XMM-Newton observations of transients

Tidal Disruption events and AGN outbursts workshop

26 June 2012, ESAC, Madrid, Spa

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(XMM-Newton Project Scientist)

Contents

- XMM-Newton
- TOO observations
- SN
- Extragalactic (Galactic) black holes
- Supermassive black holes
- AGN (winds, low states)
- What’s past is prologue

XMM-Newton

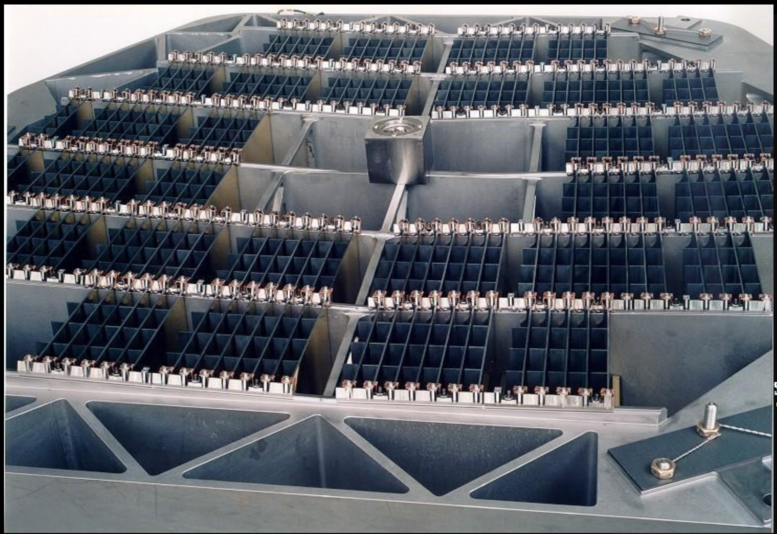
- XMM-Newton = .
  X-ray Multi-mirror Mission

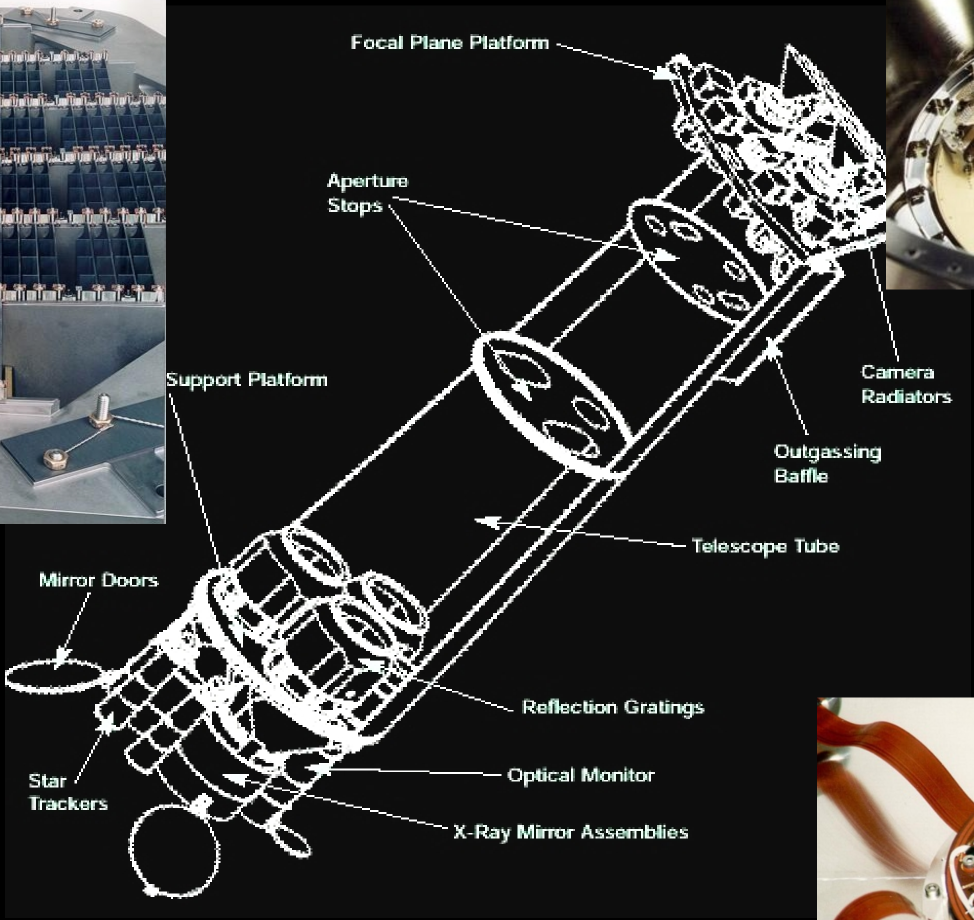
XMM-Newton preparation

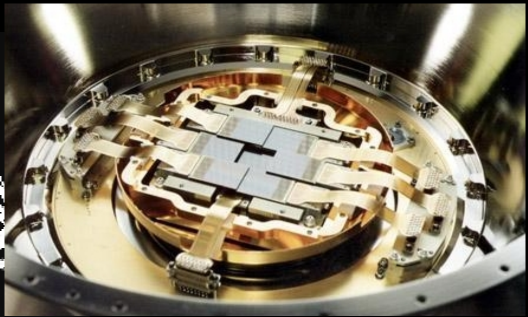
Image courtesy of D. Parker

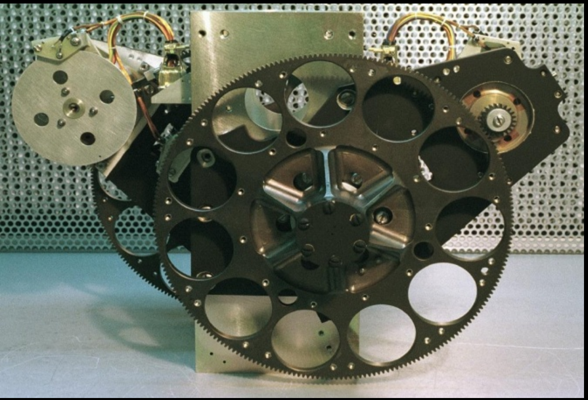
European Space Agency

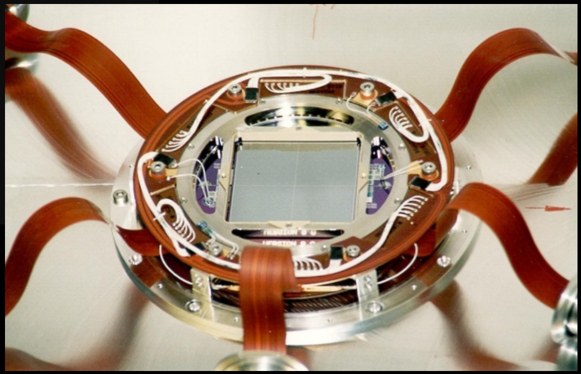
Instruments







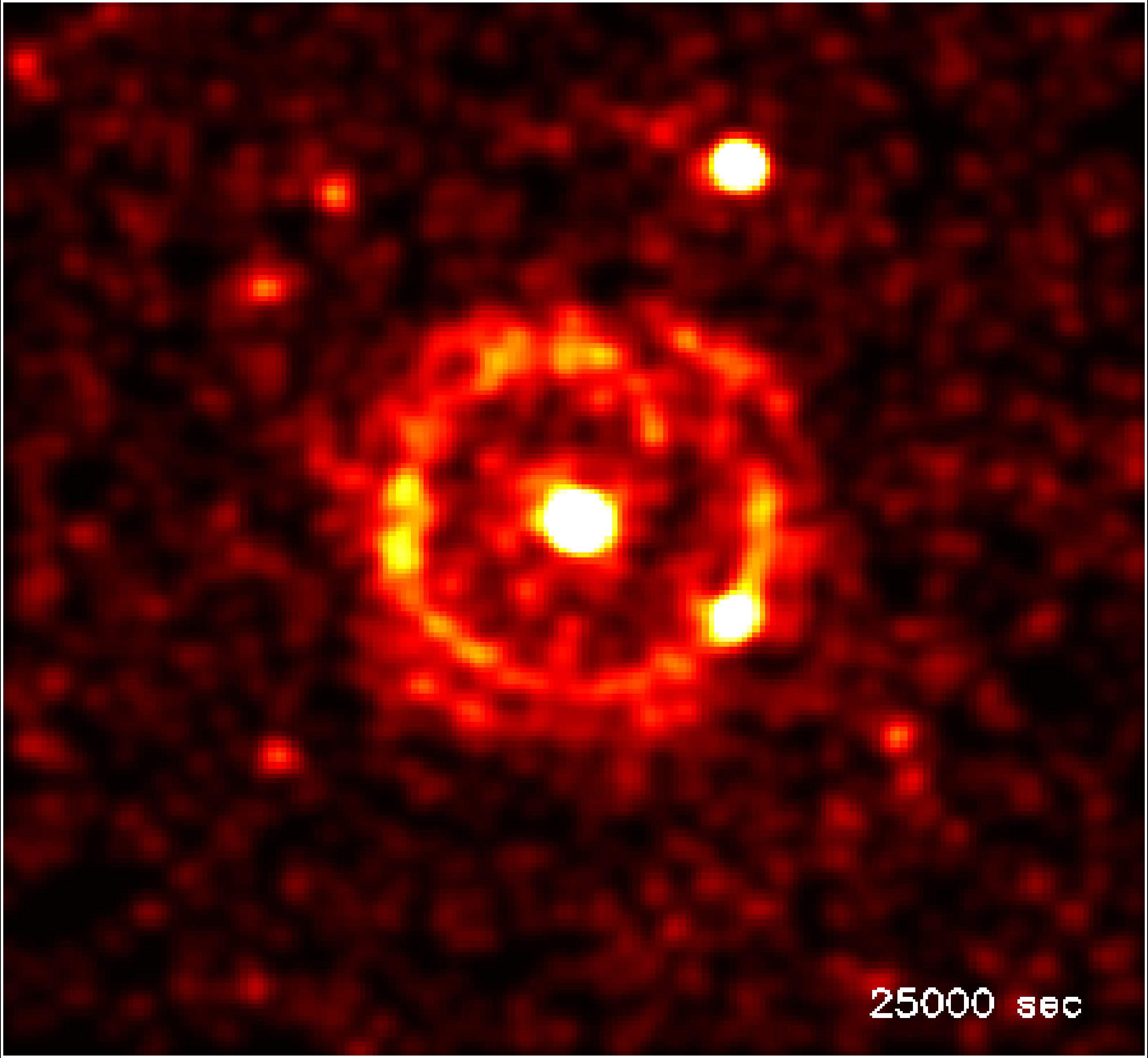




XMM-Newton

- 3 Mirror Modules / highest effective collecting area ever
- Six simultaneously observing instruments:
  - 3 CCD cameras (one pn and two MOSs)
  - 2 spectrometers (RGS)
  - 1 optical Monitor (OM)

GRB 031203 XMM–Newton observation



ESA, S. Vaughan (University of Leicester)

S. Vaughan et al., 2004, ApJ 603, L5

- Discovery of an evolving dust-scattered X-ray halo
- Will allow highly accurate distance determina-tions to the dust

XMM-Newton TOOs: Policies and Procedures

- The policies and procedures of TOO observations have changed several times along the mission reflecting changes of the scientific requirements
- A further major change is planned for the next AO which will streamline and simplify the procedures
- There will be two types of TOOs
  - Anticipated TOO observations:
  - All kind of transient events which are expected to be observable with XMM-Newton once within three years

  → A proposal must be send to OTAC and must be approved by OTAC
- Unanticipated TOO observations:
  - Events which are too rare to be expected to be observable with XMM-Newton within a timeframe of three years

  → TOO notification should be send to XMM-Newton

  → http://xmm2.esac.esa.int/external/xmm_sched/too/too_alert.shtml

Anticipated TOO observations

PropId	PI	Target	RA	Dec	Duration (s)	AO	Priority	Valid during
60184	Starling	GRB1	0.00000	0.00000	13000	8	B	AO8, AO9, AO10
60184	Starling	GRB1	0.00000	0.00000	63000	8	B	AO8, AO9, AO10
65061	Gendre	GRB#1	0.00000	0.00000	53000	9	B	AO9, AO10, AO11
65099	SOLERI	GRS 1915+105	288.79834	10.94556	43000	9	A	AO9, AO10, AO11
65129	Starling	GRB 1	0.00000	0.00000	13000	9	A	AO9, AO10, AO11
65129	Starling	GRB 1	0.00000	0.00000	63000	9	A	AO9, AO10, AO11
65152	Hiemstra	XTE J1118+480	169.54543	48.03694	37000	9	A	AO9, AO10, AO11
65152	Hiemstra	XTE J1817-330	274.43143	-33.01880	42000	9	B	AO9, AO10, AO11
65228	Grosso	PMS star in outburst	0.00000	0.00000	31900	9	B	AO9, AO10, AO11
65241	Pandel	Fermi Transient	0.00000	0.00000	13000	9	B	AO9, AO10, AO11
65413	Uttley	SWIFT J1753.5-0127	268.36792	-1.45250	33000	9	A	AO9, AO10, AO11
69044	Israel	SWIFT J1834.9-0846	278.71751	-8.76597	0	11	B	AO11, AO12, AO13
69087	Schartel	AGN 1 (short)	0.00000	0.00000	13000	11	B	AO11, AO12, AO13
69087	Schartel	AGN 2 (short)	0.00000	0.00000	13000	11	B	AO11, AO12, AO13
69087	Schartel	Follow-up AGN (long)	0.00000	0.00000	83000	11	B	AO11, AO12, AO13
69109	Boettcher	New VHE Blazar	0.00000	0.00000	23000	11	C	AO11
69109	Boettcher	New VHE Blazar	0.00000	0.00000	23000	11	C	AO11
69110	Saxton	Galaxy 11	0.00000	0.00000	33000	11	C	AO11
69110	Saxton	Galaxy 11	0.00000	0.00000	33000	11	C	AO11
69127	Reis	MAXI J1836-194	278.93084	-19.32000	43000	11	C	AO11
69127	Reis	MAXI J1543-564	235.82224	-56.41340	0	11	C	AO11

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Unanticipated TOO observations

