

GALACTIC TRANSIENTS

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Summary

- What do we call Galactic X-ray transients?
- How? from the discovery to the broad band studies
- Why? from astronomy to astrophysics model independent approach and physics of some sources
- Today/Tomorrow: large flows of data (radio, optical). What strategies, organization (to be discussed during this workshop)

Galactic Transients

- **Magnetically active stars** (RS CVn) also > 20 keV emitters (Swift, INTEGRAL, Maxi)
- **Supernovae** : optical-X-ray-neutrinos-GW(?); Rare events: 1-3 ev/century (?!!), none during the 20th century. Closer to 0.1-0.01/century
 - type II, Ib/c \Leftrightarrow Collapse massive star
 - Type Ia \Leftrightarrow Thermonuclear, white dwarf
- **WD, isolated neutron stars**: radio, optical, X/ γ -rays
 - incl. SGR and AXPs giant flares and bursts
- **X/ γ -ray Binaries/CVs**: full em spectrum; neutrinos(?), GW (?)
 - CV (IP) are > 20 keV emitters ; Fermi detection of HE flare from novae
 - Hadronic models for jets : VHE (TeV) emission, and neutrino production (pp interaction, and pions decay)
- **Galactic Centre (Sgr A*)**: Radio, Optical/IR, Soft X-rays
 - Quasi periodic flares
 - TDEs

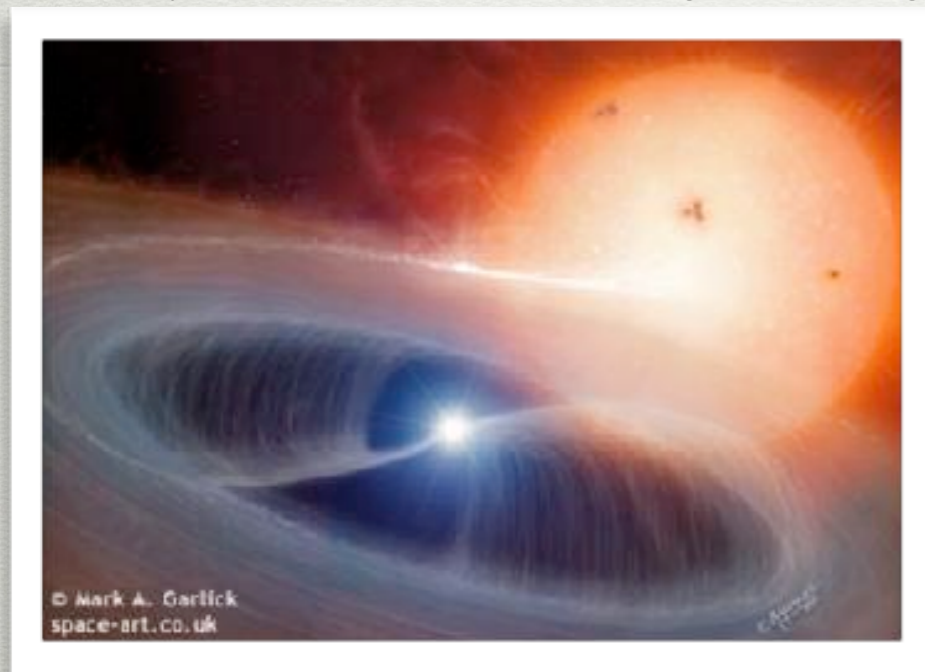
Galactic Transients

- ❑ WD, isolated neutron stars : pure physics of compact objects (no accretion / companion evolved)
 - Crustal quake => size of NS
 - WD as SN progenitors of type Ia

- ❑ X/gamma-ray Binaries/CVs : compact source as a central engine for accretion and related processes
 - BH « visible » => access to mass and spin
 - Transient vs persistent sources : outbursts vs flares
 - Numerous tools (timescale, multi-wavelength)

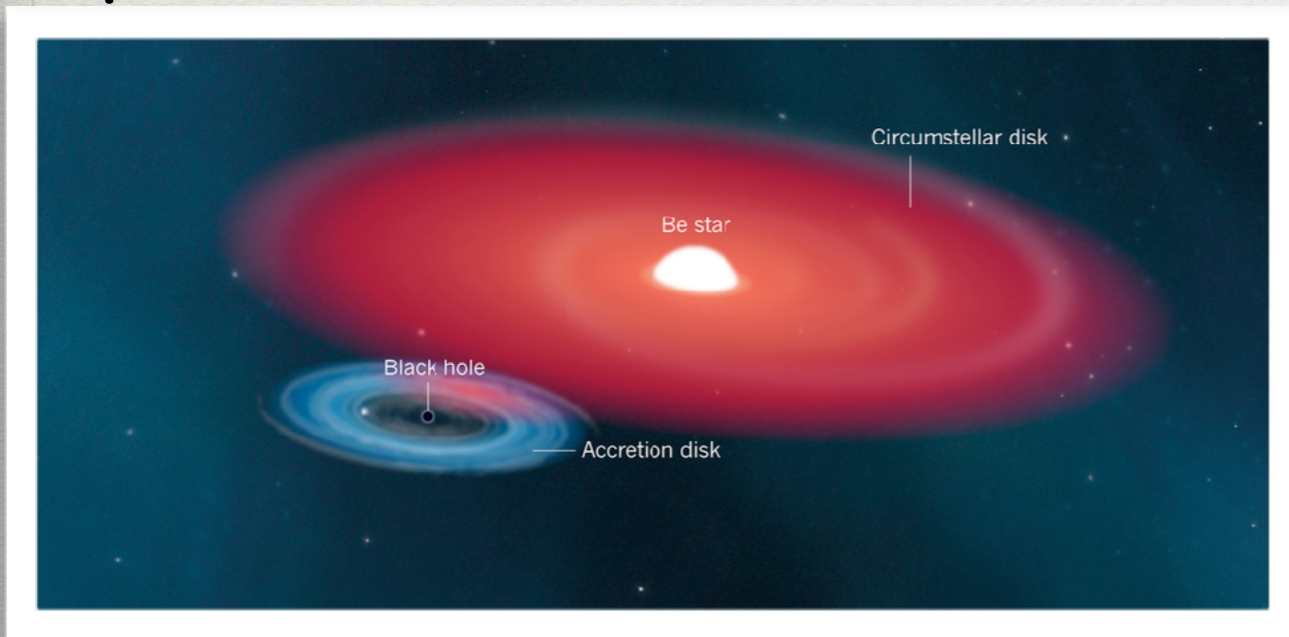
Zoology of X-ray emitting binaries

Cataclysmic variables (jet/no jet)



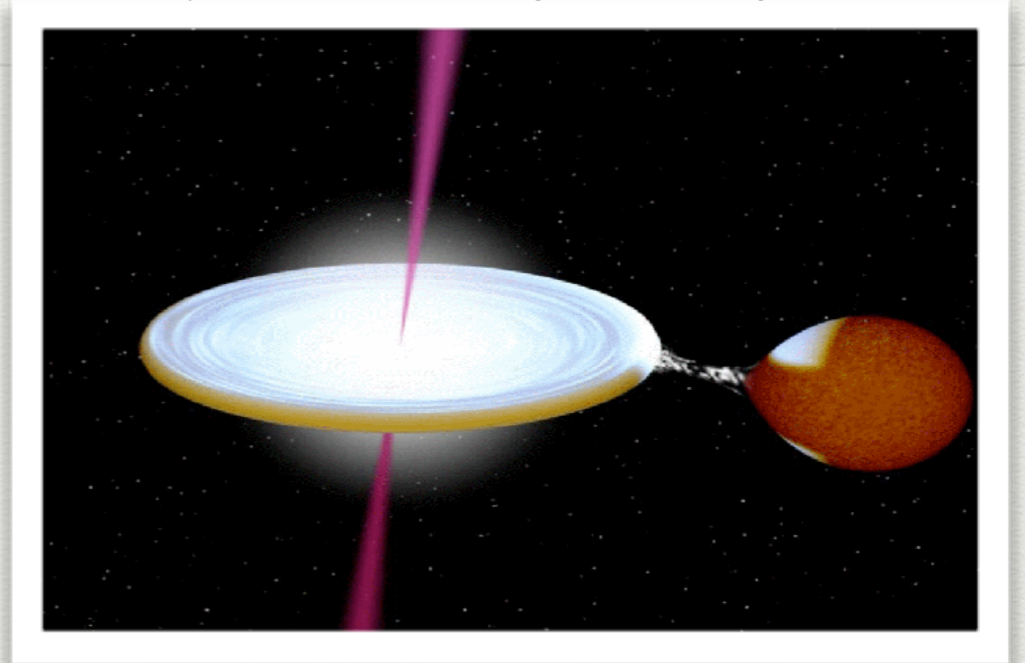
WD+star: Polar, IP, Novae

γ -ray Binaries (no jet)

