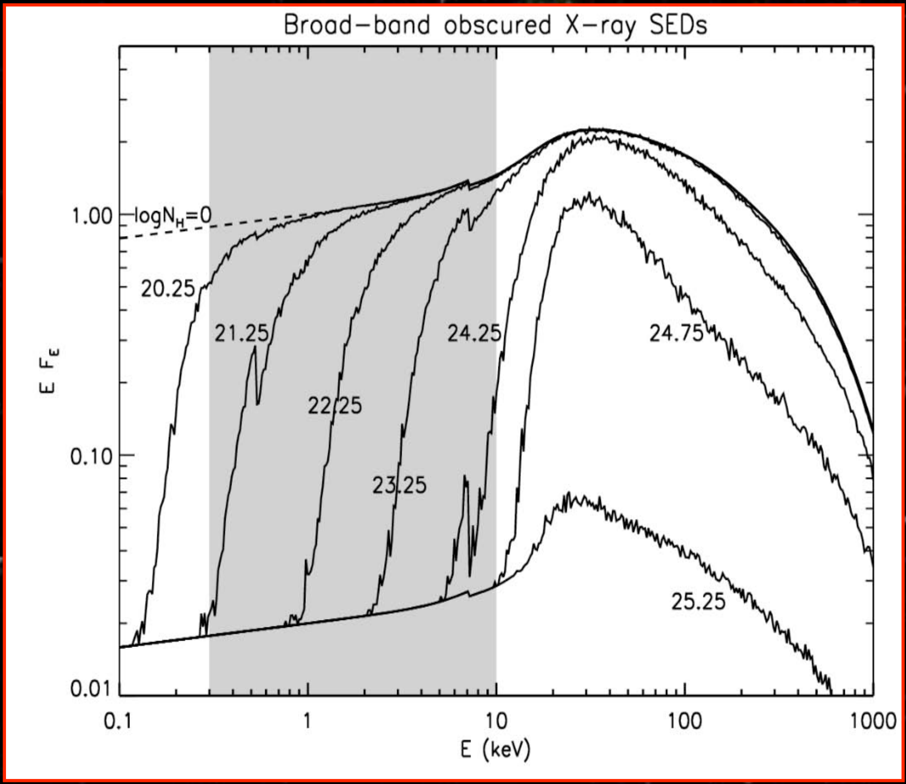
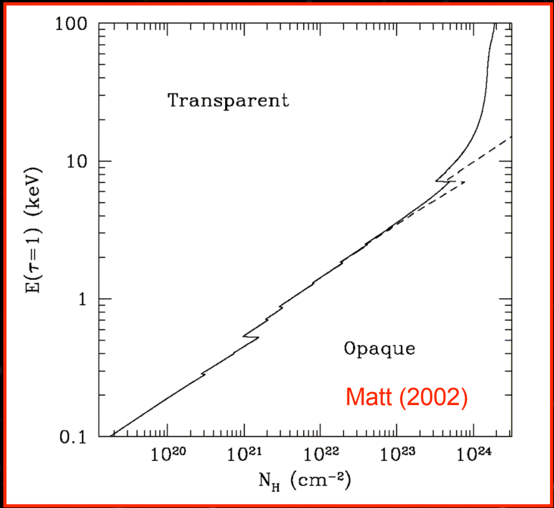
Active Galaxy Science Possibilities for Swift: BAT Source Follow-Up and Variability Studies



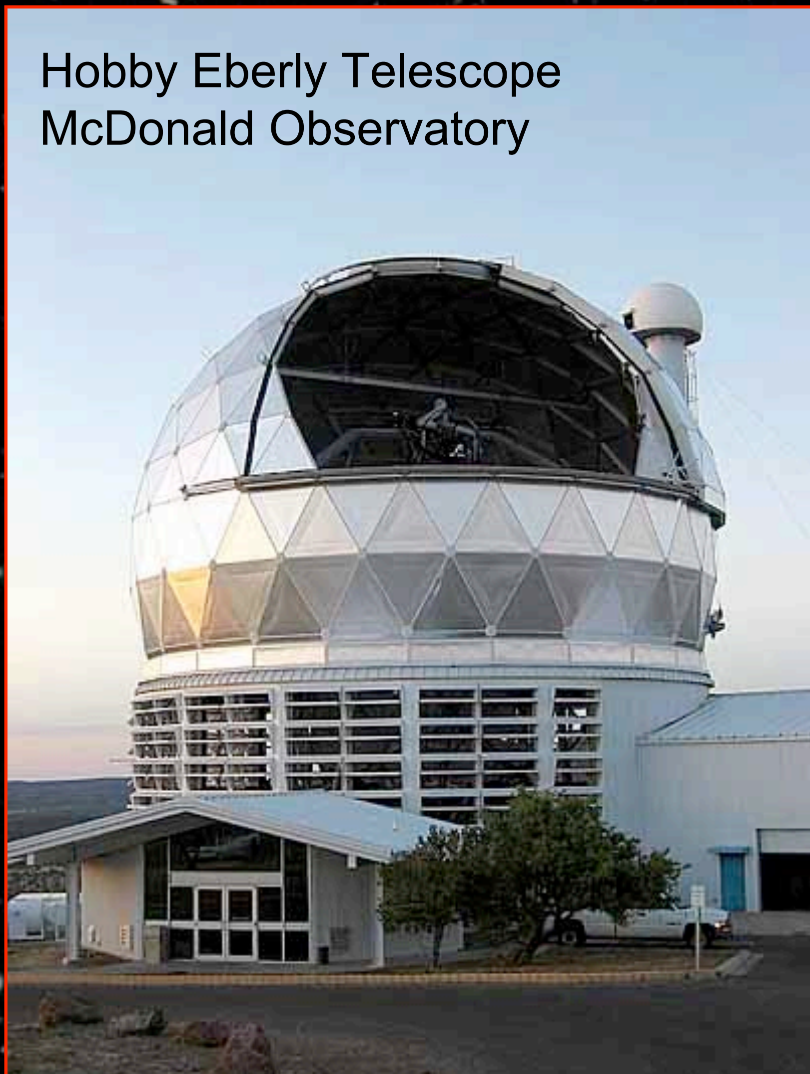


Majority of AGNs obscured.