Rev	Observation Id	Target	RA	Dec	Exp. Time (ksec)	Data Status	ODF Data when available	PPS Data when available	Comments
2204	0679381201	XMMSL1J063045-603110	06:30:45.45	-60:31:12.8	15.8	ToO (02-Jul-2012)	ODF Data	PPS Data	(Dr. R. Saxton)
2200	0679381101	NGC3690	11:28:28.00	+58:33:38.0	12.8	ToO (22-Jun-2012)	ODF Data	PPS Data	(Dr. M. Perez Torres)
2189	0679380901	Swift 2058+0516	20:58:19.85	+05:13:33.0	30.4	ToO (30-May-2012)	ODF Data	PPS Data	(Dr. A. Levan)
2188	0679380801	Swift 2058+0516	20:58:19.85	+05:13:33.0	25.0	ToO (30-May-2012)	ODF Data	PPS Data	(Dr. A. Levan)
2175	0679381001	Mars	09:37:21.10	+15:47:26.0	23.0	ToO (02-May-2012)	ODF Data	PPS Data	(Dr. K. Dennerl)
2173	0658400901	GRB 111020A	19:08:12.73	-38:00:42.4	30.0	ToO (Public)	ODF Data	PPS Data	-
2172	0679380401	XMMSL1 J061313.2-274206	06:13:13.3	-27:42:05.5	8.0	ToO (26-Apr-2012)	ODF Data	PPS Data	(Dr. B. Stelzer)
2170	0679380701	OJ 287	08:54:48.87	+20:06:30.6	25.0	ToO (Public)	ODF Data	PPS Data	-
2169	0679380601	XMMSL1 J192252.3-483210	19:22:52.40	-48:32:10.5	8.0	ToO (21-Apr-2012)	ODF Data	PPS Data	(Dr. B. Stelzer)
2169	0679181201	PLCK G11.2-40.4	21:00:55.9	-33:06:24.5	15.3	DPS (21-Apr-2012)	ODF Data	PPS Data	(Dr. M. Arnaud)
2168	0679181401	PLCK G210.6+20.4	8:00:52.3	+11:05:35.5	15.3	DPS (21-Apr-2012)	ODF Data	PPS Data	(Dr. M. Arnaud)
2167	0679180701	PLCK G204.7+15.9	7:34:26.9	+14:16:21.4	16.4	DPS (21-Apr-2012)	ODF Data	PPS Data	(Dr. M. Arnaud)
2164	0678381201	SWIFT J164449.3+573451	16:44:49.30	+57:34:51.0	29.5	ToO (11-Apr-2012)	ODF Data	PPS Data	(Dr. J. Miller)
2161	0679380501	CXOU J164710.2-455216	16:47:10.2	-45:52:17.0	20.0	ToO (04-Apr-2012)	ODF Data	PPS Data	(Dr. G. Israel)
2159	0679380301	IGR J17361-4441	17:36:17.41	-44:44:06.0	43.6	ToO (30-Mar-2012)	ODF Data	PPS Data	(Dr. Wijnands)
2159	0679180101	PLCK G348.4-25.5	19:24:54.6	-49:25:55.6	15.3	DPS (21-Apr-2012)	ODF Data	PPS Data	(Dr. M. Arnaud)
2158	0678381101	SWIFT J164449.3+573451	16:44:49.30	+57:34:51.0	23.8	ToO (11-Apr-2012)	ODF Data	PPS Data	(Dr. J. Miller)
2157	0679180201	PLCK G352.1-24.0	19:20:55.9	-45:50:32.6	15.3	DPS (21-Apr-2012)	ODF Data	PPS Data	(Dr. M. Arnaud)
2156	0679380201	SGR J1834.9-0846	18:34:52.10	-08:45:56.0	30.0	ToO (28-Mar-2012)	ODF Data	PPS Data	(Dr. Kargaltsev)
2156	0679180301	PLCK G305.9-44.6	0:23:47.0	-72:23:33.0	17.1	DPS (21-Apr-2012)	ODF Data	PPS Data	(Dr. M. Arnaud)
2153	0679181501	PLCK G329.5-22.7	18:33:04.8	-65:34:12.4	15.3	DPS (21-Apr-2012)	ODF Data	PPS Data	(Dr. M. Arnaud)
2151	0678381001	SWIFT J164449.3+573451	16:44:49.30	+57:34:51.0	25.0	ToO (11-Apr-2012)	ODF Data	PPS Data	(Dr. J. Miller)
2146	0678380901	SWIFT J164449.3+573451	16:44:49.30	+57:34:51.0	30.0	ToO (11-Apr-2012)	ODF Data	PPS Data	(Dr. J. Miller)
2143	0679181301	PLCK G147.3-16.6	2:56:29.30	+40:15:47.8	18.0	DPS (21-Apr-2012)	ODF Data	PPS Data	(Dr. M. Arnaud)
2142	0679180501	PLCK G219.9-34.4	4:54:44.50	-20:17:28.0	16.5	DPS (21-Apr-2012)	ODF Data	PPS Data	(Dr. M. Arnaud)
2142	0679180401	PLCK G196.7-45.5	3:42:56.10	-08:42:40.9	16.4	DPS (21-Apr-2012)	ODF Data	PPS Data	(Dr. M. Arnaud)
2141	0679181001	PLCK G239.9-40.0	4:46:48.80	-37:05:04.2	17.0	DPS (21-Apr-2012)	ODF Data	PPS Data	(Dr. M. Arnaud)
2140	0679180801	PLCK G130.1-17.0	1:30:55.60	+45:16:34.6	16.4	DPS (21-Apr-2012)	ODF Data	PPS Data	(Dr. M. Arnaud)
2140	0677981201	Comet 45P Honda	07:18:35.62	-60:01:36.0	25.2	ToO (Public)	ODF Data	PPS Data	-
2139	0679180901	PLCK G310.5+27.1	13:24:38.30	-35:13:29.9	20.6	DPS (21-Apr-2012)	ODF Data	PPS Data	(Dr. M. Arnaud)
2139	0678380801	SWIFT J164449.3+573451	16:44:49.30	+57:34:51.0	30.5	ToO (21-Apr-2012)	ODF Data	PPS Data	(Dr. J. Miller)

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2204	0679381201	XMMSL1 J063045-603110	06:30:45.45	-60:31:12.8	15.8	ToO (02-Jul-2012)	ODF Data	PPS Data	(Dr. R. Saxton)
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2170	067938070	OJ 287	08:54:48.87	+20:06:30.6	25.0	ToO (Public)	ODF Data	PPS Data	-
2169	0679380601	XMMSL1 J192252.3-483210	19:22:52.40	-48:32:10.5	8.0	ToO (21-Apr-2012)	ODF Data	PPS Data	(Dr. B. Stelzer)
2169	0679181201	PLCK G11.2-40.4	21:00:55.9	-33:06:24.5	15.3	DPS (21-Apr-2012)	ODF Data	PPS Data	(Dr. M. Arnaud)
2168	0679181401	PLCK G210.6+20.4	8:00:52.3	+11:05:35.5	15.3	DPS (21-Apr-2012)	ODF Data	PPS Data	(Dr. M. Arnaud)
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2159	0679380301	IGR J17361-4441	17:36:17.41	-44:44:06.0	43.6	ToO (30-Mar-2012)	ODF Data	PPS Data	(Dr. Wijnands)
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2146	0678380901	SWIFT J164449.3+573451	16:44:49.30	+57:34:51.0	30.0	ToO (11-Apr-2012)	ODF Data	PPS Data	(Dr. J. Miller)
2143	0679181301	PLCK G147.3-16.6	2:56:29.30	+40:15:47.8	18.0	DPS (21-Apr-2012)	ODF Data	PPS Data	(Dr. M. Arnaud)
2142	0679180501	PLCK G219.9-34.4	4:54:44.50	-20:17:28.0	16.5	DPS (21-Apr-2012)	ODF Data	PPS Data	(Dr. M. Arnaud)
2142	0679180401	PLCK G196.7-45.5	3:42:56.10	-08:42:40.9	16.4	DPS (21-Apr-2012)	ODF Data	PPS Data	(Dr. M. Arnaud)
2141	0679181001	PLCK G239.9-40.0	4:46:48.80	-37:05:04.2	17.0	DPS (21-Apr-2012)	ODF Data	PPS Data	(Dr. M. Arnaud)
2140	0679180801	PLCK G130.1-17.0	1:30:55.60	+45:16:34.6	16.4	DPS (21-Apr-2012)	ODF Data	PPS Data	(Dr. M. Arnaud)
2140	0677981201	Comet 45P Honda	07:18:35.62	-60:01:36.0	25.2	ToO (Public)	ODF Data	PPS Data	-
2139	0679180901	PLCK G310.5+27.1	13:24:38.30	-35:13:29.9	20.6	DPS (21-Apr-2012)	ODF Data	PPS Data	(Dr. M. Arnaud)
2139	0678380801	SWIFT J164449.3+573451	16:44:49.30	+57:34:51.0	30.5	ToO (21-Apr-2012)	ODF Data	PPS Data	(Dr. J. Miller)

Unanticipated TOO observations

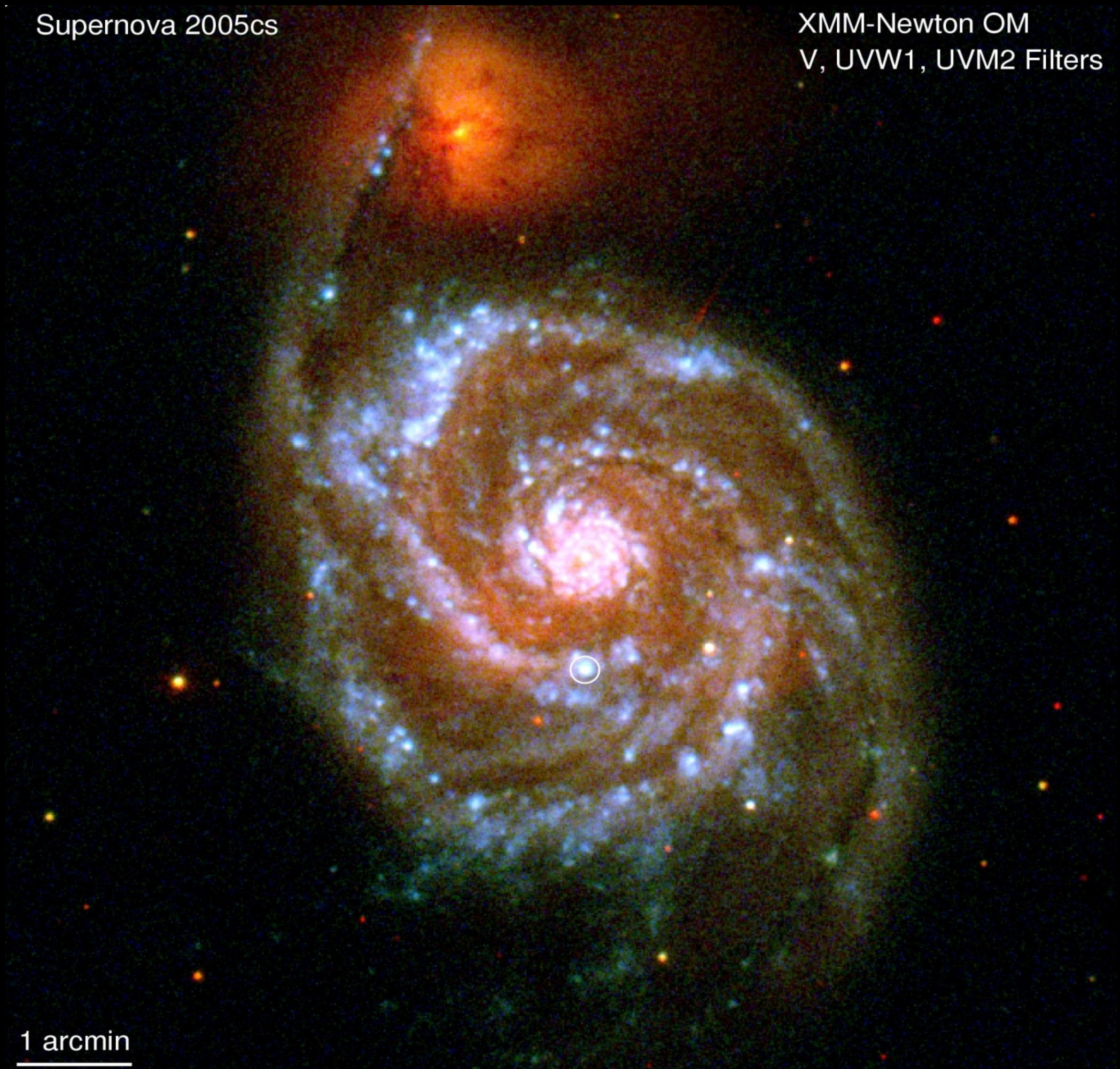
Rev	Observation Id	Target	RA	Dec	Exp. Time (ksec)	Data Status	ODF Data when available	PPS Data when available	Comments
2204	0679381201	XMMSL1J063045-603110	06:30:45.45	-60:31:12.8	15.8	ToO (02-Jul-2012)	ODF Data	PPS Data	(Dr. R. Saxton)
2200	0679381101	NGC3690	11:28:28.00	+58:33:38.0	12.8	ToO (22-Jun-2012)	ODF Data	PPS Data	(Dr. M. Perez Torres)
2189	0679380901	Swift 2058+0516	20:58:19.85	+05:13:33.0	30.4	ToO (30-May-2012)	ODF Data	PPS Data	(Dr. A. Levan)
2188	0679380801	Swift 2058+0516	20:58:19.85	+05:13:33.0	25.0	ToO (30-May-2012)	ODF Data	PPS Data	(Dr. A. Levan)
2175	0679381001	Mars	09:37:21.10	+15:47:26.0	23.0	ToO (02-May-2012)	ODF Data	PPS Data	(Dr. K. Dennerl)
2173	0658400901	GRB 111020A	19:08:12.73	-38:00:42.4	30.0	ToO (Public)	ODF Data	PPS Data	-
2172	0679380401	XMMSL1 J061313.2-274206	06:13:13.3	-27:42:05.5	8.0	ToO (26-Apr-2012)	ODF Data	PPS Data	(Dr. B. Stelzer)
2170	0679380701	OJ 287	08:54:48.87	+20:06:30.6	25.0	ToO (Public)	ODF Data	PPS Data	-
2169	0679380601	XMMSL1 J192252.3-483210	19:22:52.40	-48:32:10.5	8.0	ToO (21-Apr-2012)	ODF Data	PPS Data	(Dr. B. Stelzer)
2169	0679181201	PLCK G11.2-40.4	21:00:55.9	-33:06:24.5	15.3	DPS (21-Apr-2012)	ODF Data	PPS Data	(Dr. M. Arnaud)
2168	0679181401	PLCK G210.6+20.4	8:00:52.3	+11:05:35.5	15.3	DPS (21-Apr-2012)	ODF Data	PPS Data	(Dr. M. Arnaud)
2167	0679180701	PLCK G204.7+15.9	7:34:26.9	+14:16:21.4	16.4	DPS (21-Apr-2012)	ODF Data	PPS Data	(Dr. M. Arnaud)
2164	0678381201	SWIFT J164449.3+573451 ←	16:44:49.30	+57:34:51.0	29.5	ToO (11-Apr-2012)	ODF Data	PPS Data	(Dr. J. Miller)
2161	0679380501	CXOU J164710.2-455216	16:47:10.2	-45:52:17.0	20.0	ToO (04-Apr-2012)	ODF Data	PPS Data	(Dr. G. Israel)
2159	0679380301	IGR J17361-4441	17:36:17.41	-44:44:06.0	43.6	ToO (30-Mar-2012)	ODF Data	PPS Data	(Dr. Wijnands)
2159	0679180101	PLCK G348.4-25.5	19:24:54.6	-49:25:55.6	15.3	DPS (21-Apr-2012)	ODF Data	PPS Data	(Dr. M. Arnaud)
2158	0678381101	SWIFT J164449.3+573451 ←	16:44:49.30	+57:34:51.0	23.8	ToO (11-Apr-2012)	ODF Data	PPS Data	(Dr. J. Miller)
2157	0679180201	PLCK G352.1-24.0	19:20:55.9	-45:50:32.6	15.3	DPS (21-Apr-2012)	ODF Data	PPS Data	(Dr. M. Arnaud)
2156	0679380201	SGR J1834.9-0846	18:34:52.10	-08:45:56.0	30.0	ToO (28-Mar-2012)	ODF Data	PPS Data	(Dr. Kargaltsev)
2156	0679180301	PLCK G305.9-44.6	0:23:47.0	-72:23:33.0	17.1	DPS (21-Apr-2012)	ODF Data	PPS Data	(Dr. M. Arnaud)
2153	0679181501	PLCK G329.5-22.7	18:33:04.8	-65:34:12.4	15.3	DPS (21-Apr-2012)	ODF Data	PPS Data	(Dr. M. Arnaud)
2151	0678381001	SWIFT J164449.3+573451 ←	16:44:49.30	+57:34:51.0	25.0	ToO (11-Apr-2012)	ODF Data	PPS Data	(Dr. J. Miller)
2146	0678380901	SWIFT J164449.3+573451 ←	16:44:49.30	+57:34:51.0	30.0	ToO (11-Apr-2012)	ODF Data	PPS Data	(Dr. J. Miller)
2143	0679181301	PLCK G147.3-16.6	2:56:29.30	+40:15:47.8	18.0	DPS (21-Apr-2012)	ODF Data	PPS Data	(Dr. M. Arnaud)
2142	0679180501	PLCK G219.9-34.4	4:54:44.50	-20:17:28.0	16.5	DPS (21-Apr-2012)	ODF Data	PPS Data	(Dr. M. Arnaud)
2142	0679180401	PLCK G196.7-45.5	3:42:56.10	-08:42:40.9	16.4	DPS (21-Apr-2012)	ODF Data	PPS Data	(Dr. M. Arnaud)
2141	0679181001	PLCK G239.9-40.0	4:46:48.80	-37:05:04.2	17.0	DPS (21-Apr-2012)	ODF Data	PPS Data	(Dr. M. Arnaud)
2140	0679180801	PLCK G130.1-17.0	1:30:55.60	+45:16:34.6	16.4	DPS (21-Apr-2012)	ODF Data	PPS Data	(Dr. M. Arnaud)
2140	0677981201	Comet 45P Honda	07:18:35.62	-60:01:36.0	25.2	ToO (Public)	ODF Data	PPS Data	-
2139	0679180901	PLCK G310.5+27.1	13:24:38.30	-35:13:29.9	20.6	DPS (21-Apr-2012)	ODF Data	PPS Data	(Dr. M. Arnaud)
2139	0678380801	SWIFT J164449.3+573451 ←	16:44:49.30	+57:34:51.0	30.5	ToO (21-Apr-2012)	ODF Data	PPS Data	(Dr. J. Miller)