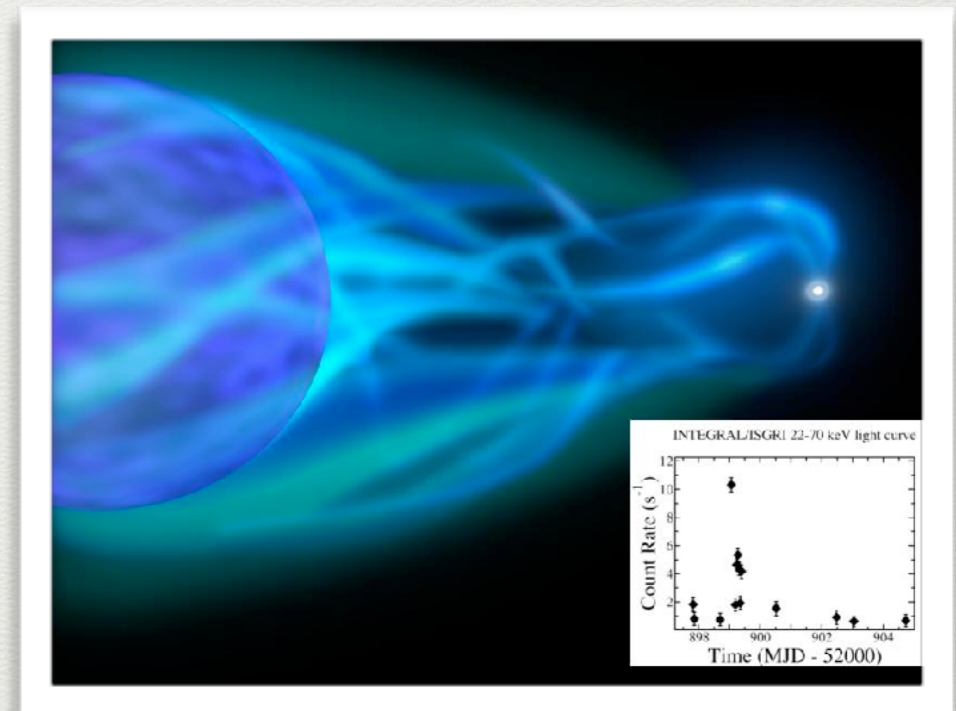


Pulsar+Be stars: a few objects (Fermi-HESS-Magic)

X-ray Binaries (jet/no jet)

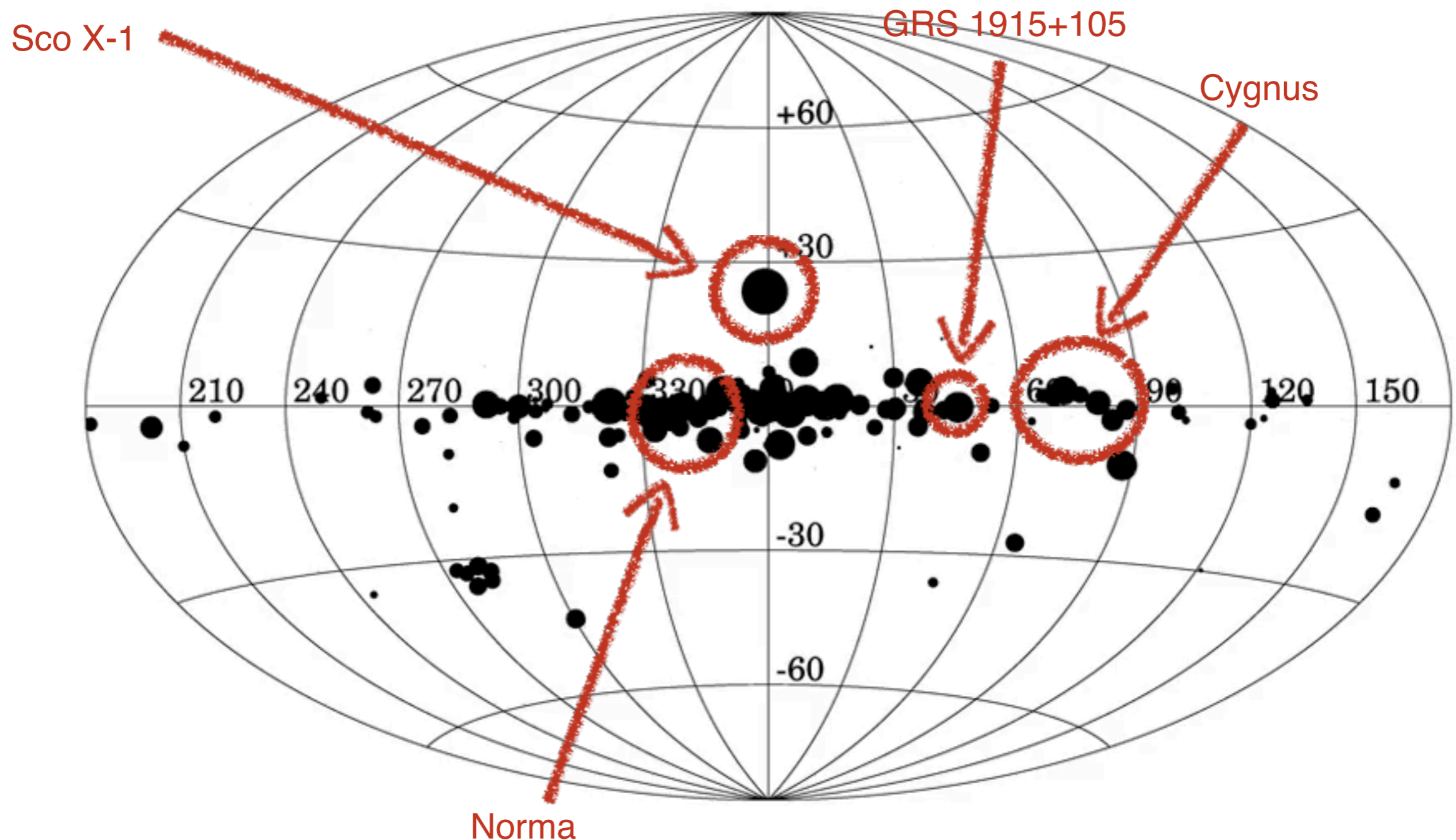


NS/BH+low mass stars: LMXB, microquasars



NS/BH+high mass stars: HMXB, microquasars

RXTE ASM (1.2-12 keV): 16 years of monitoring (1995-2012)