Swift BAT gives penetrating power and lack of confusion with stellar sources.

HET and XMM-Newton follow-up.

HET Follow-Up of BAT AGNs


Hobby Eberly Telescope
McDonald Observatory

Expect ~ 450 AGNs in 36-month BAT catalog.

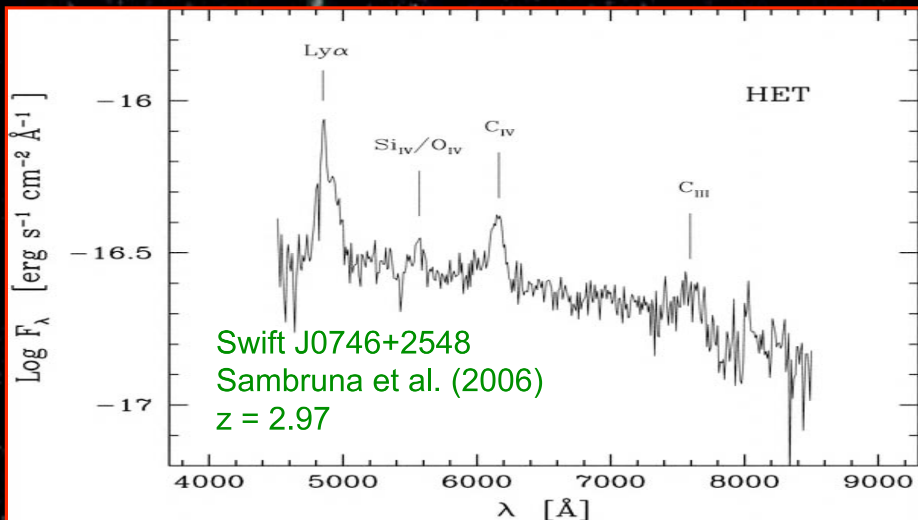
Effective 8-meter aperture

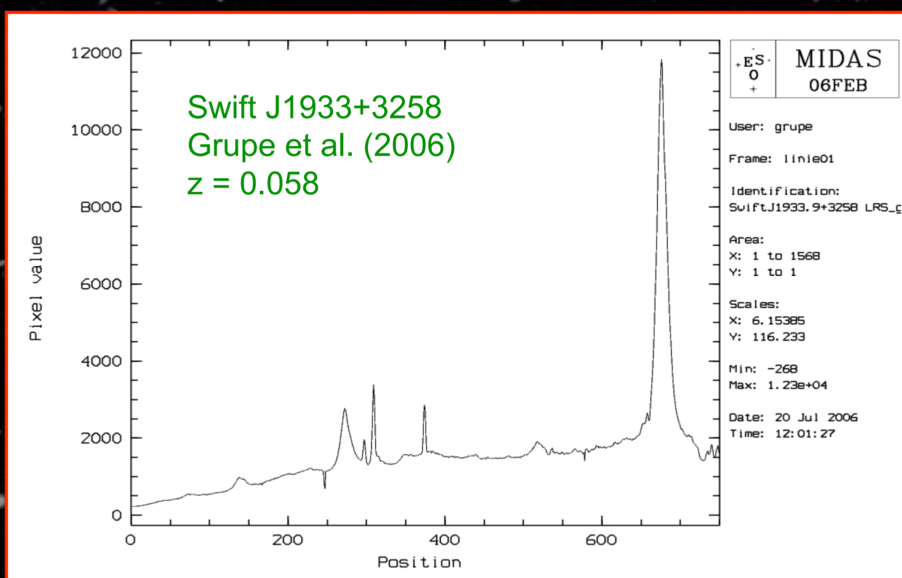
Covers -10 to +72 declination. Can access ~ 250 BAT AGNs.

Queue scheduled

25% of time owned by Penn State

HET Follow-Up of BAT Sources





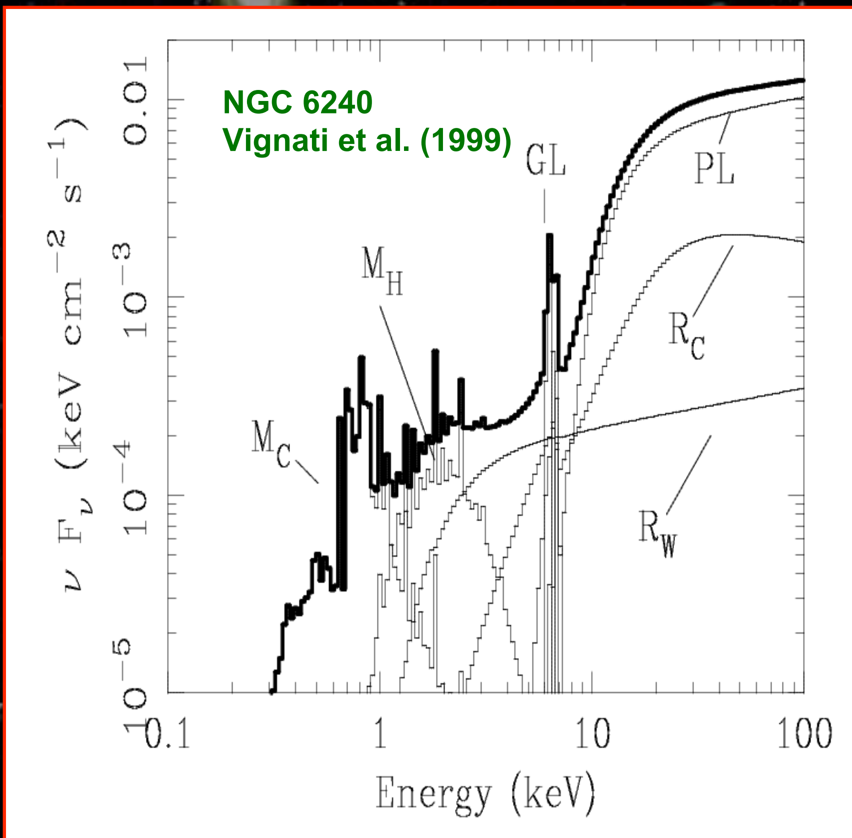
HET already used for some Swift BAT follow-up work effectively.