12 x 25ks = 300 ks

AO-12 Joint XMM-Newton / SWIFT

- Joint XMM-Newton SWIFT program from next AO onward
- The details are:
  - Proposers can ask for Swift time through XMM-Newton AO.
  - Swift time can be constrained (including monitoring) or unconstrained, ToOs or non-ToOs.
  - Proposals will be evaluated and selected by XMM-Newton OTAC only.
  - If accepted, successful proposers are requested to fill out a Swift cover and target form in the SWIFT RPS/ARK.

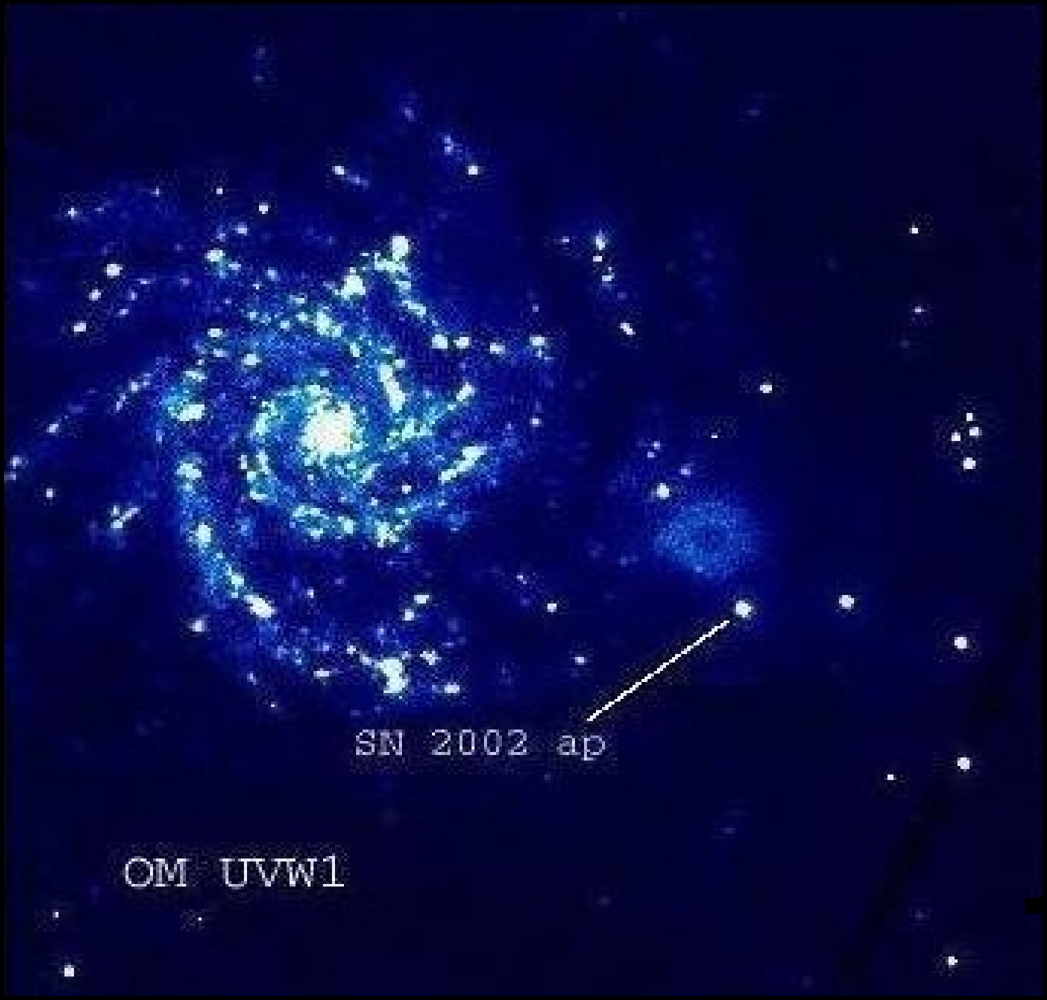
Supernova: SN 2005cs



- OM image of SN 2005cs
- Type II supernova in the nearby galaxy M51
- Observed as a Target of Opportunity the 1st of July, 2005.

➔ In the ultra-violet the supernova is brighter than the galaxy nucleus.

Supernova: SN 2002ap

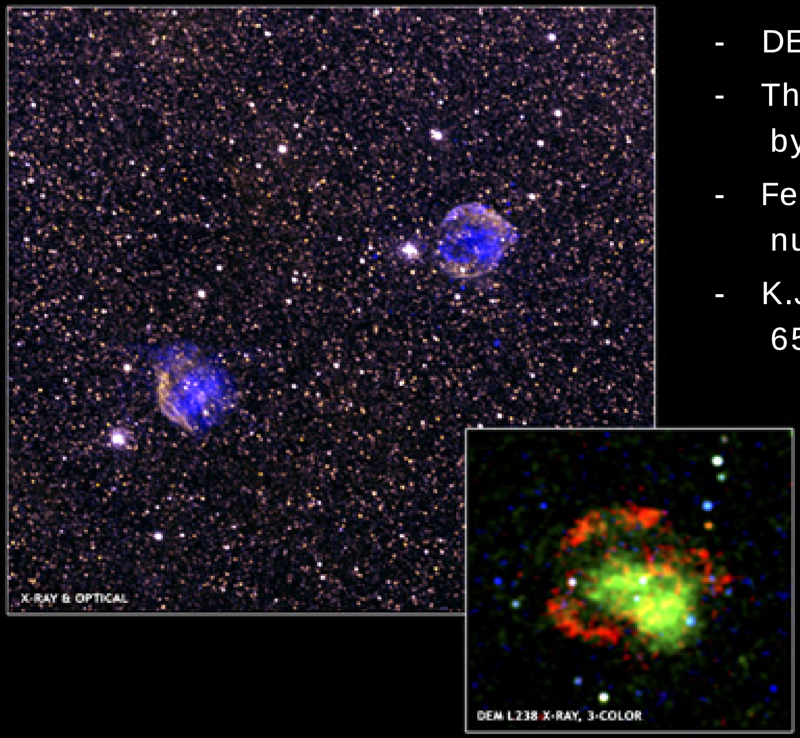


- in M74 (NGC 628)
- SN in general detected in UV, but often not in X-rays

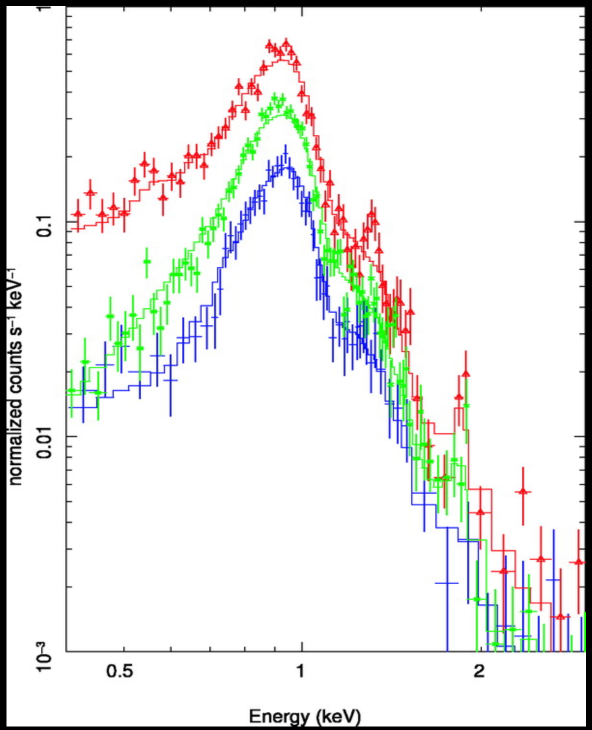
➔ SN 2002ap detected in X-rays with XMM-Newton

- R. Soria et al., 2002, ApJ 572, L33; F. K. Sutaria et al., 2003, A&A 397, 1011; R. Soria et al., 2004, A&A 413, 107; C.-I. Björnsson & C. Fransson, 2004, ApJ 605, 823; P. Chandra et al., 2004, NuPhS 132, 308
- Image courtesy P. Rodriguez

New Class Of Type 1 SN



- DEM L238 & DEM L249
- Thermal spectrum dominated by Fe L-shell lines
- Fe over-abundance ➔ Thermo-nuclear Type Ia explosions
- K.J. Borkowski et al. 2007, ApJ 652, 1259

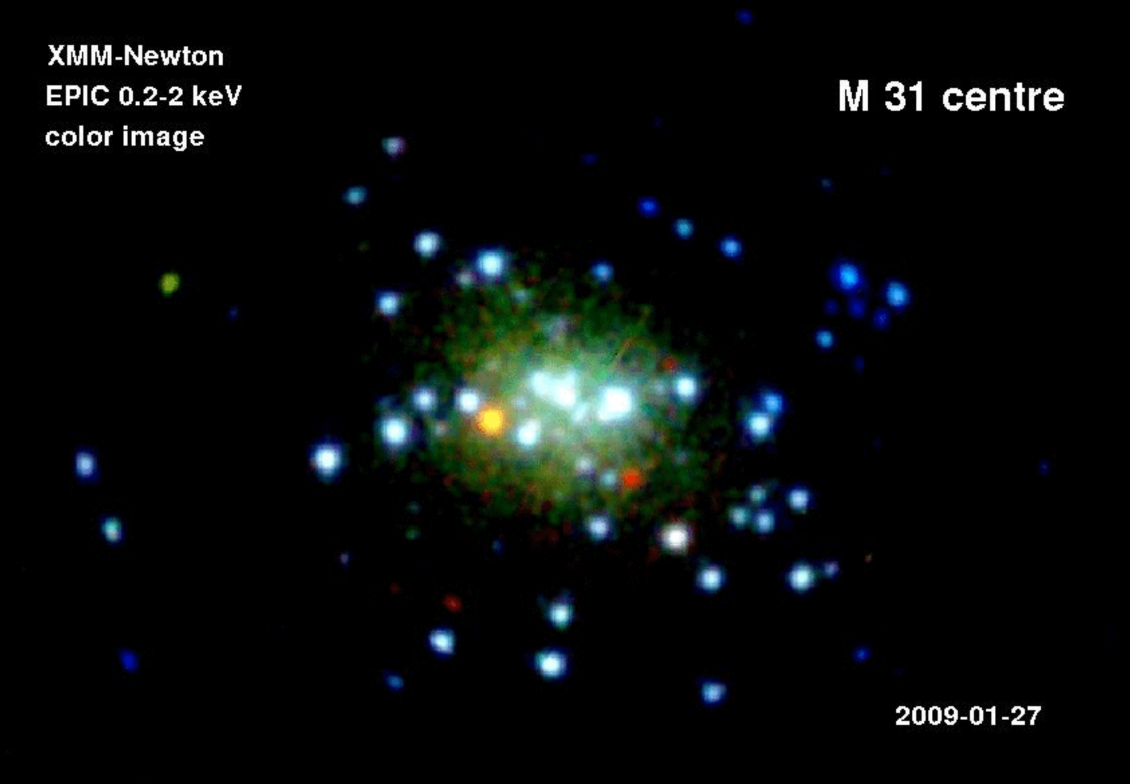


➔ Explosions with energies of 3×10^{50} ergs

➔ New class of SN Ia, more massive and young (100 Myr old) progenitors

Black Holes

The first ultraluminous X-ray source (ULX) in M31



- New, transient ultraluminous X-ray source (ULX) discovered by Chandra in M31 with a luminosity at ~5 × 10^{39} erg s^{-1}.
- 5 subsequent XMM-Newton observations show steady decline in X-ray luminosity over 1.5 months, from 1.8 × 10^{39} to 0.6 × 10^{39} erg s^{-1}

➔ Best sequence of high Eddington spectra ever assembled (low absorption & XMM-Newton)

- The spectra can be described by our best current disc model (10 M_{sun} black hole) or by a disc emission affected by advection & low-temperature Comptonization.

➔ Accretion on to a stellar mass black hole in a LMXB accreting in the Eddington regime.

➔ unambiguous connection of this object, and, by extension, similar low-luminosity ULXs, to 'standard' X-ray binaries.