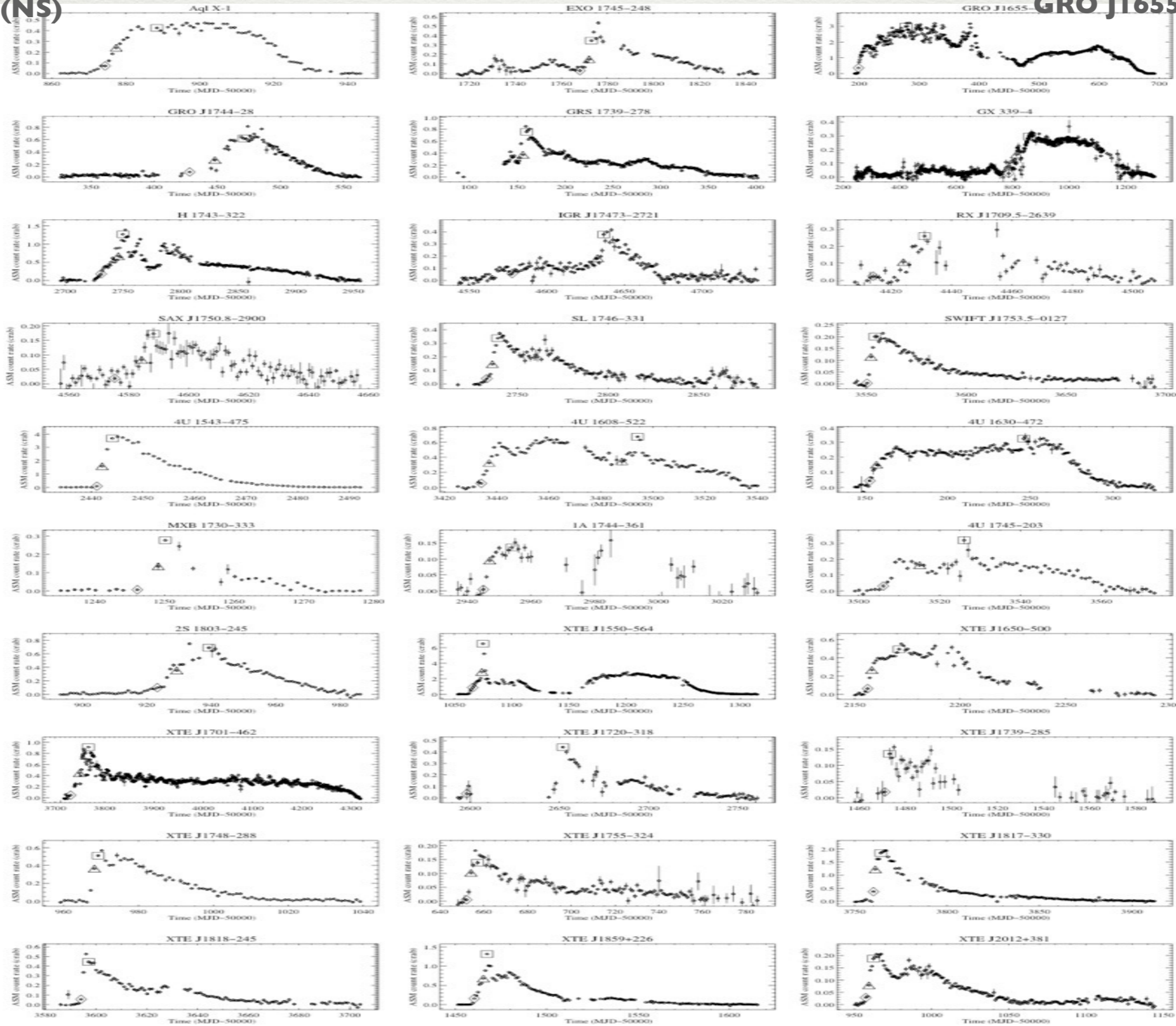
MJD50100

Credit: Zhan Yan (SHAO)

Outbursts and profiles

Aql X-1 (NS)

GRO J1655-40 (BH)



Yan & Yu
2015

Potentiality brought by a wide band mission: the SVOM view

Thermal emission black body: soft X-rays ~1 keV

MXT

Jet emission: radio to IR/
Optical

GFT/GWAC/VT

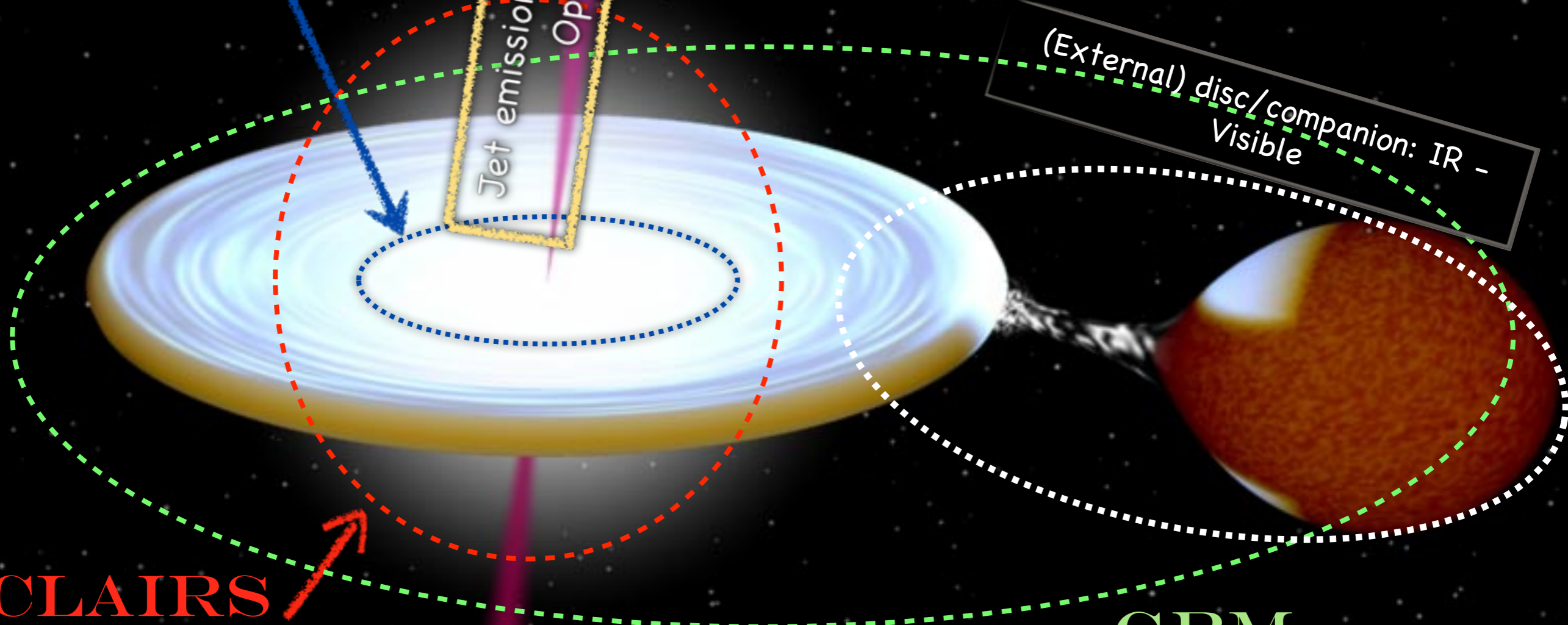
(External) disc/companion: IR -
Visible

ECLAIRS

Hard X-ray (10-200 keV):
« Corona »

