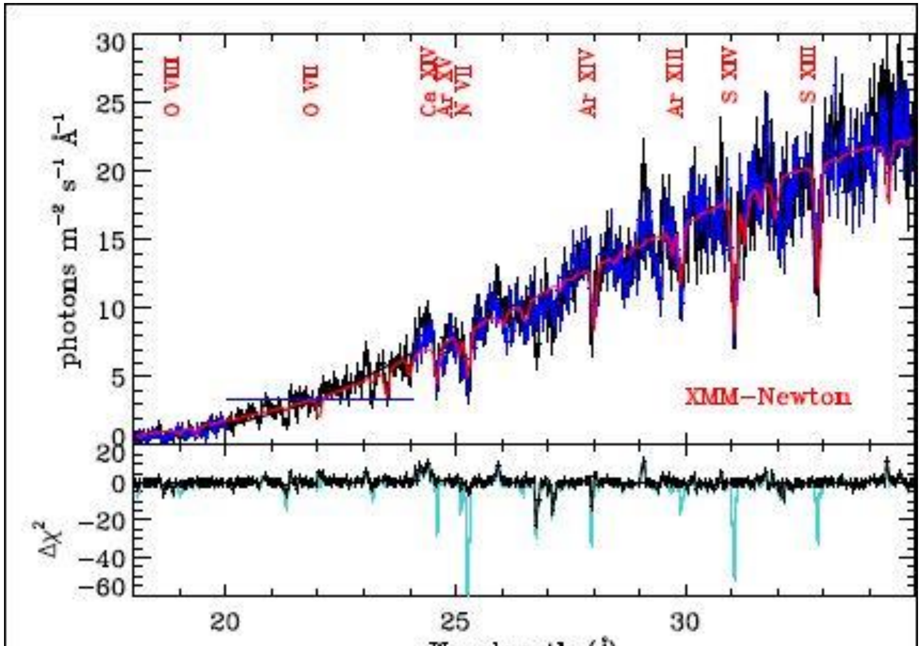
X-ray TDEs: discoveries & contributions from XMM – ionized outflow

- optically identified TDE (z=0.02) ASASSN14li, with luminous X-rays
- declining radio emission indicates presence of low-power jet (+ permanent component indicating permanent low-level AGN)
- XMM-RGS: thermal conti (kT ~ 0.05 keV) & highly ionized matter near BH in outflow v = few 100 km/s



Miller+ 15

→ new probe of early formation & evolution of disk wind and/or stellar debris

[Jose+ 14 Atel #6777, Miller+ 15]

The next decade of TDEs with XMM-Newton

XMM will continue to discover new events [then: rapid (multi-λ) follow-ups incl. deeper in X-rays]; or do follow-up spectroscopy of TDEs identified in other wavebands
→ Probe accretion down to last stable orbit & extreme outflows, relativistic effects, jet-disk coupling & early jet evolution in jetted events
→ **rich discovery space upcoming**

<u>future</u>: rapid response / repeat & *deep* observations if interesting spectral features present (i.e., enough ToO/DDT time) / (more) agreements with other observatories for joint & quasi-simultaneous observations (e.g., with radio, for jetted TDEs). Perhaps: dedicated XMM transients program for more automated follow-ups ?

Accretion, jets, & gravitational waves from black hole systems

registration deadline July 31, 2016

Kathmandu, Oct. 16-21, 2016

http://events.iasfbo.inaf.it/nepal2016/index.php

INTERNATIONAL CONFERENCE ON

SHINING FROM THE HEART OF DARKNESS: BLACK HOLE ACCRETION AND JETS

Kathmandu, Nepal, October 16 - 21, 2016

Sixth in a series of astrophysical conferences held in Kathmandu (Nepal), the meeting will mainly focus on accretion physics and jet launching and evolution mechanisms in galactic and extragalactic sources. We plan to address major observational and theoretical results on these topics for a wide range of cosmic sources. Emphasis will also be given to multiwavelength studies of cosmic sources and to multi-messenger physics, gravitational waves in particular.

Aims of the conference

Registration

Accommodation

Programme

Circulars

Conference information

About Nepal

List of participants

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