A. Kaur, et al., 2012, AA 538, 49

M. J. Middleton, et al., 2012, MNRAS.tmp.2390M

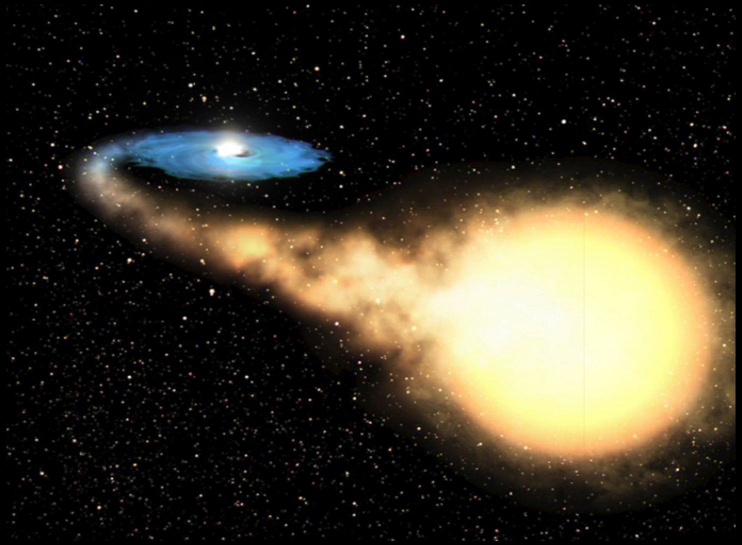
First Black Hole In Globular Star Clusters

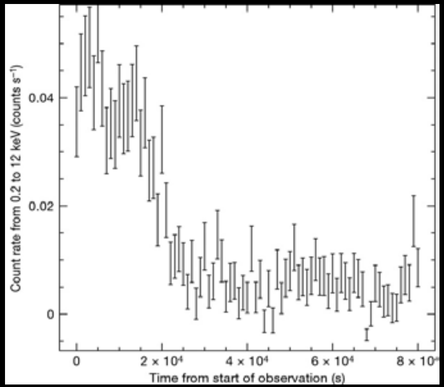
- GCs contain 10^3-10^6 old stars packed within tens of light years

➔ Formation of 10^3 solar mass BH ?

➔Interaction will eject BHs ?

T.J. Maccarone et al., 2007, Nature 445, 183



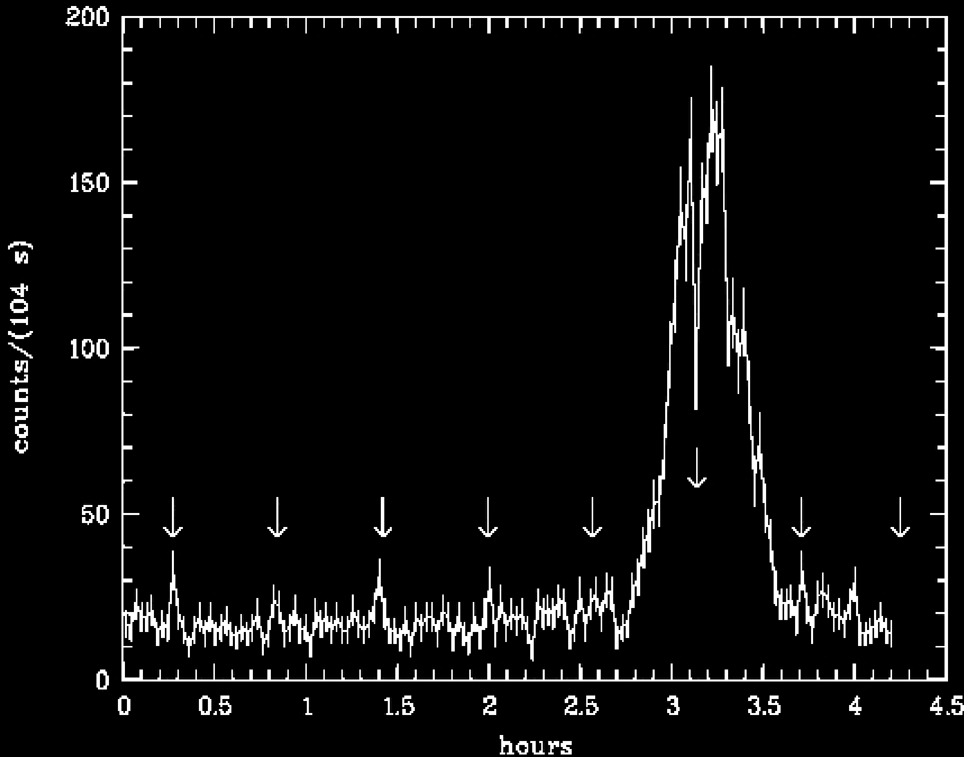


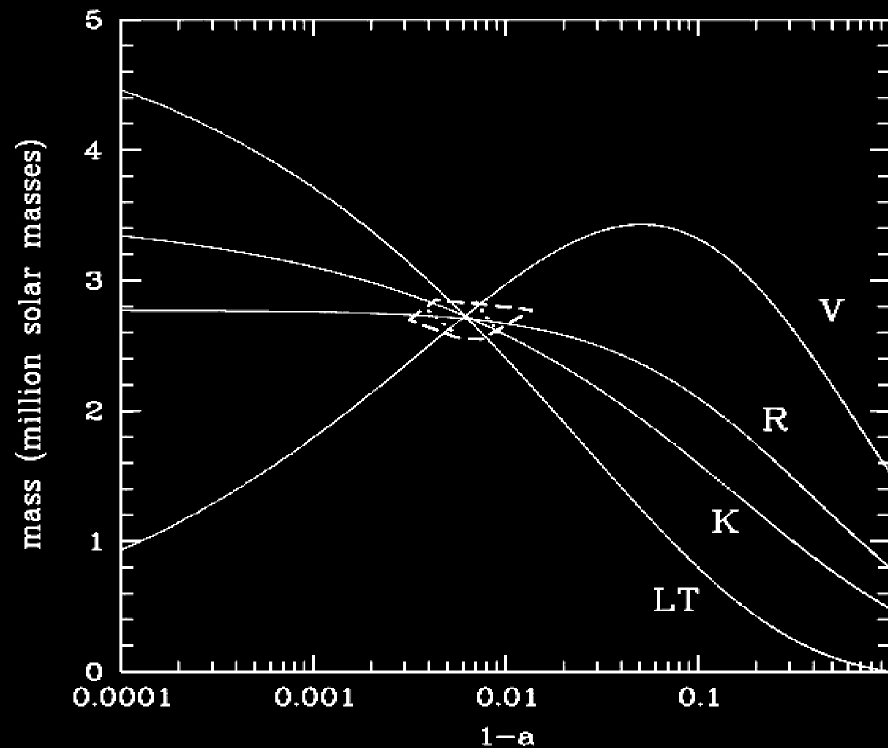
- X-ray source in GC associated with NGC 4472 (in the Virgo cluster)
- X-ray luminosity: $4x10^{39}$ erg s^{-1}
- Variability excludes composition by several objects

➔ Black hole (15-30 or 400 solar masses)

Supermassive black hole transients

X-Ray Flare of the Galactic Center BH





B. Aschenbach et al., 2004, A&A 417, 71

-Power density spectrum peaks at periods of 100s, 219s, 700s, 1150s and 2250s

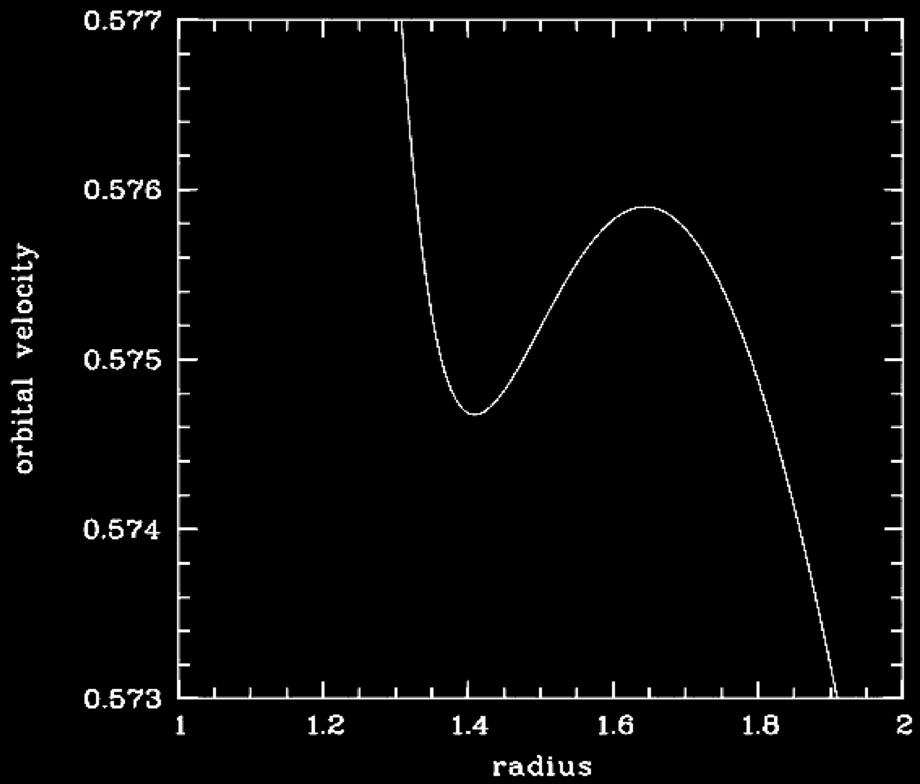
Micro-quasars / Galactic Center BH

- GRO J1655-40, XTE J1550-564 and GRS 1915+105 show twin high frequency quasi-periodic oscillations with a ratio of 3:2 and/or 3:1
- Resonance between vertical and radial epicyclic oscillations and Kepler orbits

➔ New topological structure

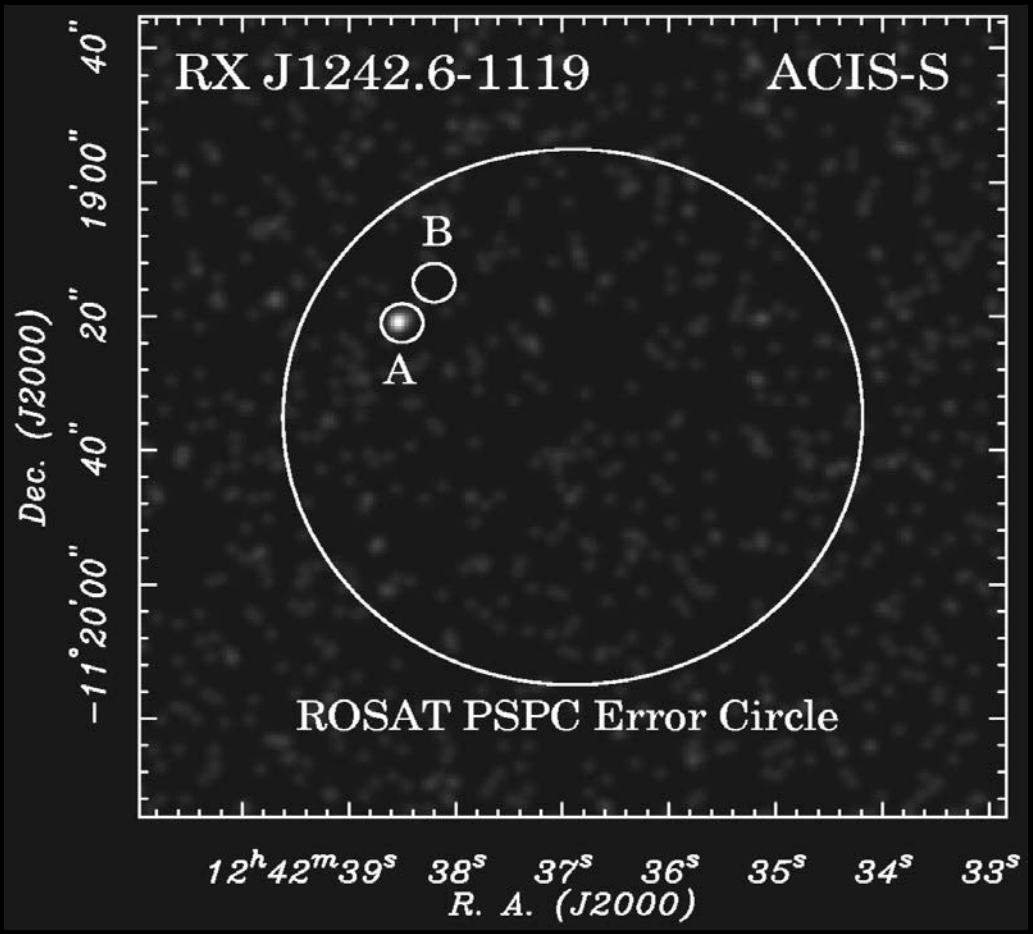
➔ a = 0.99616

➔ Galactic Center BH: M = (3.28±0.13) $10^6 M_\odot$



B. Aschenbach, 2004, A&A 425, 1075

Huge Drop in the X-Ray Luminosity of the Nonactive Galaxy RX J1242.6-1119A



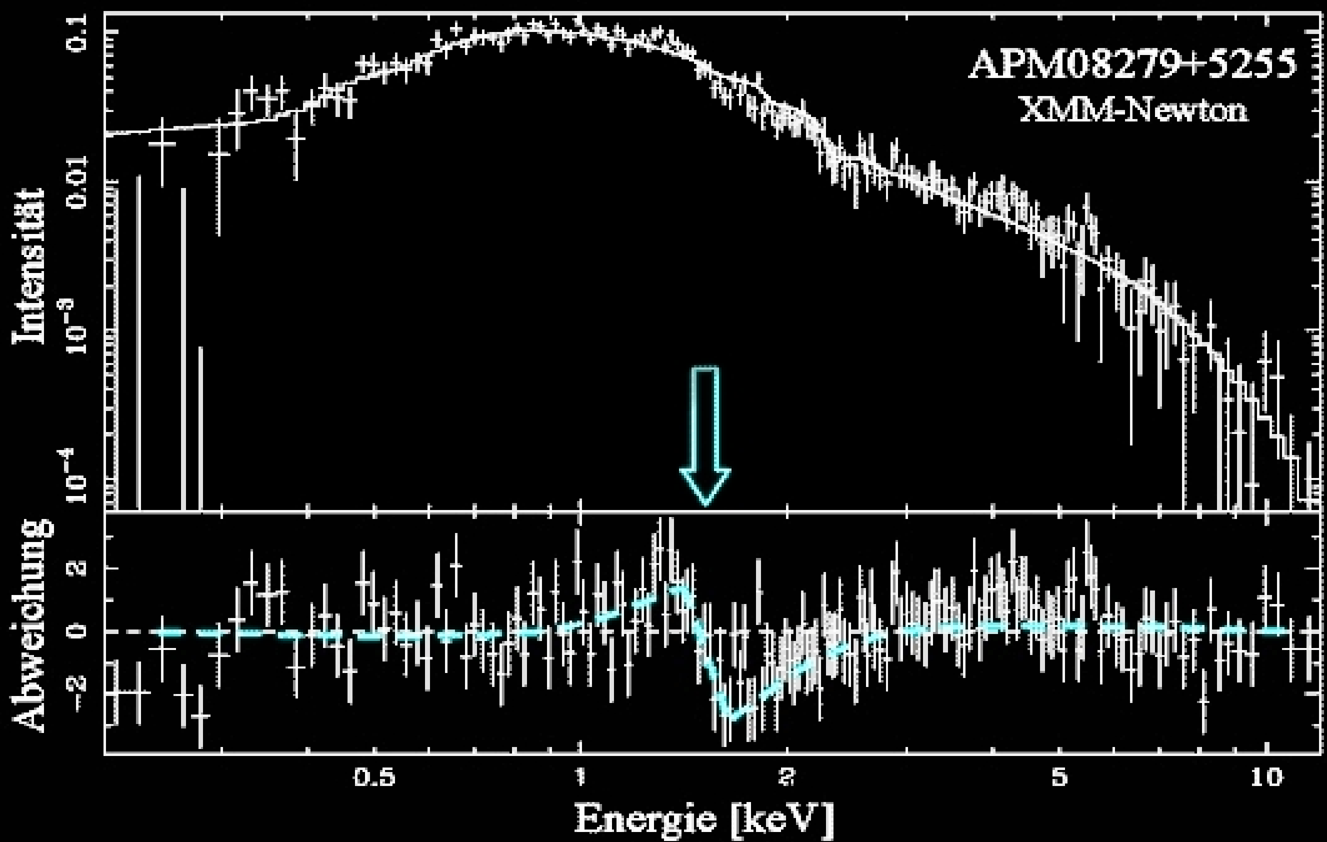
- ROSAT, Chandra and XMM-Newton
- ~200 drop in X-ray luminosity