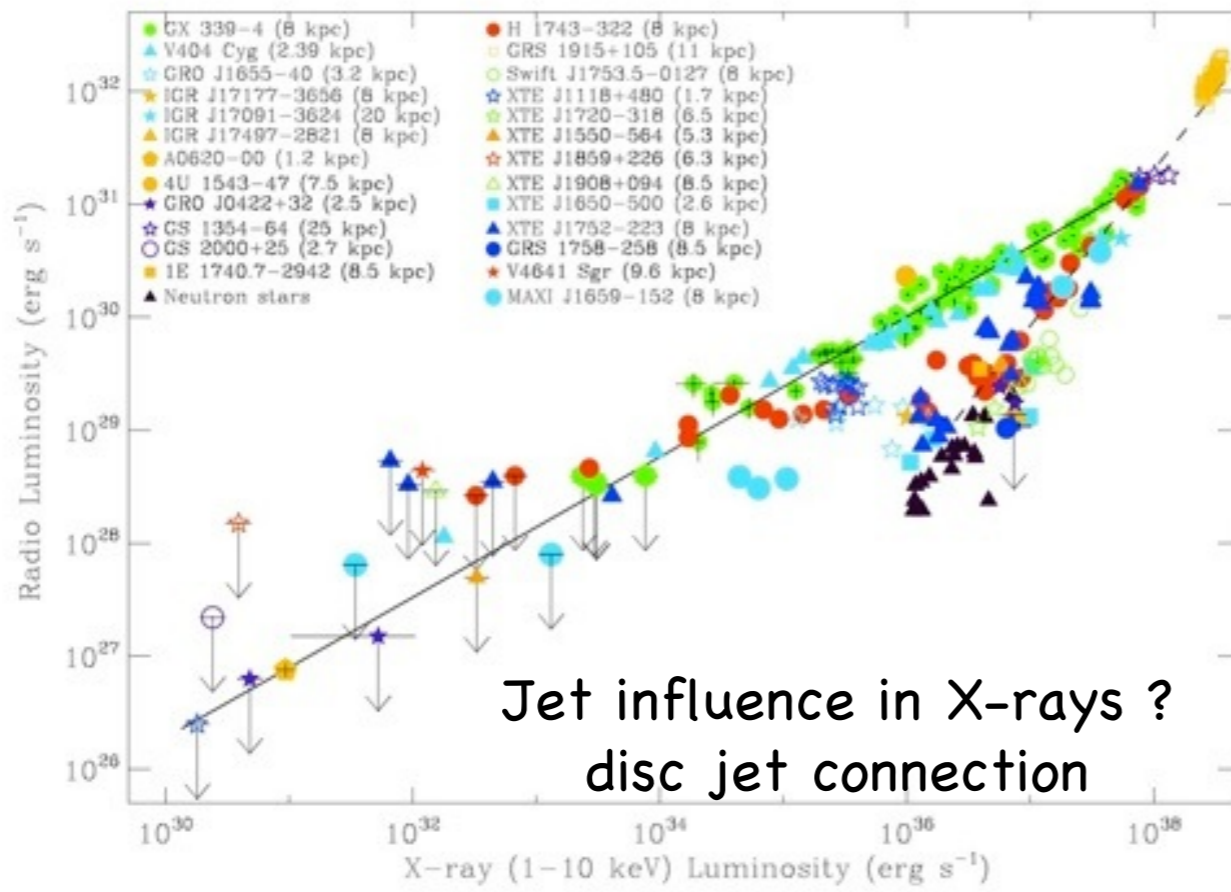
GRM

γ -ray emission 0.2-10 MeV: Origin?