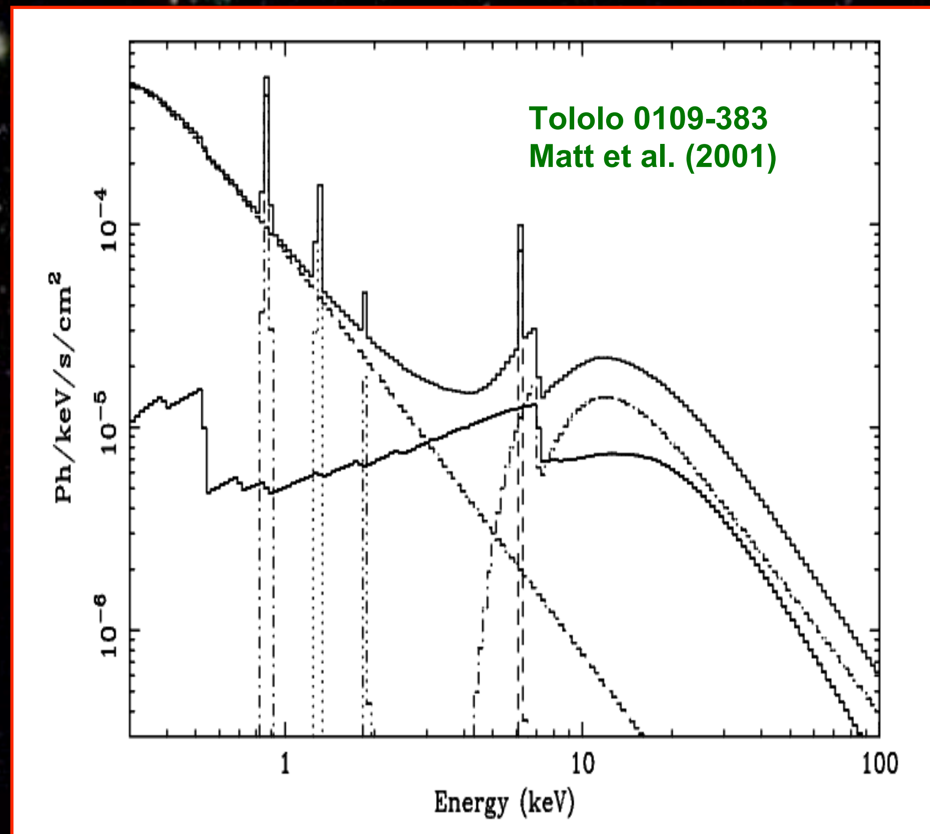
HET well matched to BAT sources in terms of

- Sky separation – queue scheduling
- Expected magnitudes – R ~ 15-20
- Line properties

Plan to put in HET proposal for 2007 June 15 deadline.

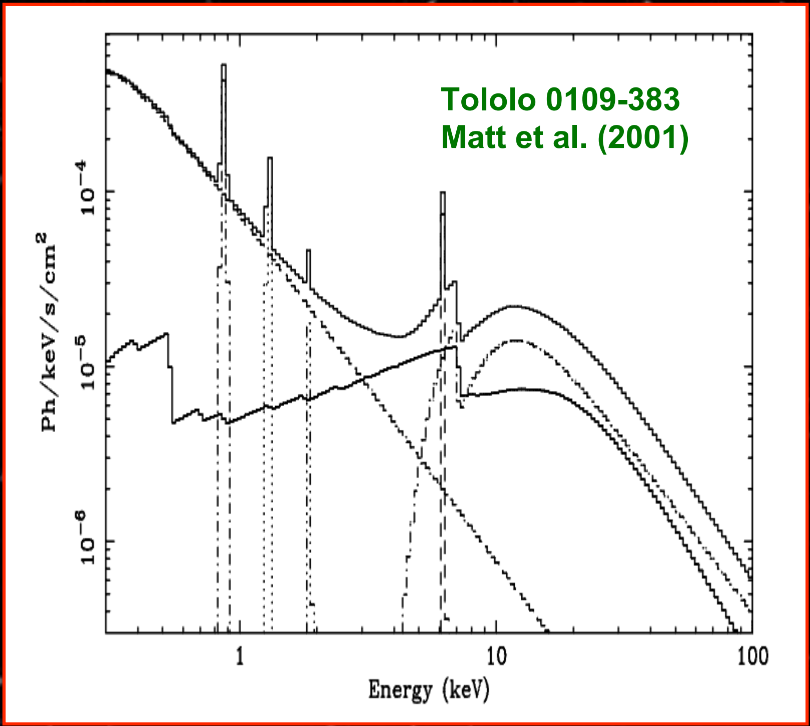
Complex X-ray Spectra of Obscured AGNs





Swift XRT effective at identification, but short exposures and small effective area limit photon statistics and understanding.