➔ (Partial or complete) tidal disruption of stars captured by the black holes

S. Komossa et al., 2004, ApJ 603. L17

Aspects of variability in AGNs

Iron Abundances: APM08279+5255

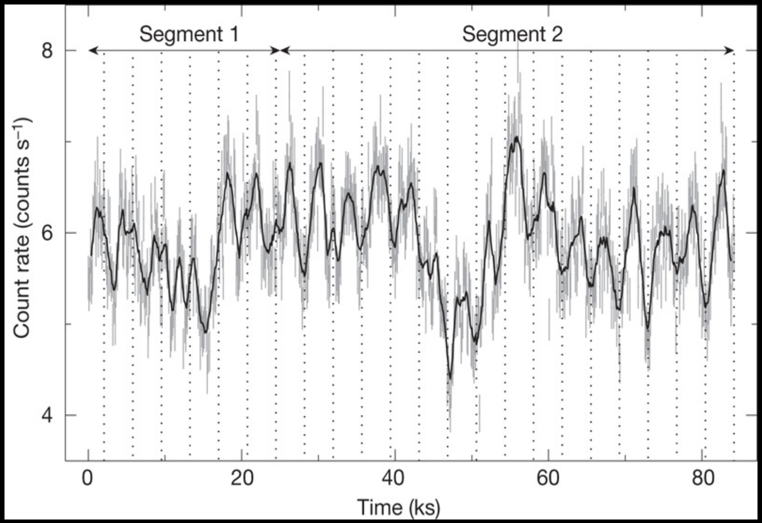


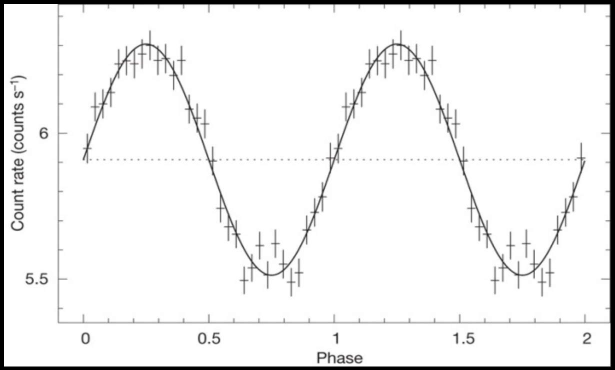
- Ionized Fe Kα edge in the z=3.91 broad absorption line quasar APM 08279 +5255

➔ Constraints on the age of the universe

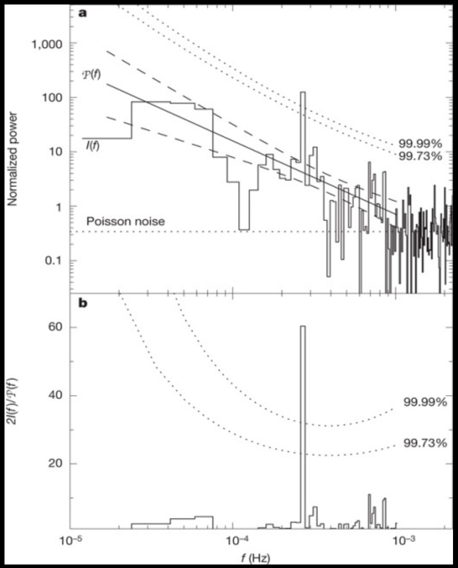
G. Hasinger et al., 2002, ApJ 573, 77

First QPO from an AGN





Gierlinski et al., 2008, Nature 455, 369



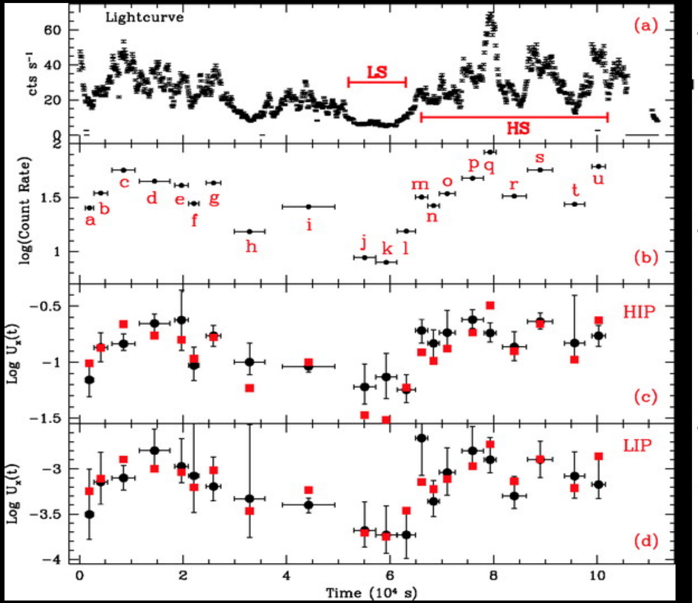
- Since 20 years QPO in X-ray binaries, but never found for AGNs (13y)
- RE J1034+396 nearby (z=0.043) narrow-line Seyfert 1
- Black hole mass: 6.3 x 10^5 to 3.6 x 10^7 M_{sun}

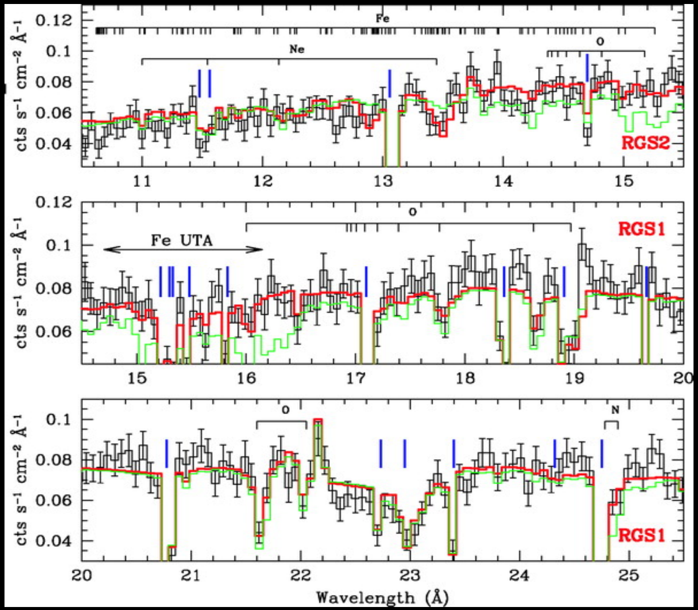
➔ XMM-Newton detection of a ~ 1 hour quasi periodic oscillation (QPO)

➔ Provides fundamental length-scale of SMBH system

Aspects of variability in AGNs: Outflows

Compact, Conical, Accretion-Disk Warm Absorber Of The Seyfert 1 Galaxy NGC 4051





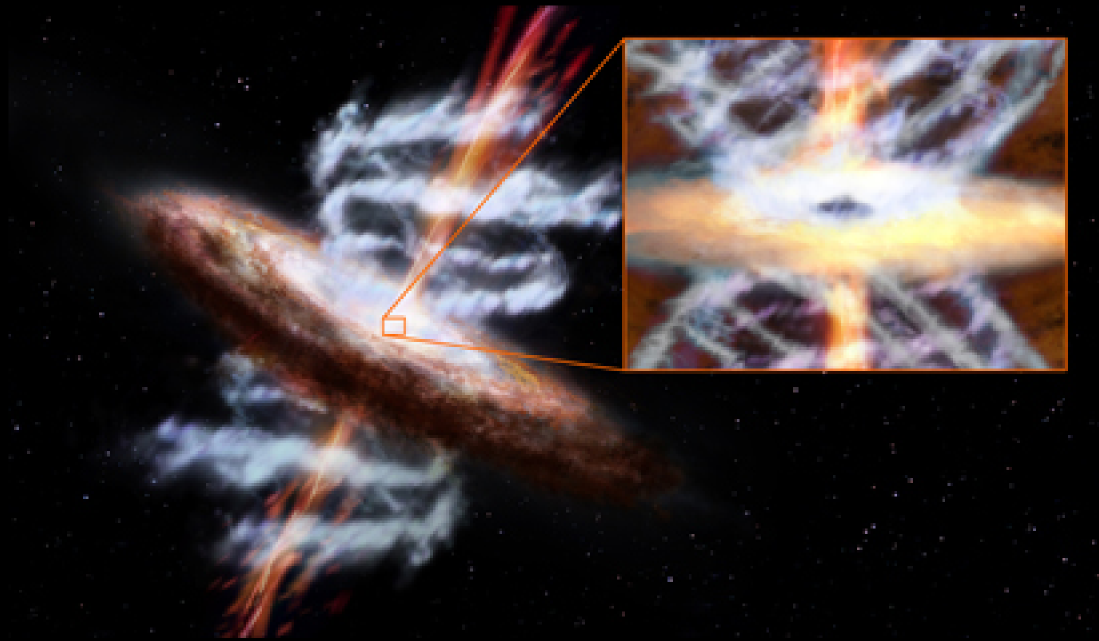
- Absorber consists of two different ionization components, with a difference of ~100 in ionization parameter and ~5 in column density
- Distances 0.5-1.0 lt-days (2200RS-4400RS) and <3.5 lt-days (<15,800 RS) from the continuum source

➔ Suggests strongly accretion-disk origin for the warm absorber wind

➔ Mass outflow rate from wind is 2%-5% of the mass accretion rate

Krongold et al., 2007, ApJ 659, 1022

Ultra-fast Outflows in Radio-quiet Active Galactic Nuclei



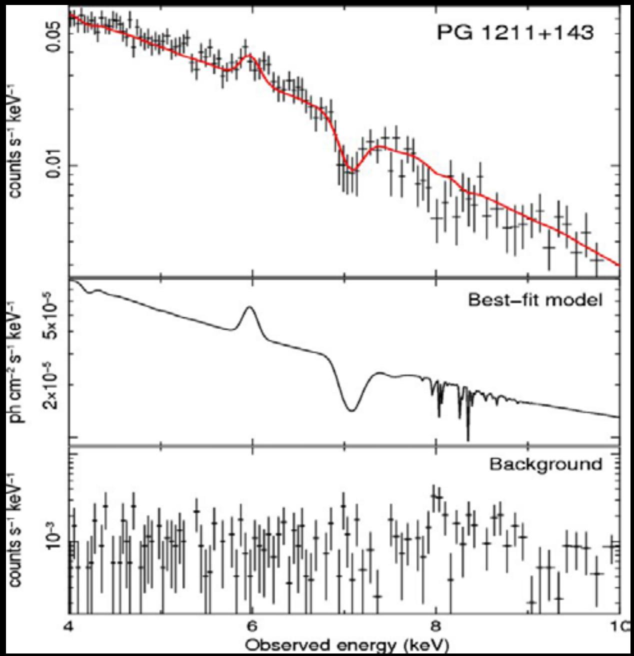
- ➔ Location is in the interval ~0.0003-0.03pc ($\sim 10^2$-10^4 r_s) from the central black hole
- ➔ Outflow rates: ~0.01-1 Mo y^{-1} / 5-10% of the accretion rates
- ➔ Mechanical power ~42.6-44.6 erg s^{-1}
- ➔ UFOs provide a significant contribution to the AGN cosmological feedback, in agreement with theoretical expectations

- Ultra-fast outflows (UFOs) are detected through blueshifted Fe XXV/XXVI K-shell transitions.
- 42 local radio-quiet AGNs observed with XMM-Newton.
- ➔ >35% are showing UFOs
- ➔ v ~ 0.03c -0.3c, mean value of ~0.14c
- ➔ Ionization parameter is very high: log ξ ~ 3-6 erg s^{-1} cm
- ➔ Column densities are $N_H \sim 10^{22}$-10^{24} cm^{-2}

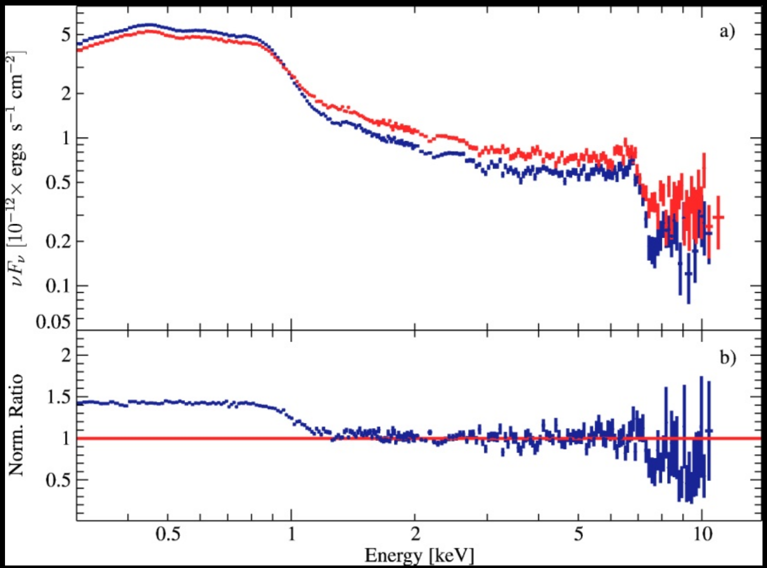
F. Tombesi et al., 2012, arXiv1201.1897T