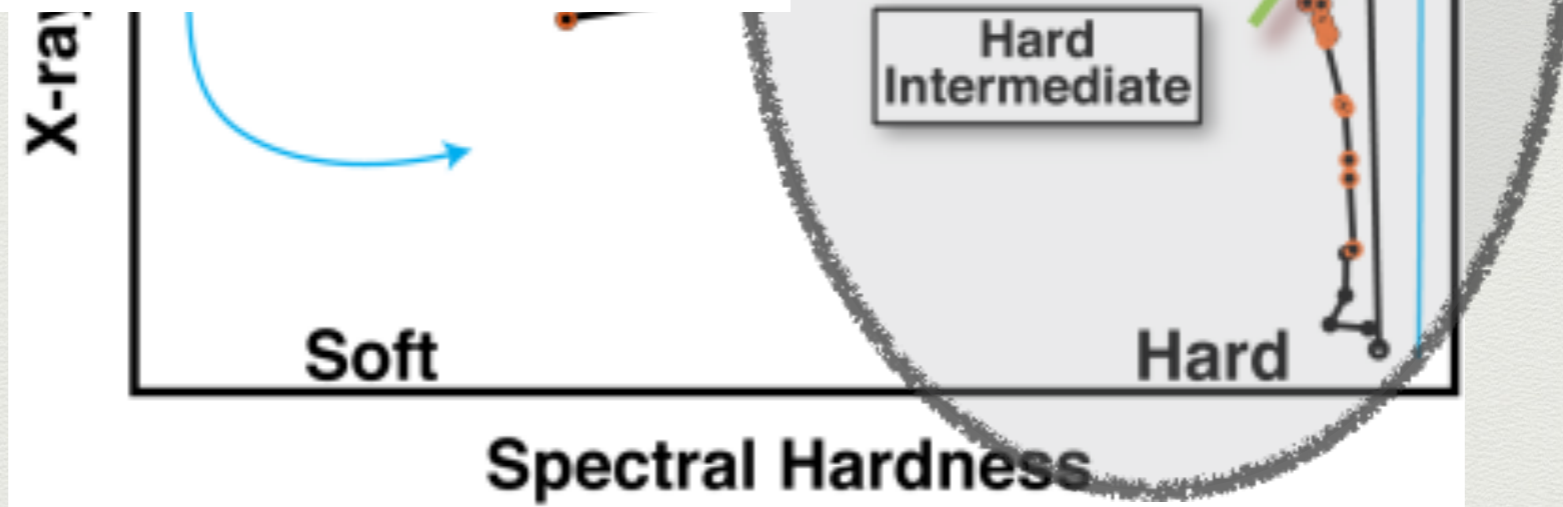


Phenomenological approach

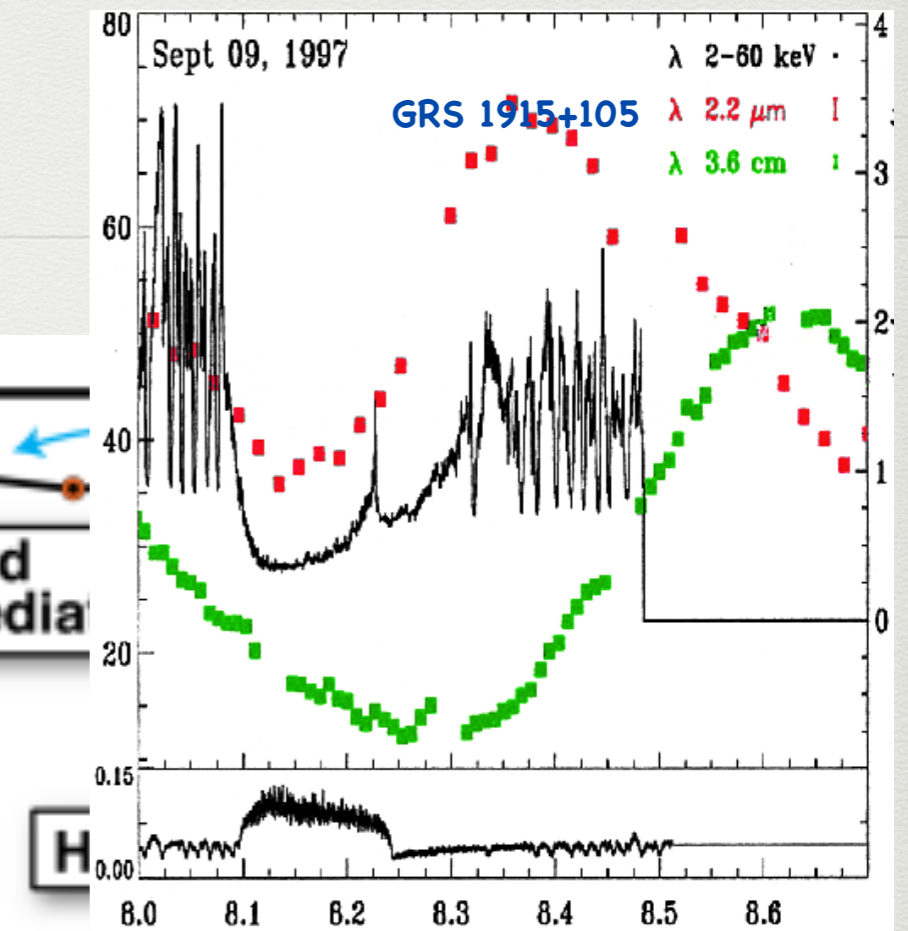
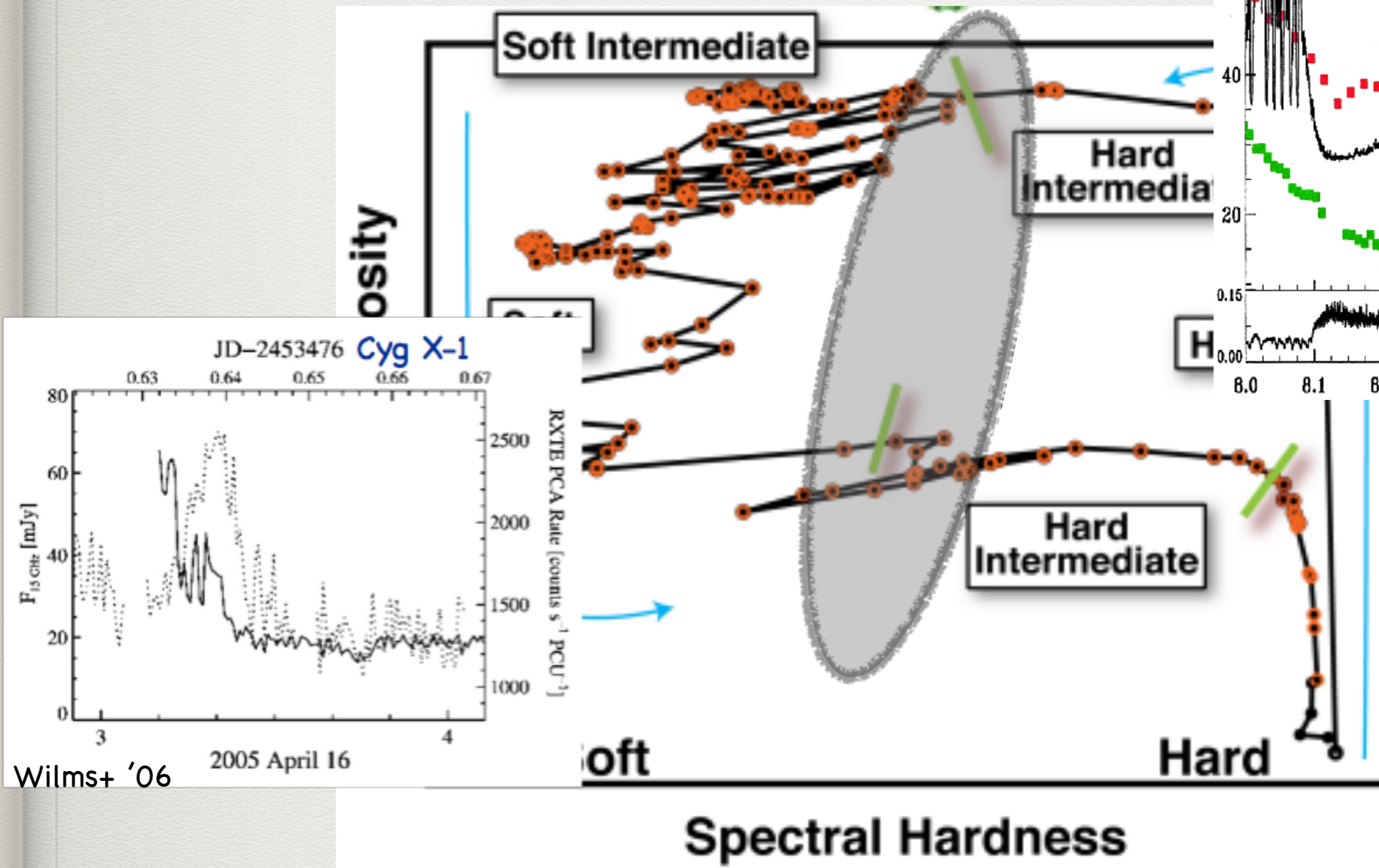
Radio vs. X-ray fluxes: « fundamental plane »



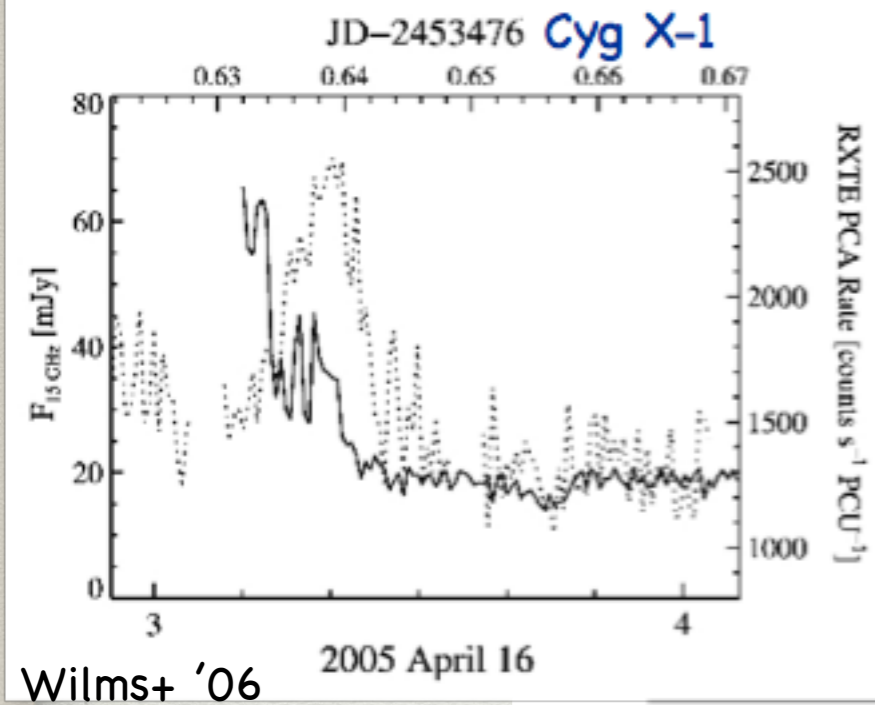
Intensity diagram



The « Jet line »



Mirabel+ '98; R.+ '08



Wilms+ '06

Physics of/from X-ray transients

Different families/sources => large number of key scientific questions (multi- λ and multi-instr. obs.)