XMM-Newton Follow-Up of BAT Sources



XMM-Newton exposures of 10-20 ks can give

- Level and nature of complex X-ray absorption
- Iron K line and Compton-reflection continuum (with BAT)
- Circumnuclear starburst activity and scattered low-energy emission
- X-ray variability

Expected XMM-Newton Targets

Have ~ 120 BAT AGNs presently with reasonable X-ray spectra.

In future need to focus on important subsets enabling new science.

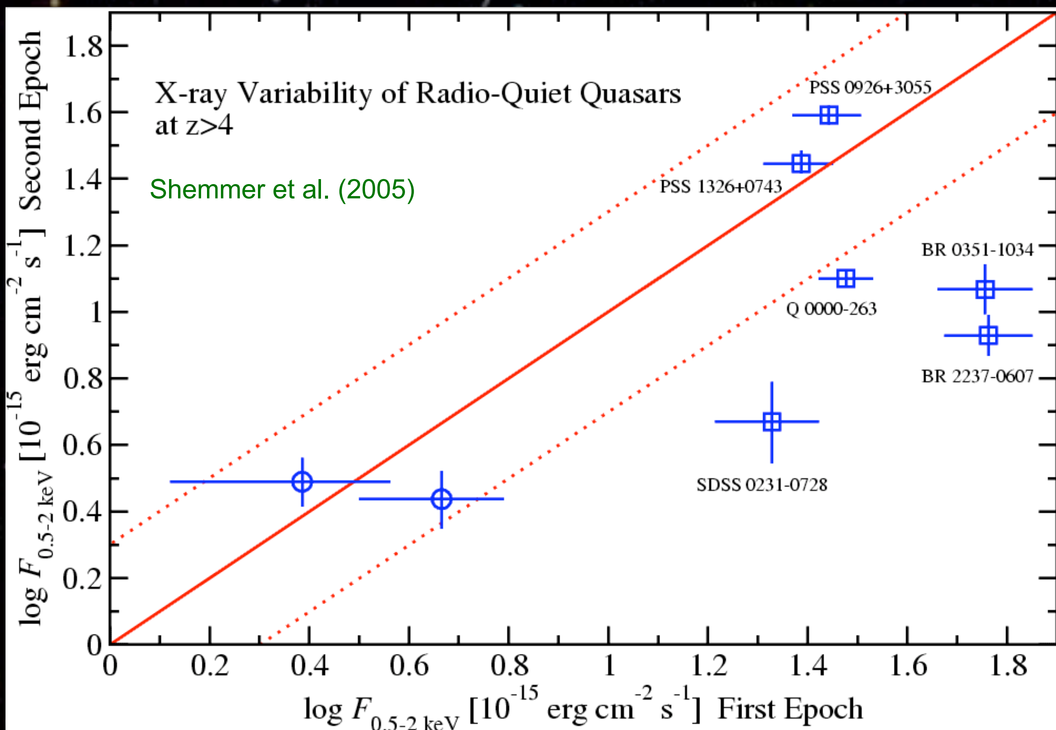
- Representative sample pushing to faintest BAT fluxes possible.
- Most-luminous obscured sources.
- Highest-redshift BAT sources.
- Objects not previously identified as AGNs at any wavelength.
- Unusual objects.

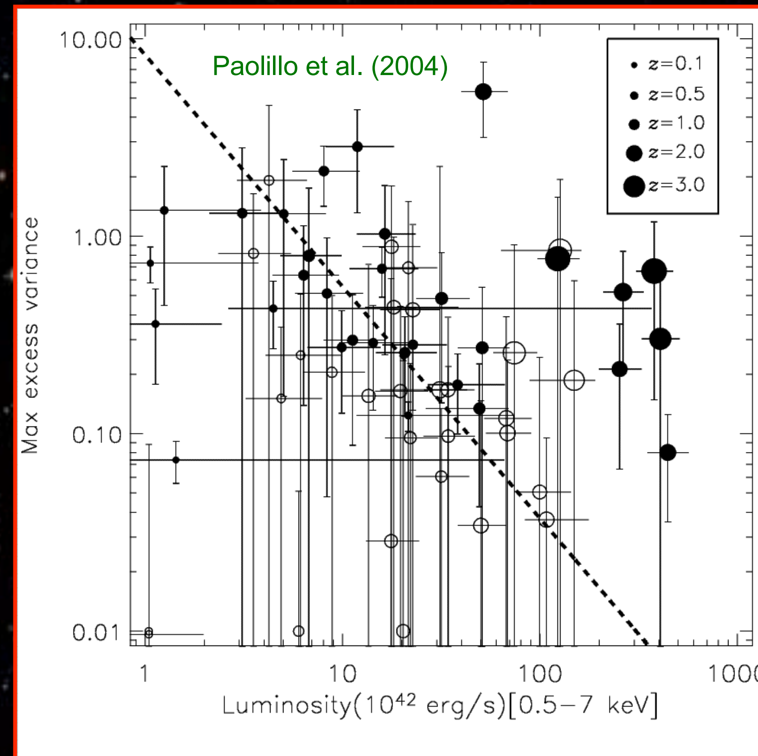
Active Galaxy Variability Studies with Swift

2-3 examples briefly – many more possibilities!

1. Luminous radio-quiet quasars at z ~ 1-5
2. Stellar tidal disruptions and other X-ray outbursts
3. Absorption-variability monitoring in local Seyferts

Changes in X-ray Variability with Redshift?