F. Tombesi, et al., 2011, ApJ 742, 44

F. Tombesi, et al., 2010, A&A 521, 57



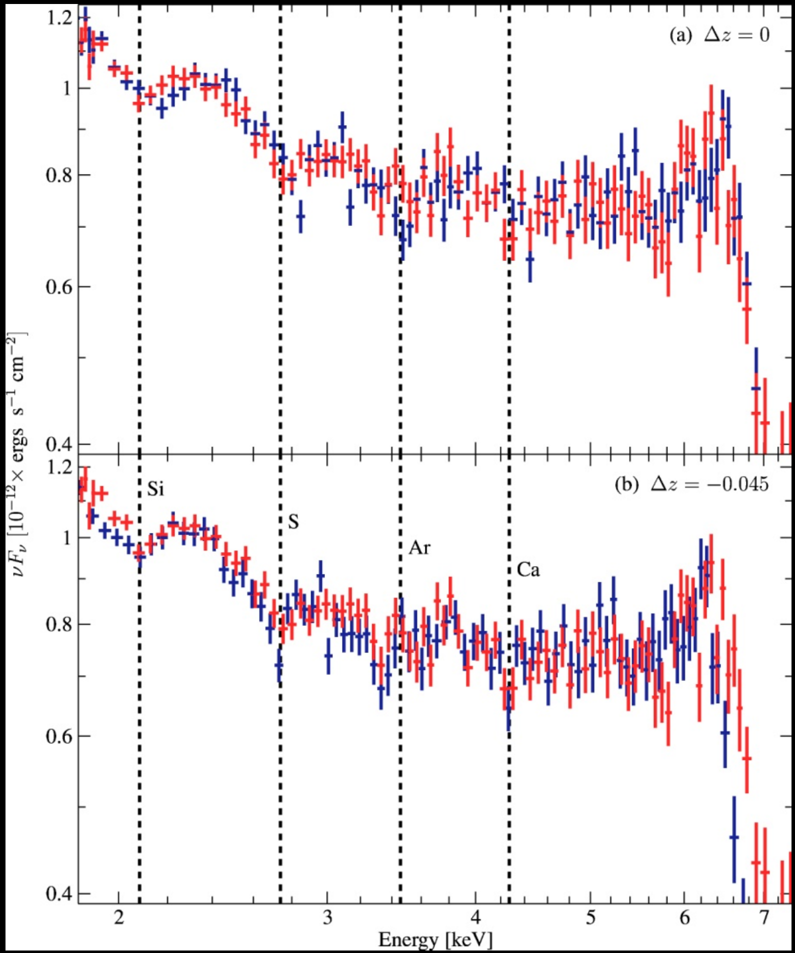
1H0707-495 in 2010: mildly relativistic ionized outflow



- Second 500 ks XMM-Newton & 120 ks Chandra observation of 1H0707-495 in 2010 September.

➔ Consistent with Fabian et al. (2009) and Zoghbi et al. (2010)

T. Dauser, et al., 2011arXiv1112.1796D



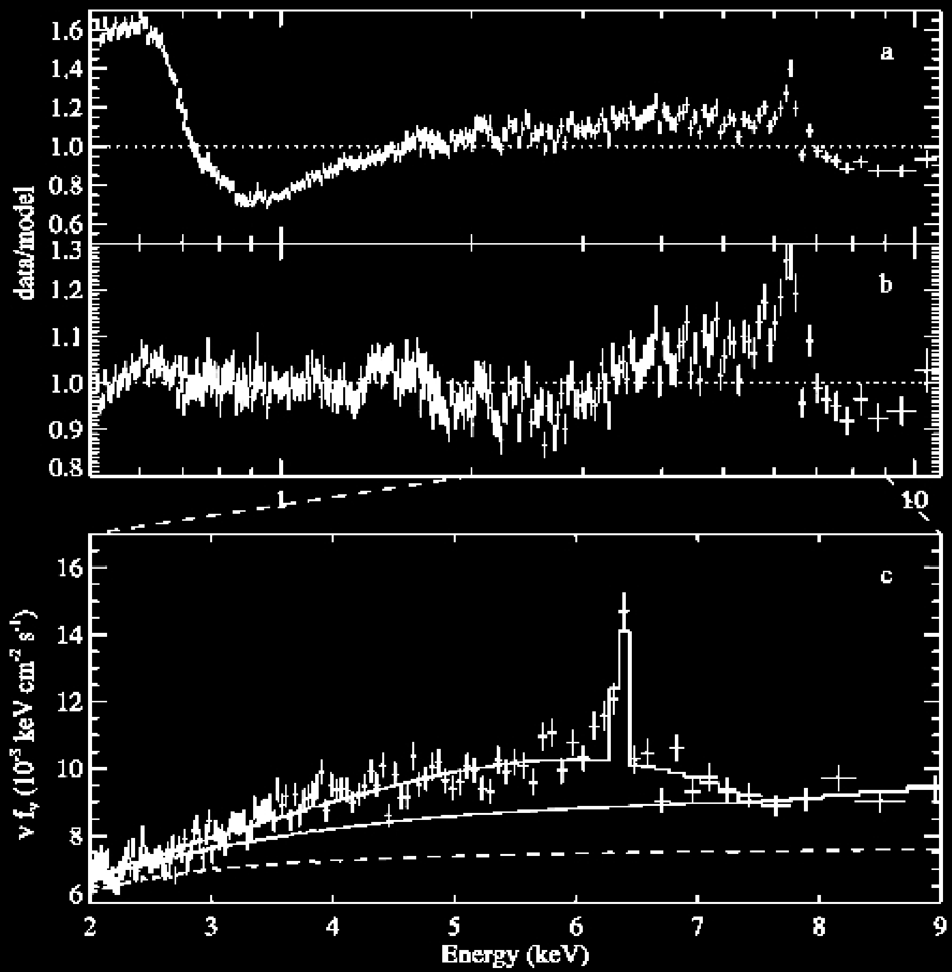
➔ spectrum is dominated by relativistically broadened reflection from an ionized accretion disc around a maximally rotating black hole

➔ Physical parameters of the black hole and accretion disc (i.e., spin and inclination) are consistent between both observations.

➔ Absorption in a mildly relativistic, highly ionized outflow which changed velocity from around 0.11c to 0.17c between 2008 January and 2010 September

Aspects of variability in AGNs: Low states

MCG-6-30-15: Extraction of Energy from the Spinning Black Hole



- \`Deep minimum' state
- Difficult to understand in any pure accretion disc model

➔ Extraction and dissipation of rotational energy from a spinning black hole

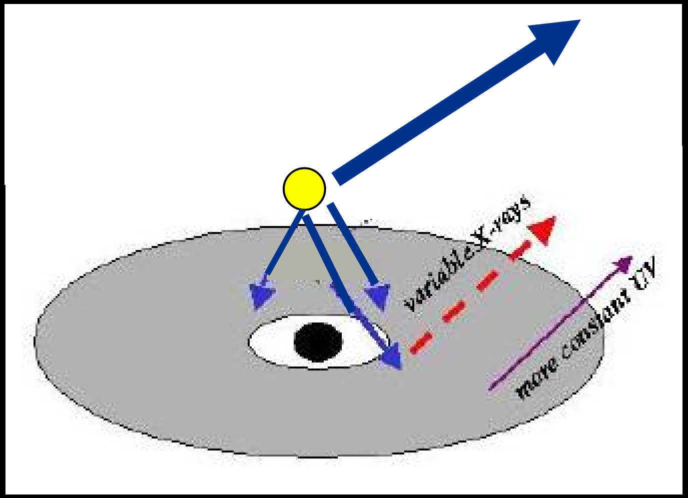
J. Wilms et al., 2001, MNRAS 328, L27

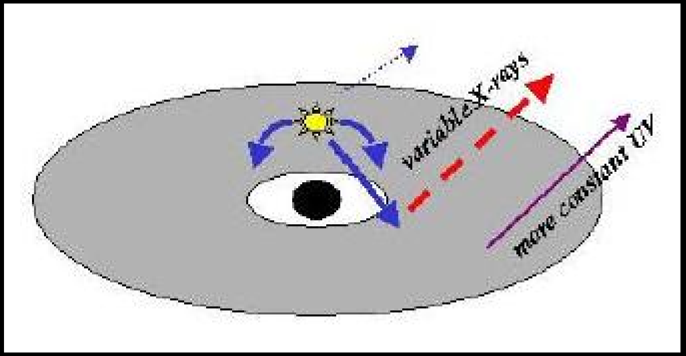
10^6–10^8 solar masses

Quasars in low or weak states

- Quasars in low or weak states show a complex spectra: ionized absorbers and reflection on ionized disk (G. Miniutti & A.C.Fabian, 2004, MNRAS 349, 1435)

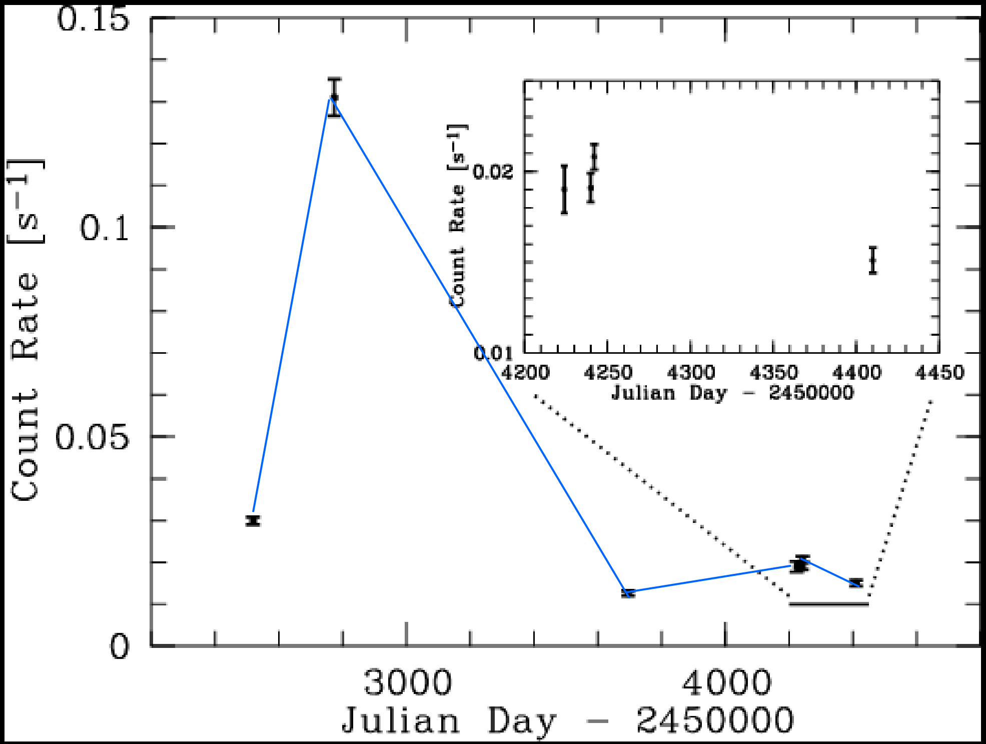
➔ Our basic idea:
- observe AGN when they are X-ray weak in order to see the reflection on ionized disk
- use ionization a check for consistency