- XRBs & CVs: physics of accretion (DIM, outburst mechanisms, state transitions,...) and links with jets/winds (energetic budget, particle acceleration, ISM feedback), plasma physics and MHD, GR=> multi lambda
- NS & WD: B topology, magnetic reconnection mechanisms and NS-quake (glitches), thermonuclear burning/explosions (feedback), crustal cooling, EOS => Timing
- Gamma-Ray Binaries & VHE emitters: Leptonic vs. hadronic models (HE-VHE), interaction with secondary, particle physics, shocks => HE, VHE

Constraining the physical processes: spectral diagnostics

(need for day/month basis observations – depending of the spectral state)

=> Accretion geometry

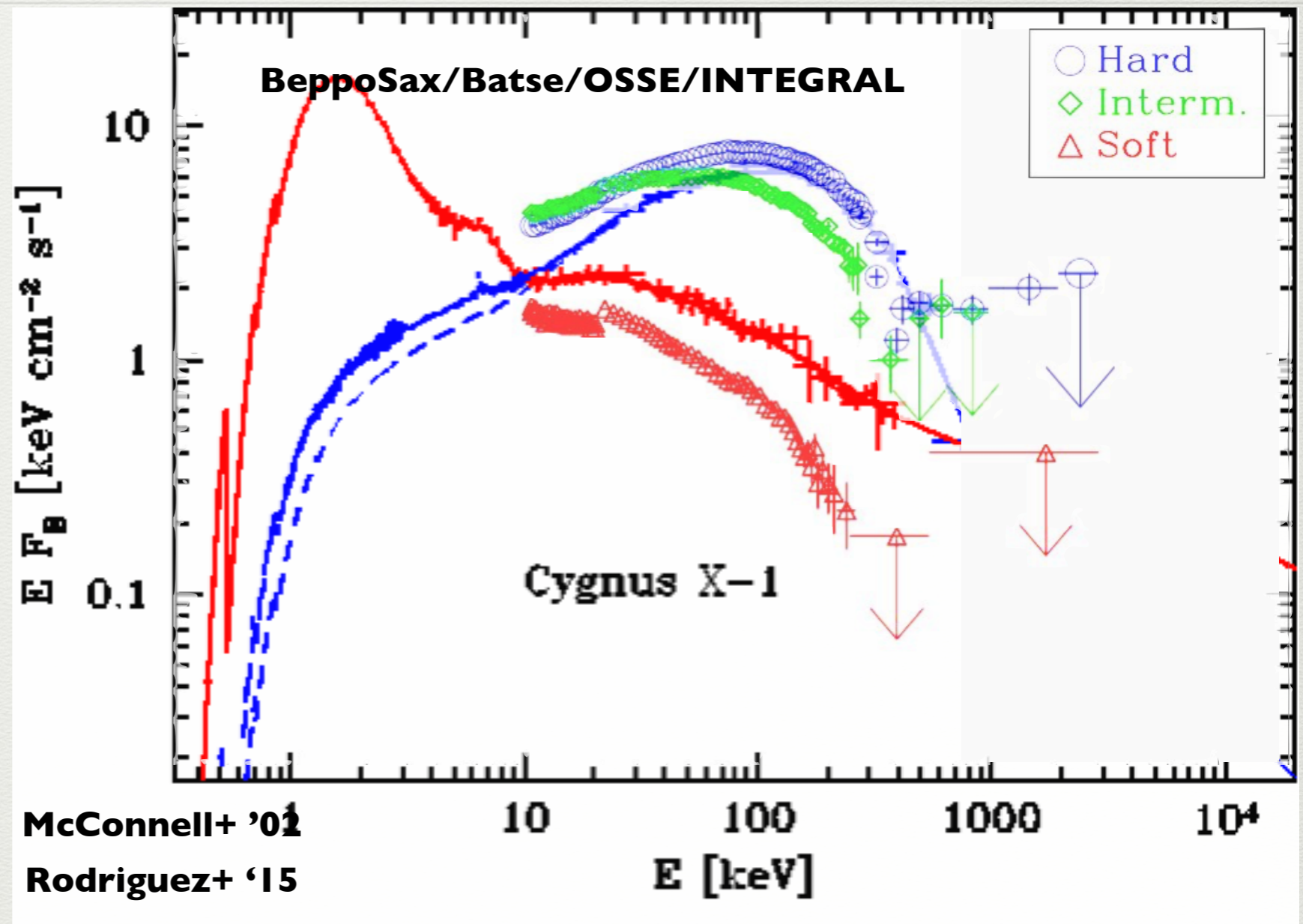
=> Origin of spectral components

=> (fast – *sec scale*) Variability

=> Disk-jet coupling (multi- λ)

=> Spin and parameters of CO

=> B of NS



Diagnositics (2): Timing

$$\tau_{\text{dyn,Kepler}} \sim \sqrt{\frac{r^3}{GM_{OC}}}$$

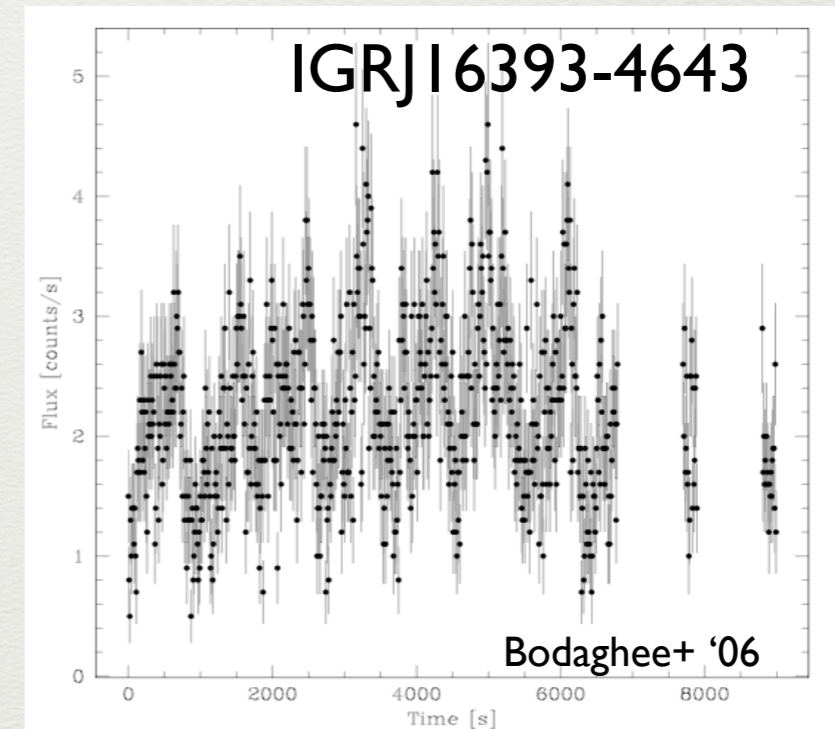
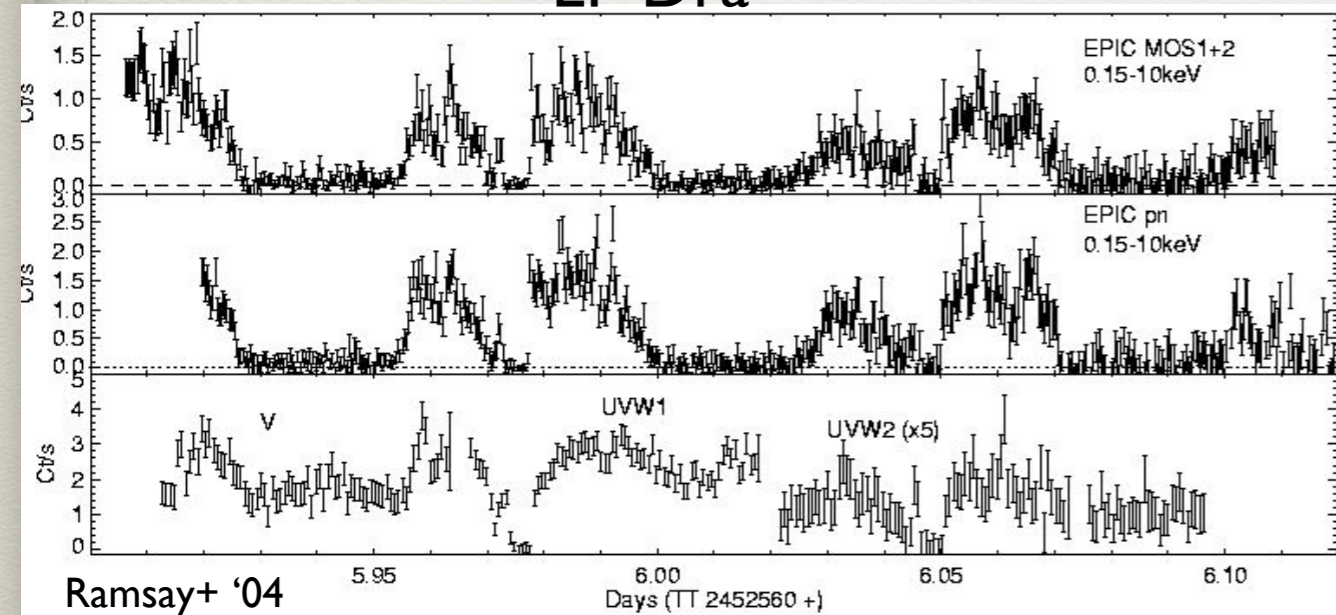
$$\tau_{\text{dyn,Kepler}} \sim 2 \text{ ms}(1 M_{\odot}, 100 \text{ km})$$