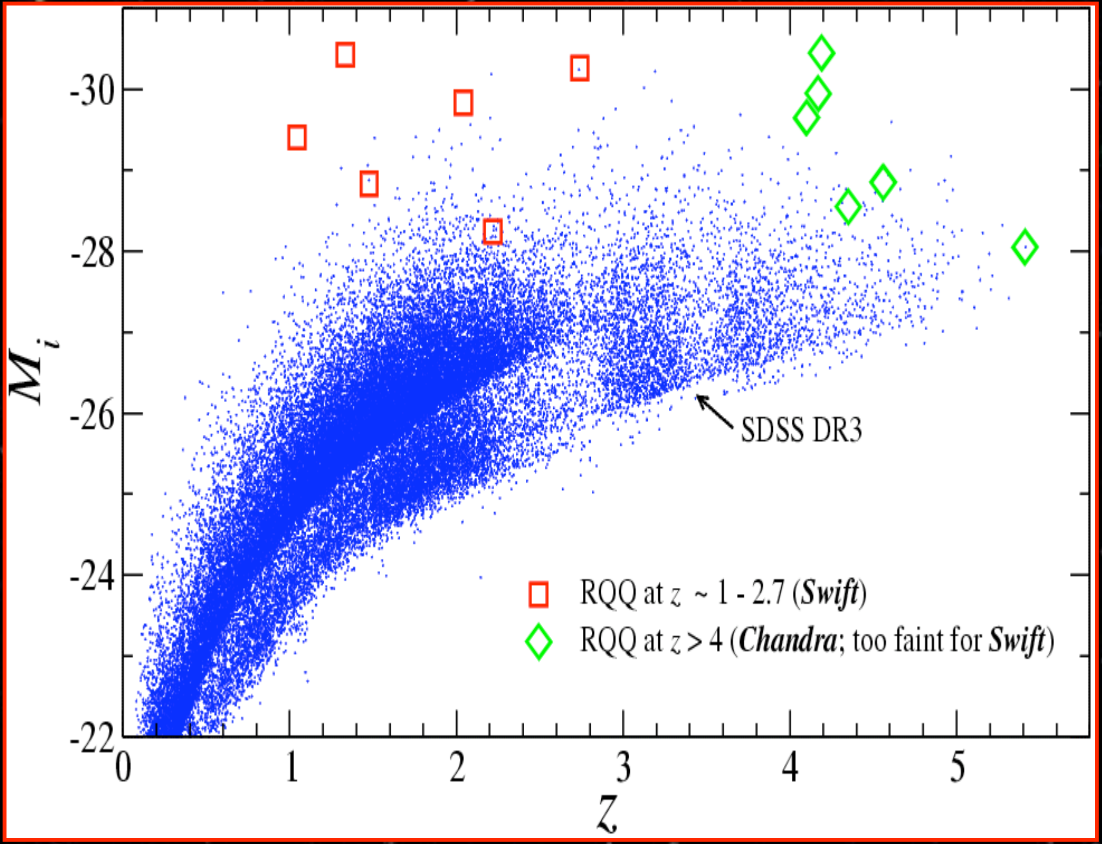


Little is known about X-ray variations of radio-quiet AGNs at moderate-to-high redshift, during main growth phase of SMBHs.

Significant X-ray variations, by a factor of ~ 2 or more, appear common among z ~ 4 quasars.

Some claims that AGNs (of matched luminosity) are more X-ray variable at high redshift. Changes of emission-region size, accretion rate, variability mechanism?

Swift + Chandra + XMM-Newton Variability Study



Swift + Chandra + XMM-Newton program can dramatically improve variability studies for luminous quasars at z ~ 1-5.

Observe ~ 10-12 luminous quasars for several years (~ 20 epochs), sampling range of timescales.

Flexible scheduling.

UVOT for optical-to-X-ray SED.

Utilize archival X-ray data for longest timescales possible.

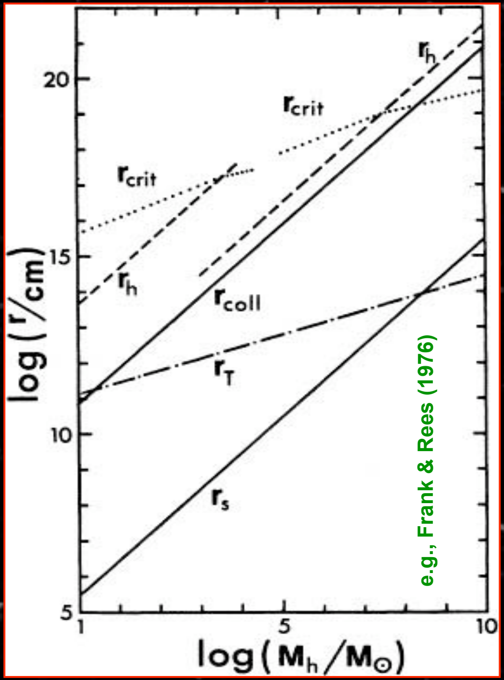
Four approved for Swift AF-4.

Combine with X-ray variability in Chandra Deep Fields to probe full luminosity-redshift space.

Three Swift targets (PG 1247+267, PG 1634+706, HS 1700+6416), being reverberation mapped to get SMBH masses.