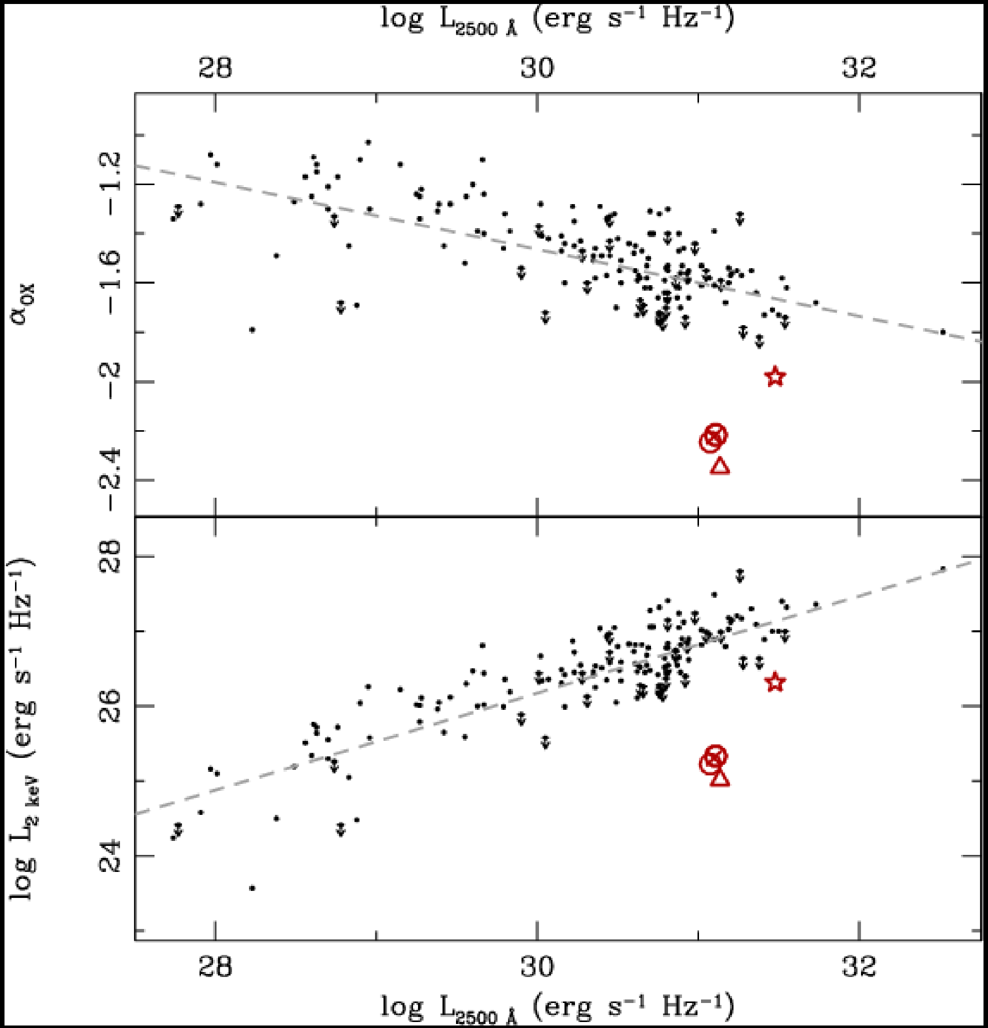




L. C. Gallo, 2006, AN 327, 1076

A long hard look at the minimum state of PG 2112+059



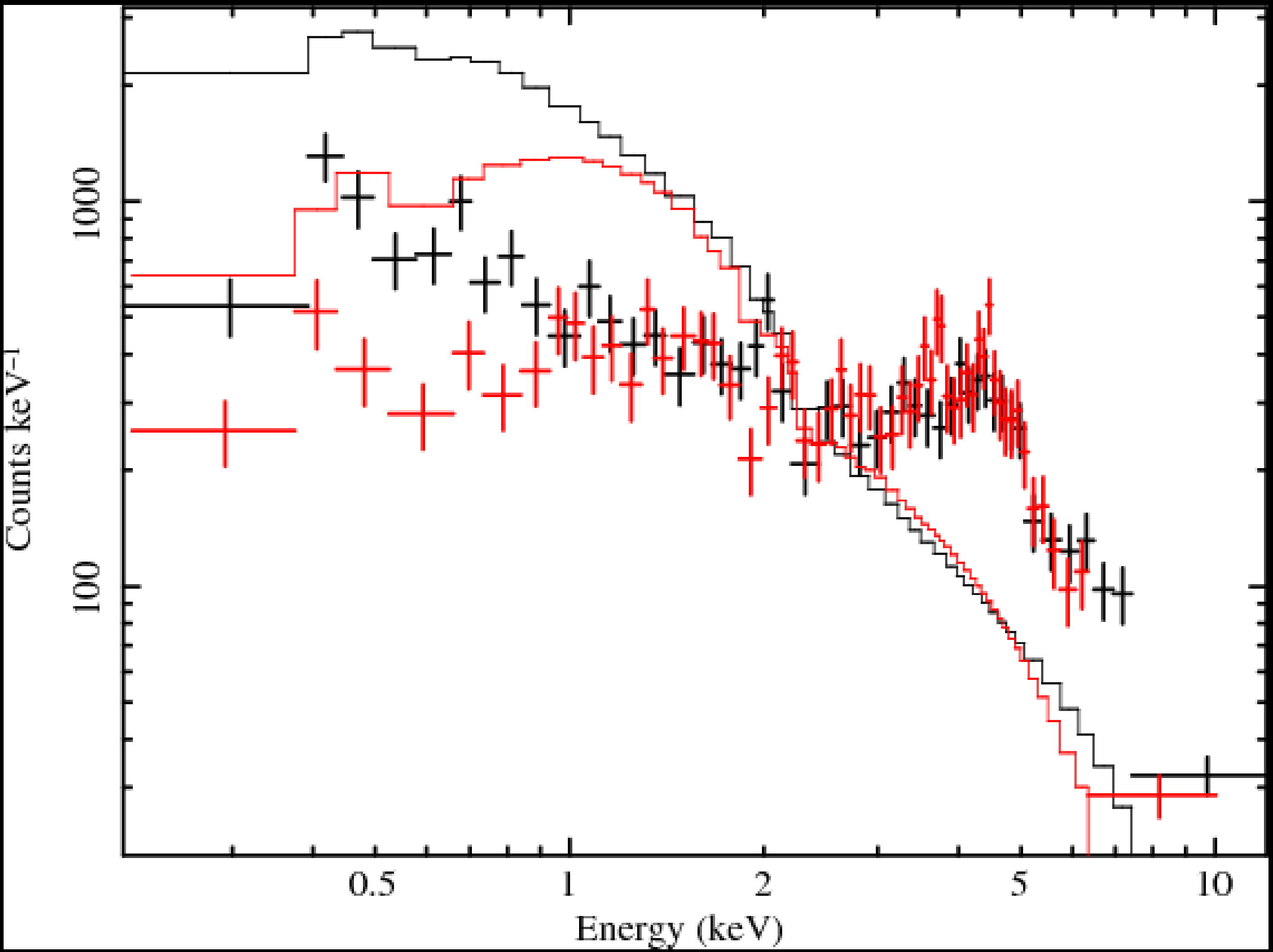


N. Schartel, et al., 2010, A&A 512, A75,

N. Schartel, et al., 2007, A&A 474, 431;

N. Schartel, et al., 2005, A&A 433, 455

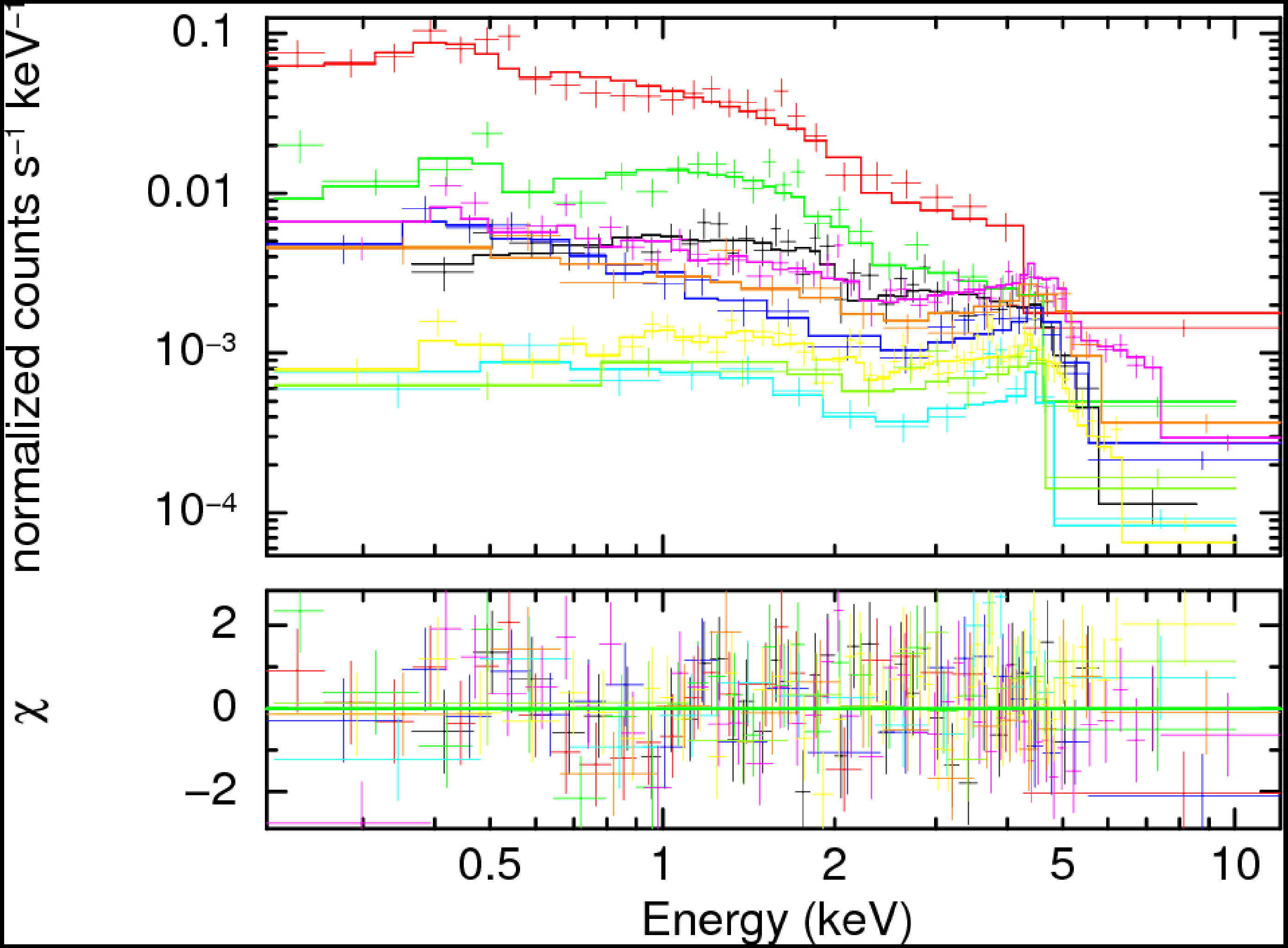
A long hard look at the minimum state of PG 2112+059



- The PG 2112+059 X-ray spectra acquired in May 2007 allowed the detection of a weak iron fluorescent line, which is interpreted as being caused by reflection from neutral material at some distance from the primary X-ray emitting source

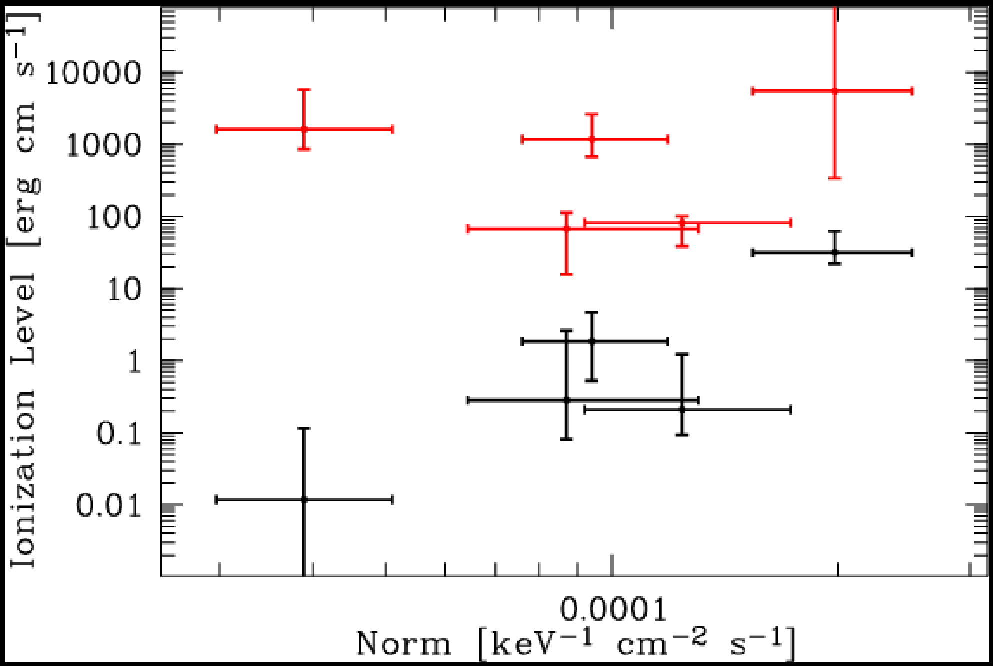
N. Schartel, et al., 2010, A&A 512, A75

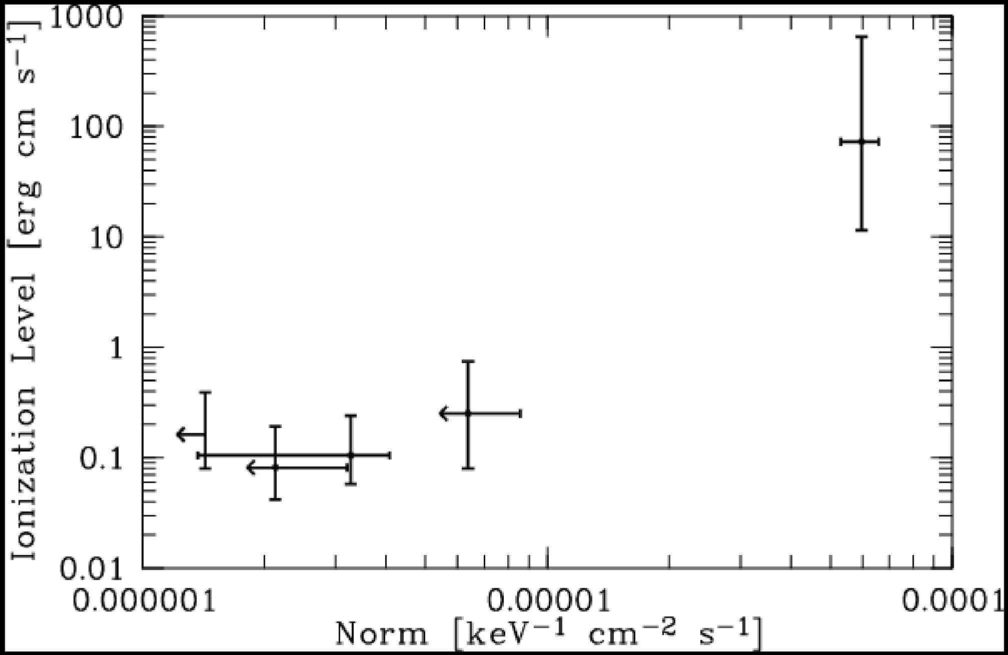
A long hard look at the minimum state of PG 2112+059



N. Schartel, et al., 2010, A&A 512, A75

A long hard look at the minimum state of PG 2112+059





Possibility 1:

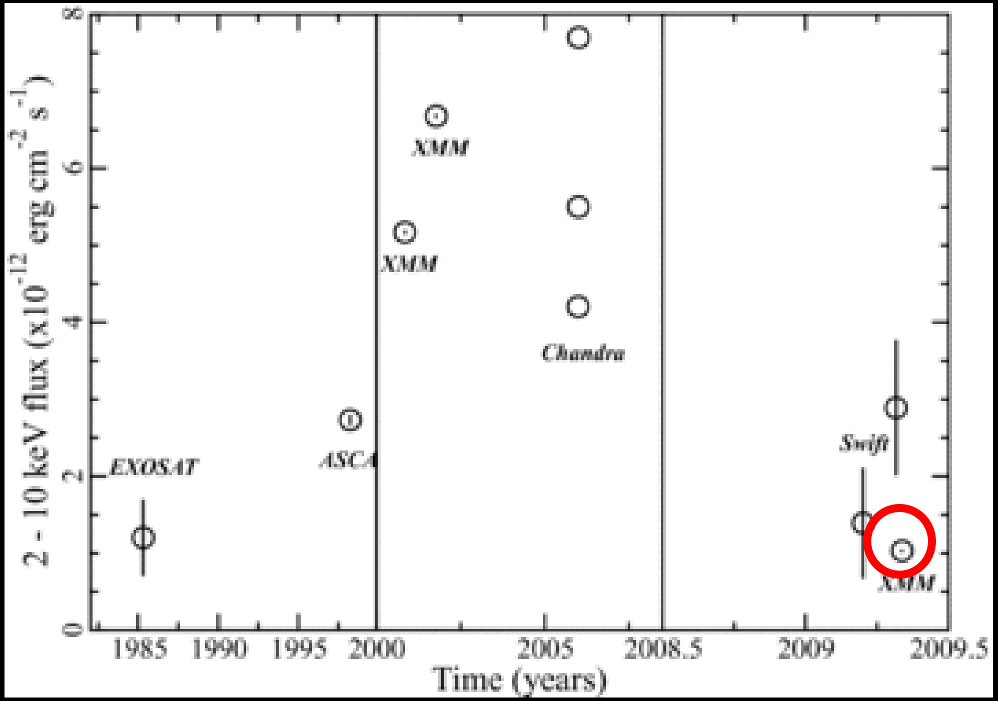
- Two layers of ionised material with column densities of NH~5 × 1022 cm-2 and NH˜ 3.5 × 1023 cm-2
- The first layer is moderately ionised and its ionisation levels follow the flux changes, while the other layer is highly ionised and does not show any correlation with the flux of the source.