$$1 \text{ hr} \lesssim P_{\text{orb}} \lesssim 100 \text{ j}$$

Spin of neutron stars : $1 \text{ ms} \lesssim P \lesssim 1 \text{ hr}$

Some typical periods (isolated / binaries)

EP Dra



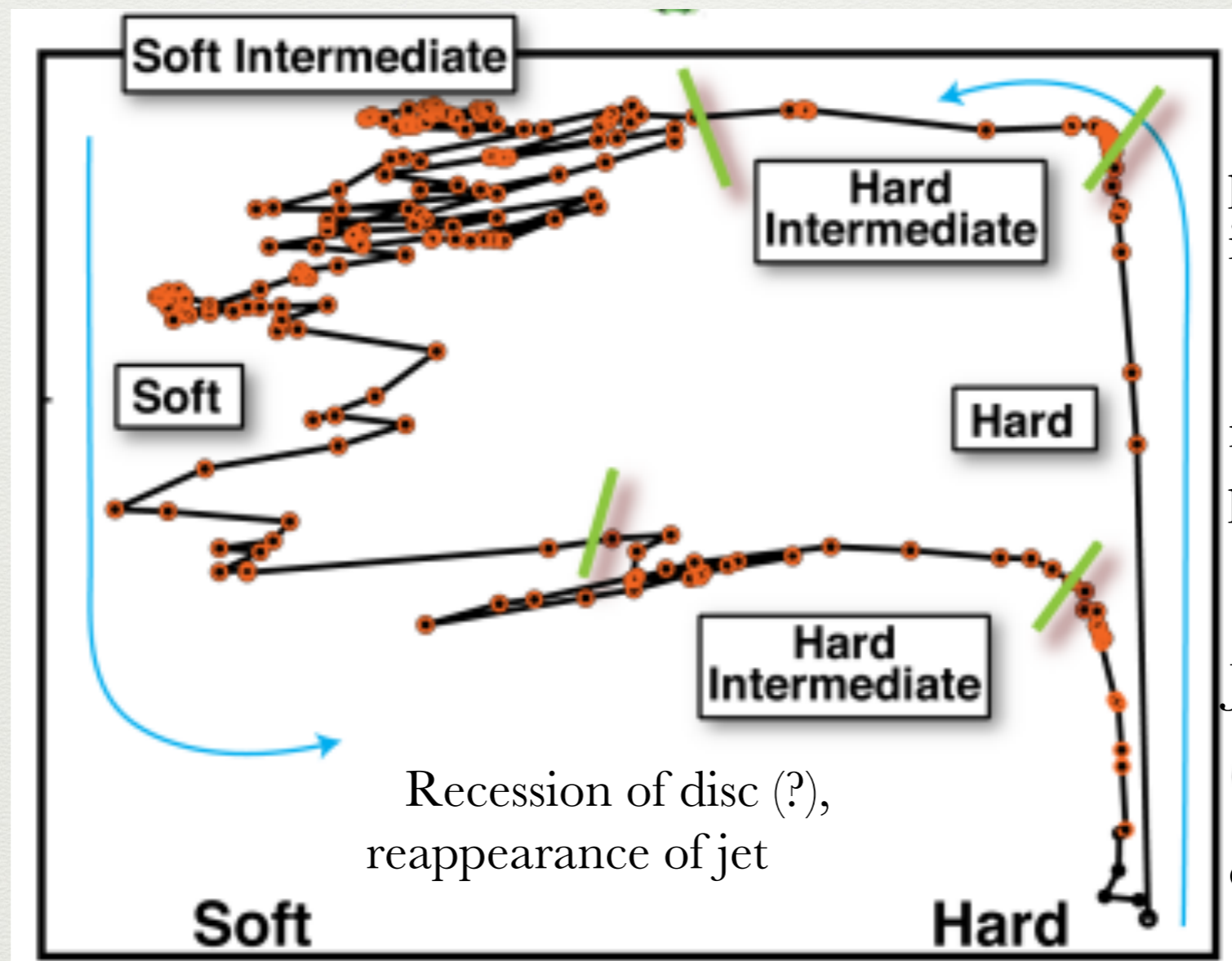
Occurrence of outbursts, NS-quakes, thermonuclear bursts ?

Serendipitous activity \Leftrightarrow Needs large field surveys/ all sky monitoring

Phase dependent diagnostics

Fine spectral analysis: line/reflection/link with jet-external disk, γ -ray flares and connections to accretion

High fluxes



X: Approach of disk, properties of corona, interplay

QPO

γ : jet composition, models of jet production/acceleration

Radio-Opt. : Jet behaviour, energetic

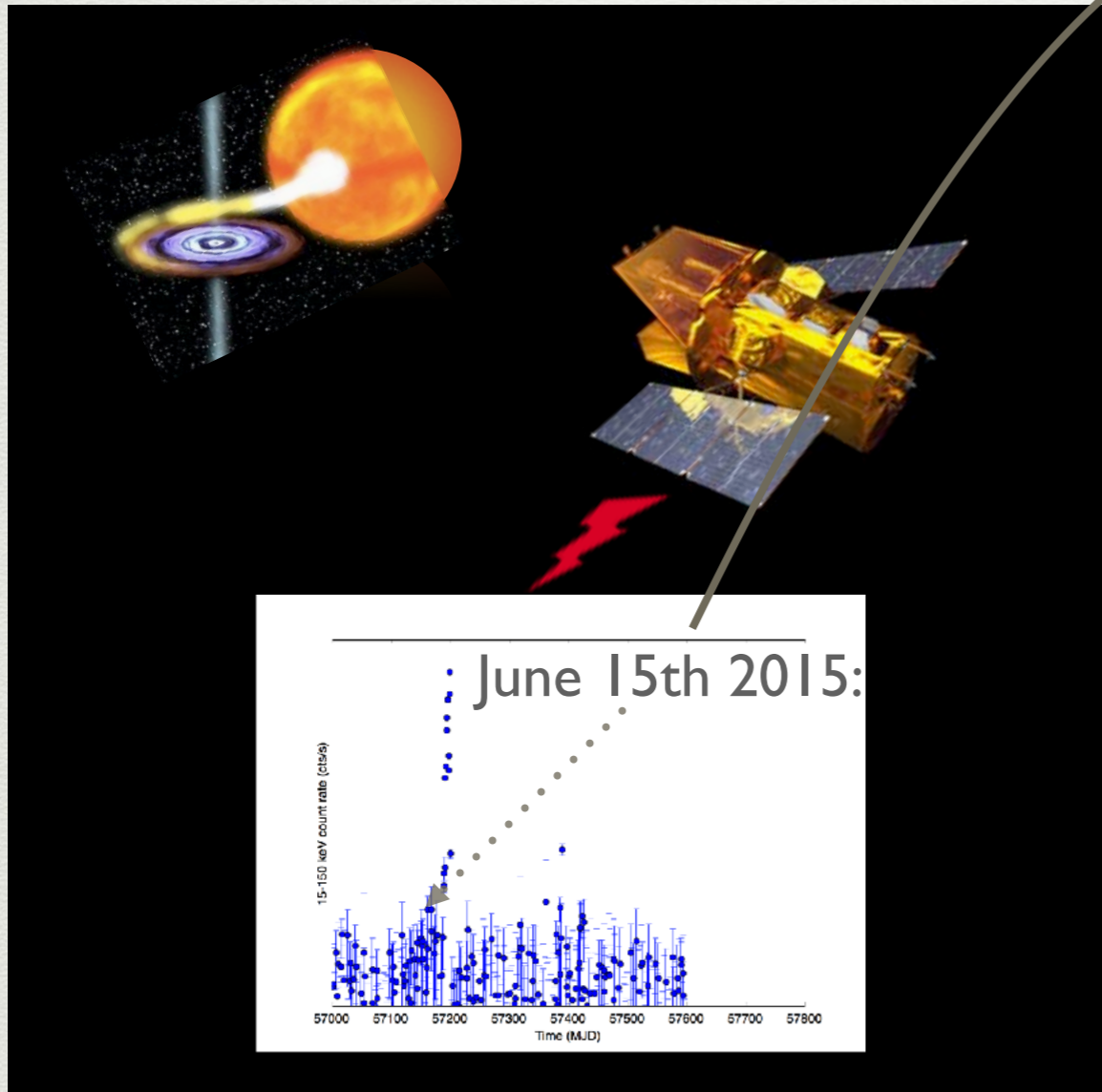
=> trigger of outburst?