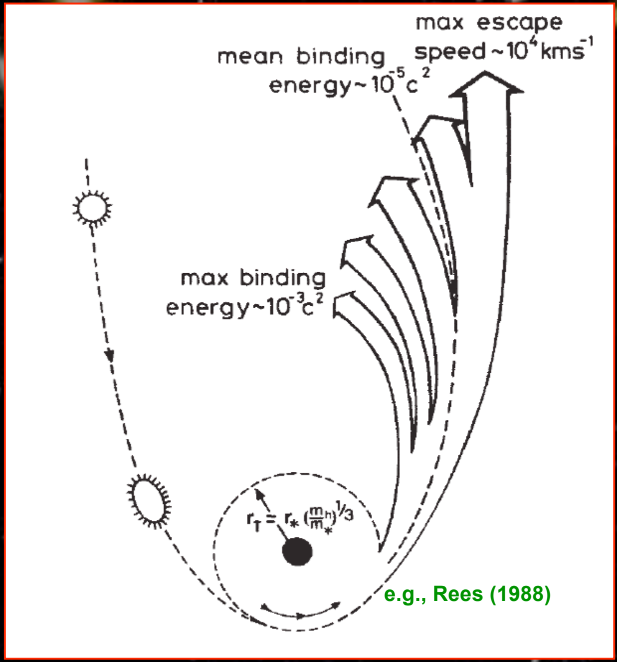
Stellar Tidal Disruptions and Accretion-Disk Instabilities

Critical Radii for Stellar Tidal Disruptions



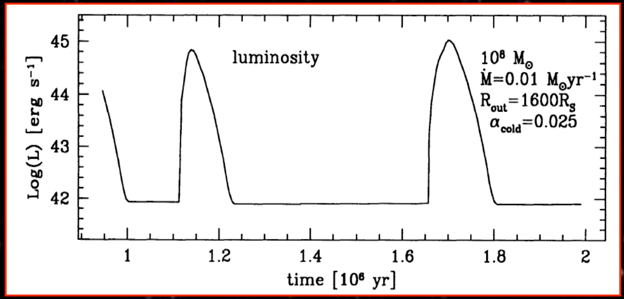
e.g., Frank & Rees (1976)

Disruption and Accretion & Ejection of Debris



e.g., Rees (1988)

Accretion Disk Instabilities in Active Galaxies



e.g., Siemiginowska et al. (1996)

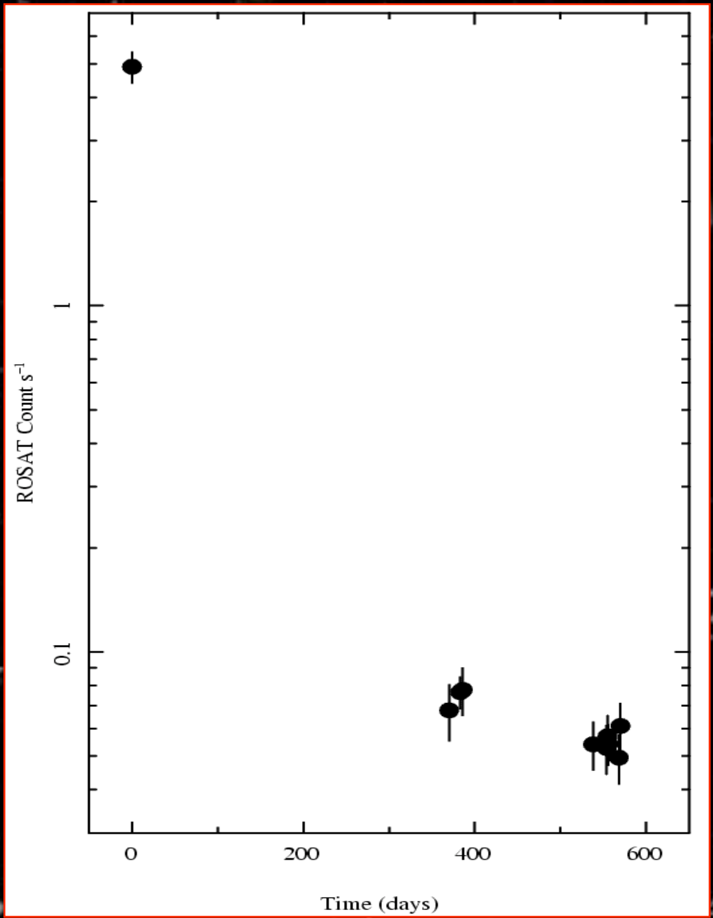
Stellar tidal disruptions (transient fueling) should be inevitable in crowded galactic centers.

Should lead to X-ray / UV flares of AGN-level luminosities over month-to-year timescales.

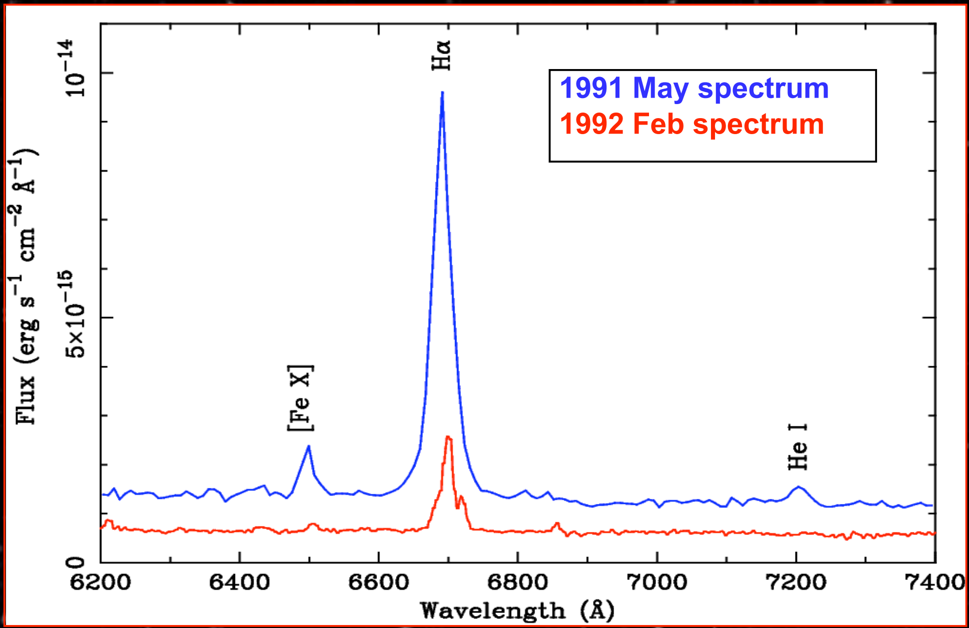
Evidence for such events, mainly from ROSAT and GALEX.