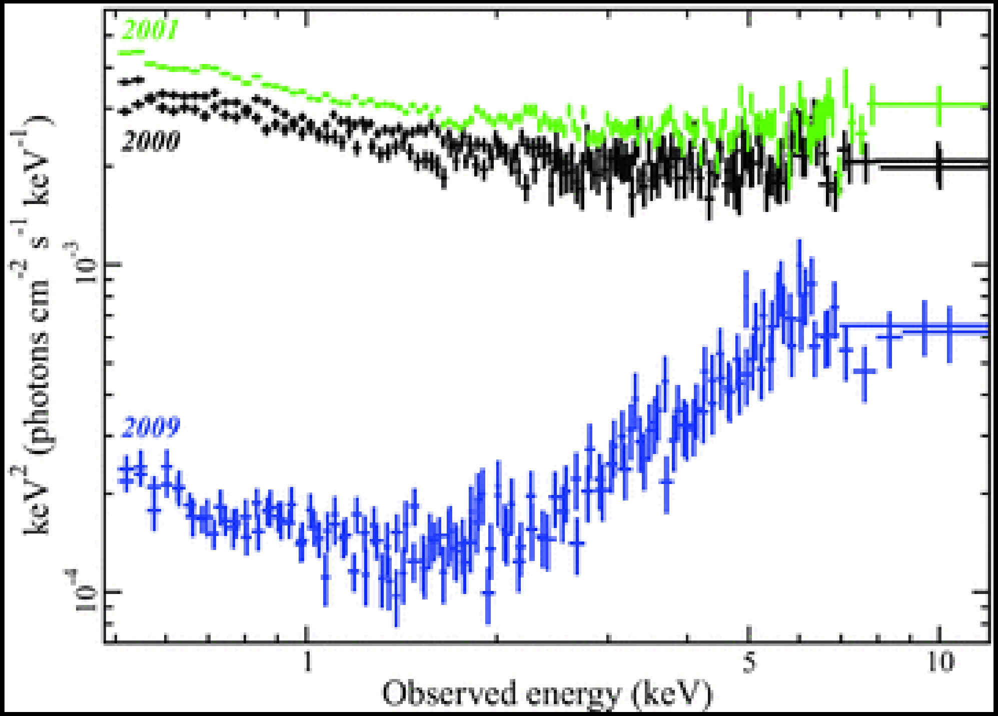
Possibility 2:

- Reflection on an ionised accretion disk seen behind a warm absorber. The warm absorber ionisation is consistent with being correlated with the flux of the source. We explain the spectral variability with light bending according to the models of Miniutti and Fabian and constrain the black hole spin to be a/M > 0.86.

N. Schartel, et al., 2010, A&A 512, A75

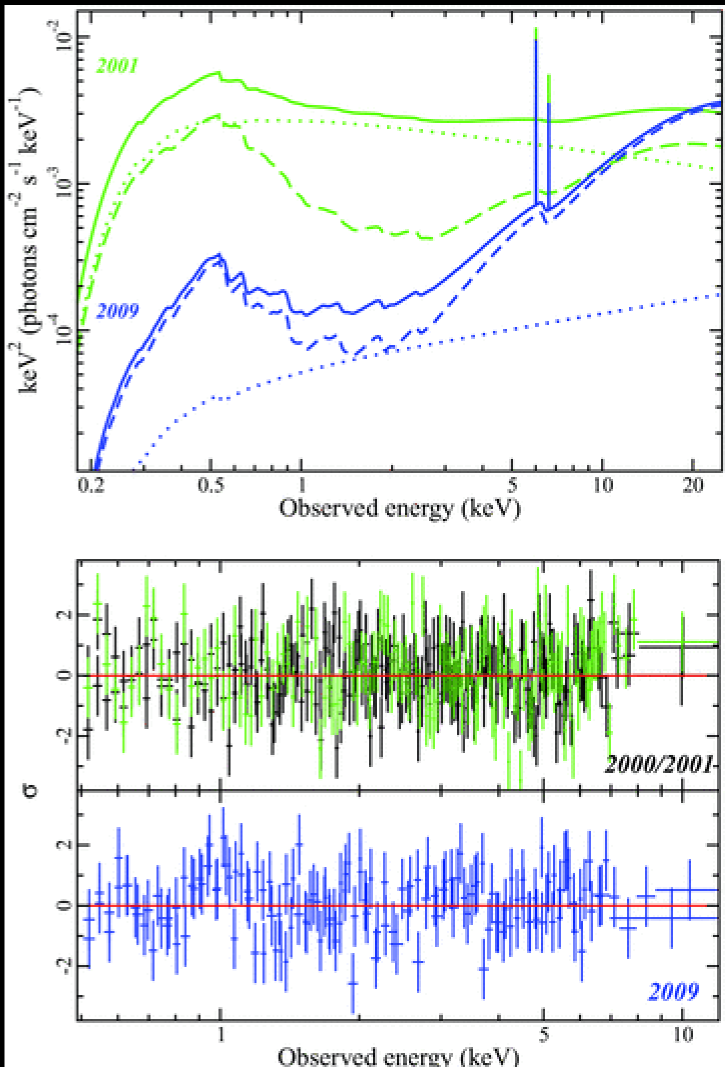
PG 0844+349 in an X-ray weak state



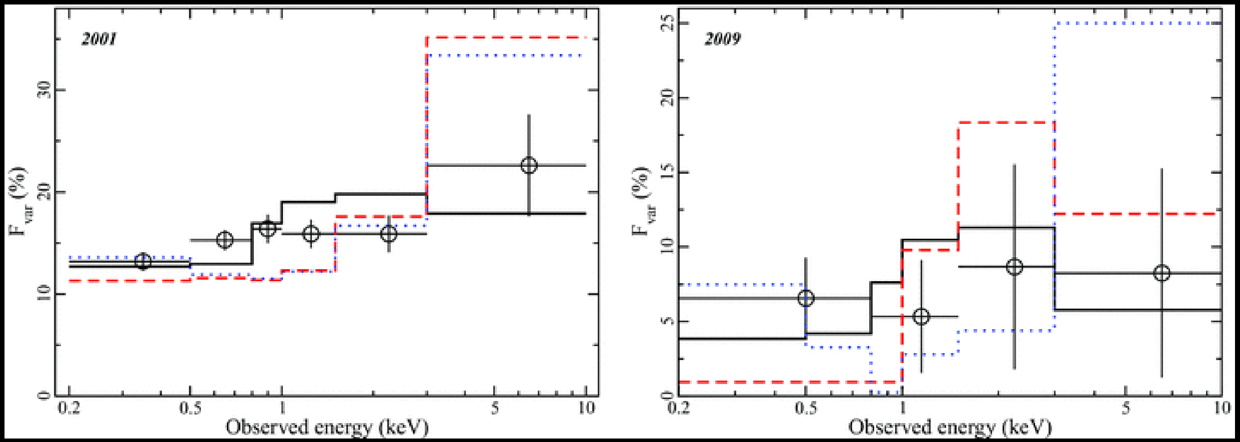


Gallo, L. C. et al., 2011, MNRAS 412, 161

PG 0844+349 in an X-ray weak state



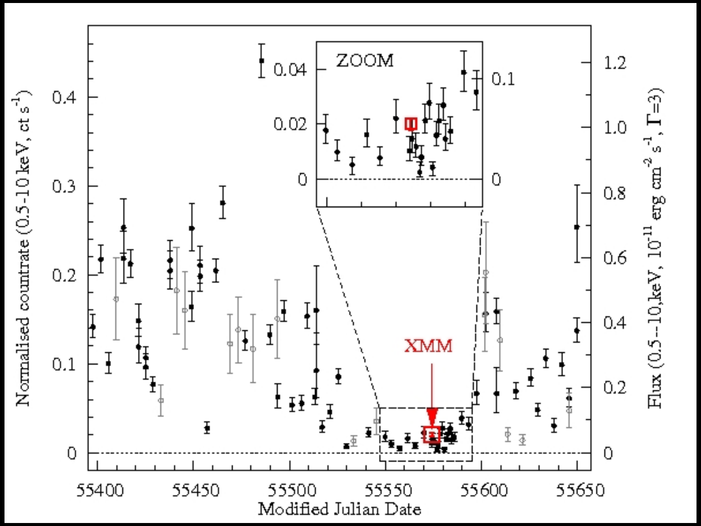
Gallo, L. C. et al., 2011, MNRAS 412, 161

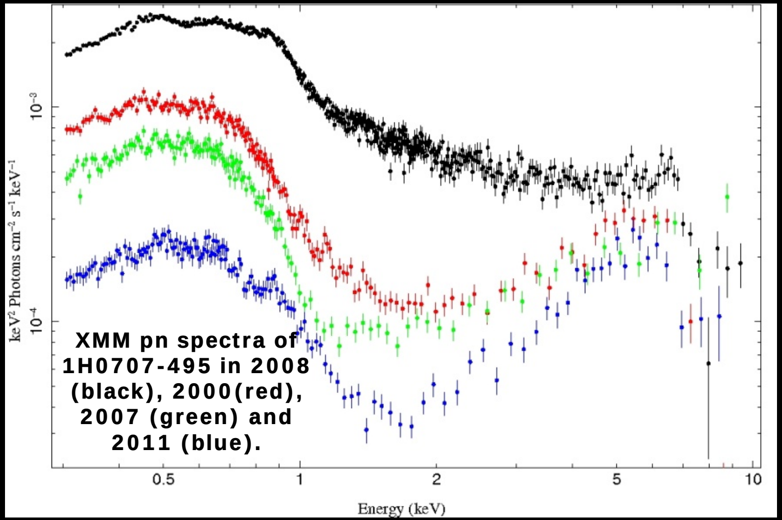


The normalized rms spectrum calculated for the 2001 (left-hand panel) and 2009 observations (right-hand panel). On the assumption that only the power-law normalization fluctuates, the expected Fvar based on the blurred reflection (black solid), double neutral partial covering (red dashed) and doubleionized partial covering (blue dotted) models are shown. The single ionized absorber produces a similar Fvar as the double ionized absorber and is not shown.The light curves used are in 1000-s bins.

- Partial covering and blurred reflection models are compared to the data at each flux state while attempting to maintain consistency between the various epochs
- Light bending scenario can also account for the short-term (i.e. ˜1000 s) spectral variability in the source

1H0707-495 in low state: An X-ray source within a gravitational radius of the event horizon

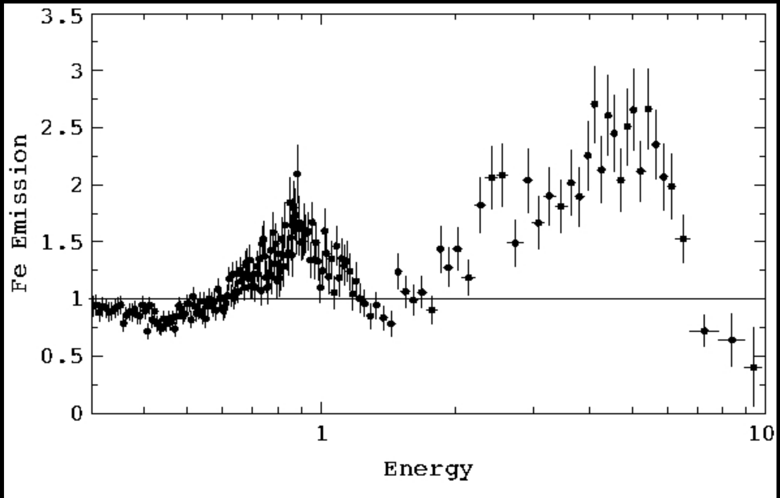




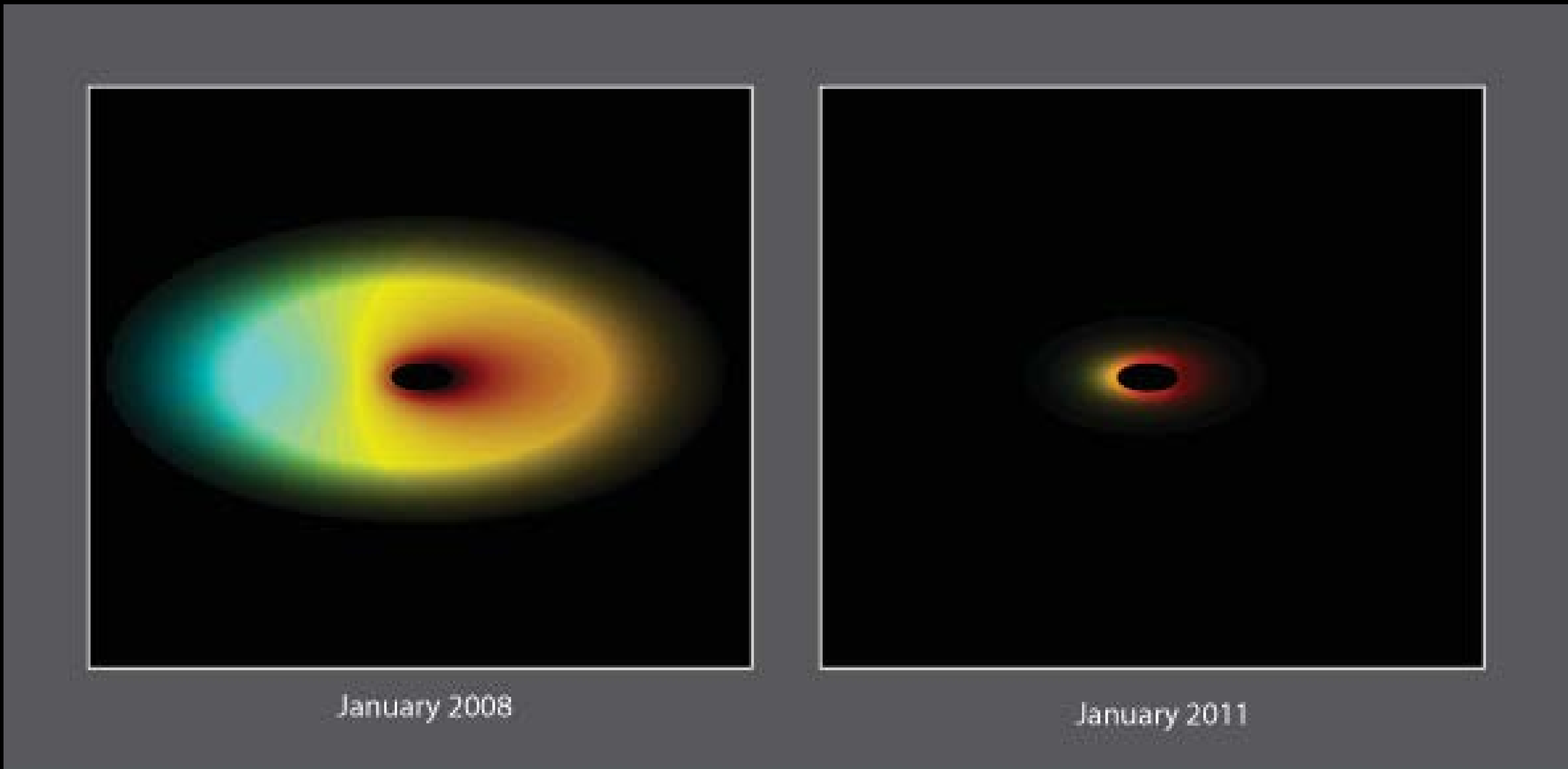
Fabian, A. C. et al., 2012, MNRAS 416, 116

- The Narrow Line Seyfert 1 Galaxy 1H0707-495 was in a low state from 12/2010 to 2/2011 February, discovered by monitoring of Swift
- 100 ks XMM-Newton observation of the low state: flux has dropped by a factor of 10 in the soft band, and a factor of 2 at 5 keV, compared with a long observation in 2008
- The spectrum is well fit by a relativistically-blurred reflection spectrum

➔ The irradiating source must lie within 1 gravitational radius of the event horizon of the black hole, which spins rapidly.



1H0707-495 in low state: An X-ray source within a gravitational radius of the event horizon



Courtesy Dan Wilkins; A.C. Fabian et al., 2012, MNRAS 419, 116

What's past is prologue[1]

[1] W. Shakespeare, 1623, The Tempest, Act 2, Scene 1