IC 3599: Example X-ray Outburst from the ROSAT All-Sky Survey

1990-1992 ROSAT Light Curve



Brandt et al. (1995); Grupe et al. (1995)



X-ray variability by factor of ~ 60+. Peak L_X ~ 5 x 10^{43} erg s^{-1}.

X-ray bright.

Very soft X-ray spectrum. Dominant kT ~ 90 eV blackbody.

X-ray outburst induced optical variability.

IC 3599 has a weak AGN. Other outbursts seen from non-AGN.

Catching Outbursts in Progress

Current outbursts only recognized after they were largely over (and faint).

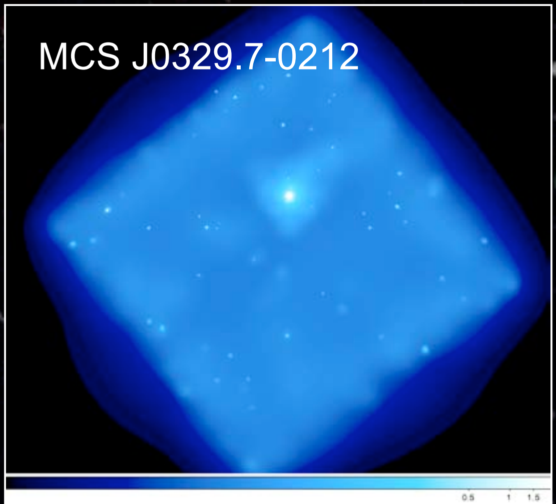
Ideally want to catch them in progress and study intensively with Swift and at other wavelengths (e.g., emission and absorption lines).

Ongoing and new surveys should deliver outbursts in progress:

- Supernova surveys
- Wide-field optical surveys
- GALEX surveys
- Chandra cluster survey

Swift Key Project on stellar tidal disruptions – waiting for event to trigger.

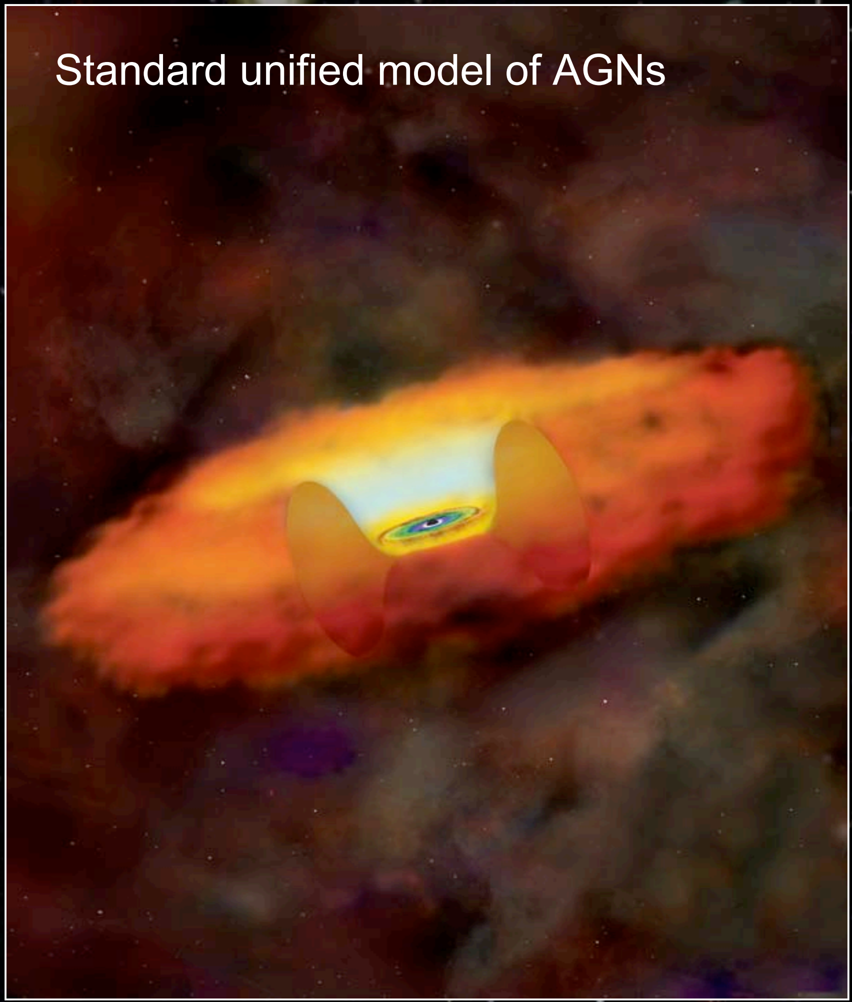
Rapid-Response X-ray Outburst Searches



CHANDRA CYCLE 8 TARGETS

Redshift	Current Chandra Exp (ks)	Name	RA 2000	DEC 2000	Requested Chandra Exp (ks)
0.494	64.04	MACS1311.0-0311	13 11 01.60	-03 10 38.0	7
0.465	68.19	MACS1621.6+3810	16 21 24.80	+38 10 08.0	7
0.450	40.17	MACS0329.7-0212	03 29 41.60	-02 11 47.0	7
0.391	34.33	MACS1720.3+3536	17 20 16.70	+35 36 26.0	7
0.390	40.34	CL0024+17	00 26 36.20	+17 09 43.0	7
0.379	25.19	ZWCL1953	08 50 06.30	+36 04 20.0	7
0.375	89.10	ABELL370	02 39 53.10	-01 34 45.0	7
0.328	54.76	ZWCL1358+6245	13 59 50.60	+62 31 04.0	7
0.318	58.23	ABELL1995	14 52 57.50	+58 02 55.2	7
0.308	25.14	A2744	00 14 13.00	-30 22 40.0	7
0.301	44.74	MS1008.1-1224	10 10 32.33	-12 39 32.2	7
0.279	59.09	A1758	13 32 43.20	+50 32 25.7	7
0.257	93.10	MS1455.0+2232	14 57 15.00	+22 20 31.0	7
0.246	82.59	A2125	15 40 58.30	+66 18 28.0	5
0.225	42.84	ABELL2219	16 40 24.00	+46 42 36.0	5
0.224	58.34	ABELL1942ANDCLUMP	14 38 21.90	+03 40 13.0	5
0.214	27.27	ZWICKY2701	09 52 49.20	+51 53 06.0	5
0.213	45.67	Abell222	01 37 34.40	-12 59 26.0	5
0.206	36.76	ABELL963	10 17 03.40	+39 02 51.0	5
0.199	67.15	ABELL520	04 54 09.80	+02 55 12.0	5
0.194	30.15	MS0839.9+2938	08 42 55.90	+29 27 27.0	5
0.183	41.44	Abell1689	13 11 34.20	-01 21 56.0	5
0.181	30.12	A665	08 30 53.30	+65 50 02.4	5
0.180	30.03	MS0906.5+1110	09 09 12.34	+10 58 30.6	5
0.175	49.24	A2218	16 35 52.80	+66 12 50.4	5
0.168	40.17	ABELL1201	11 12 54.40	+13 26 10.0	5
0.142	76.05	A1413	11 55 18.10	+23 24 17.0	5
0.113	54.70	A2034	15 10 11.71	+33 29 11.8	5
0.103	59.12	A1446	12 02 03.80	+58 02 09.4	5
0.102	28.33	PKS0745-191	07 47 31.10	-19 17 47.0	5
0.096	57.72	ABELL2244	17 02 42.60	+34 03 37.4	5
0.096	45.15	A2142	15 58 15.10	+27 14 43.0	5
0.084	170.10	Abell1650	12 58 41.30	-01 45 41.0	5
0.080	39.94	ABELL2255	17 12 41.50	+64 04 08.0	5
0.072	50.09	A2065	15 22 28.99	+27 42 29.9	5
0.059	56.47	A3158	03 42 43.90	-53 38 27.6	5
0.058	30.14	ABELL3266	04 31 15.10	-61 27 04.0	5
0.055	45.41	ABELL3667	20 12 50.30	-56 50 57.0	5

Problems with Classical AGN Obscuration Model



Unified AGN models have had great success, but classical “torus” is problematic:

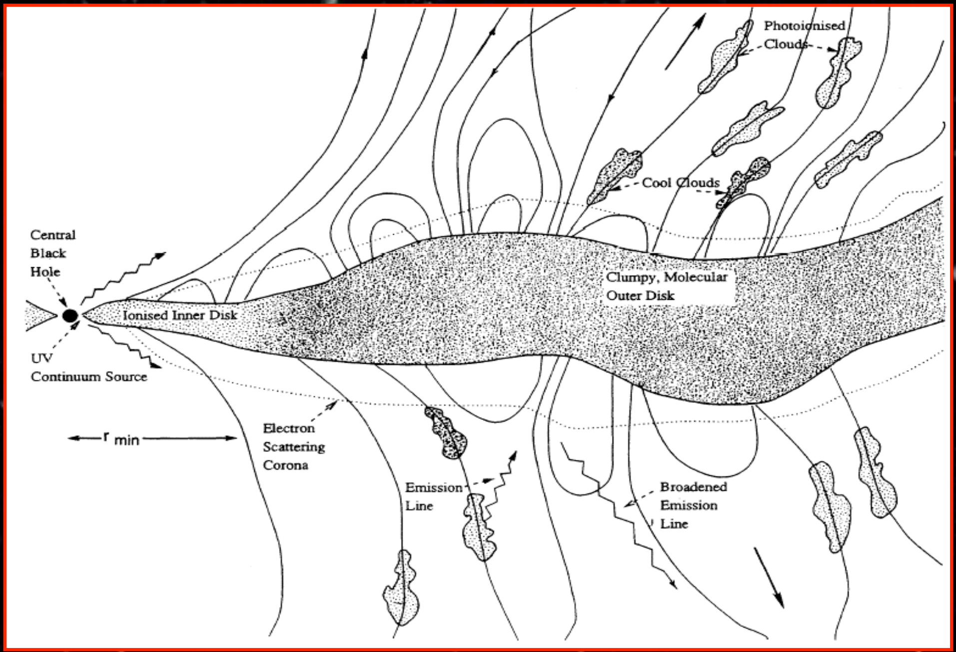
Vertical-support problem
(e.g., Krolik & Begelman 1988)

Failure to match resolved infrared measurements implies *clumping*
(e.g., Elitzur 2006)

X-ray absorption variability on timescales down to hours implies *small size*
(e.g., Risaliti et al. 2002)

Much still to be learned!

One Revised AGN Obscuration Model



Best current models propose that “torus” is a dynamic, clumpy structure.

Related to ubiquitous AGN winds that provide feedback to galaxies.

Current X-ray measurements of absorption variability suffer from
- Limited time sampling
- No complete sample studied systematically

Swift monitoring of a bright, well-defined sample of absorbed AGNs on wide range of timescales.

Constrain frequency, timescale, and level of absorption changes.
- Number of clouds along line of sight.
- Radial absorption profile – X-ray vs. infrared constraints.

Object-to-object variations
- Orientation effects
- Luminosity effects