Disk @ LSO:
line, inner radius
=> spin of BH?

Outflows (wind),
suppression of jets?
Energetic feedback
in ISM

Example: (re)activity to a specific transient

V404 Cygni



TITLE: GCN CIRCULAR
 NUMBER: 17929
 SUBJECT: Swift trigger 643949 is V404 Cyg
 DATE: 15/06/15 18:55:32 GMT
 FROM: Scott Barthelmy at NASA/GSFC <scott@milkyway.gsfc.nasa.gov>

S. D. Barthelmy (GSFC), A. D'Ai (INAF-IASFPA), P. D'Avanzo (INAF-OAB), H. A. Krimm (CRESS/USRA), A. Y. Lien (GSFC/UMBC), F. E. Marshall (NASA/GSFC), A. Maselli (INAF-IASFPA) and M. H. Siegel (PSU) report on behalf of the Swift Team:

At 18:31:38 UT, the Swift Burst Alert Telescope (BAT) triggered and located V404 Cyg. Swift slewed immediately to the source.

The BAT on-board calculated location is

RA, Dec 306.020, +33.850 which is

RA(J2000) = 20h 24m 05s

Dec(J2000) = +33d 50' 59"

with an uncertainty of 3 arcmin (radius, 90% containment, including systematic uncertainty). As is usual with an image trigger, the available BAT light curve shows no significant structure.

The XRT began observing the field at 18:34:37.3 UT, 179.1 seconds after the BAT trigger. Using promptly downlinked data we find an X-ray source with an enhanced position: RA, Dec 306.0162, 33.8673 which is equivalent to:

RA(J2000) = 20h 24m 03.89s

Dec(J2000) = +33d 52' 02.4"

with an uncertainty of 2.4 arcseconds (radius, 90% containment). This location is 63 arcseconds from the BAT onboard position, within the BAT error circle. This position may be improved as more data are received; the latest position is available at <http://www.swift.ac.uk/sper>. This position is 0.8 arcseconds from that of a known transient low-mass X-ray binary V* V404 Cyg.

A power-law fit to a spectrum formed from promptly downlinked event data gives a column density consistent with the Galactic value of $8.10 \times 10^{21} \text{ cm}^{-2}$ (Willingale et al. 2013).

UVOT took a finding chart exposure of 150 seconds with the White filter starting 183 seconds after the BAT trigger. No credible afterglow candidate has been found in the initial data products. The $2.7' \times 2.7'$ sub-image covers 100% of the XRT error circle. The typical 3-sigma upper limit has been about 19.6 mag. The $8' \times 8'$ region for the list of sources generated on-board covers 100% of the XRT error circle. The list of sources is typically complete to about 18 mag. No correction has been made for the large, but uncertain extinction expected.

[Previous | Next | ADS]

MAXI/GSC detection of a new outburst from the Galactic black hole candidate GS 2023+338 (V* V404 Cyg)

ATel #7646; H. Negoro, T. Matsumitsu (Nihon U.), T. Mihara, M. Serino, M. Matsuoka (RIKEN), S. Nakahira, S. Ueno, H. Tomida, M. Kimura, M. Ishikawa, Y. E. Nakagawa (JAXA), M. Sugizaki, M. Shidatsu, J. Sugimoto, T. Takagi (RIKEN), N. Kawai, T. Yoshii, Y. Tachibana (Tokyo Tech), A. Yoshida, T. Sakamoto, Y. Kawakubo, H. Ohtsuki (AGU), H. Tsunemi, R. Imatani (Osaka U.), M. Nakajima, K. Tanaka (Nihon U.), Y. Ueda, T. Kawamuro, T. Hori (Kyoto U.), Y. Tsuboi, S. Kanetou (Chuo U.), M. Yamauchi, D. Itoh (Miyazaki U.), K. Yamaoka (Nagoya U.), M. Morii (ISM)

on 17 Jun 2015; 03:20 UT

Credential Certification: Hitoshi Negoro (negoro@phys.cst.nihon-u.ac.jp)

Subjects: X-ray, Binary, Black Hole, Transient, Variables

Referred to by ATel #: 7647, 7655, 7659, 7661, 7662, 7663, 7667, 7669, 7671, 7674, 7677, 7681, 7686, 7693, 7695, 7701, 7702, 7708, 7709, 7717, 7718, 7720, 7721, 7722, 7729, 7734, 7740, 7755, 7772, 7959

[Tweet](#) [Recommend 8](#)

On 2015 June 16 (MJD 57189), the MAXI/GSC nova alert system detected burst-like activities from the position consistent with the Galactic black hole candidate GS 2023+338 (V404 Cyg, Makino et al. IAUC. #4786). This renewed activity from the source was first detected by Swift/BAT at 18:31 on June 15 (Barthelmy et al. GCN #17929). Currently, MAXI observed the region with the degraded and uncalibrated counter, GSC3. The GSC3 clearly detected bright X-ray flare(s) from the source in the scan transits at 18:48 and 20:21 on June 16. The 4-10 keV fluxes were roughly 500-600 mCrab. In the following scan transits at 21:53 and 23:26 on June 6 and 00:59 on June 7, however, the flux decreased again to ~100 mCrab or less. Note that the detection limit in a single scan transit with the GSC3 is roughly 100 mCrab.

Such sporadic flare activities of this source were often observed in the previous outburst in 1989 (Terada et al. 1994, PASJ 46, 477; Oosterbroek et al. 1997, A&A 321, 776). We strongly encourage multi-wavelength followup observations to observe this unique black hole candidate.

Related

- 8531 Multicolour Optical Photometry of V404 Cyg
- 8520 e-MERLIN detection of compact radio emission from V404 Cyg
- 8516 INTEGRAL/OMC optical photometric observations of V404 Cyg during its last outburst
- 8515 V404 Cyg was in optical quiescence from mid October to mid December 2015
- 8512 INTEGRAL observations of V404 Cyg (GS 2023+338): further public data products
- 8510 INTEGRAL and Swift observations of V404 Cyg: going back to quiescence?
- 8509 T100 Observations of V404 Cyg during quiescence
- 8507 A Faint X-ray Dust Scattering Echo from V404 Cyg in Response to Recent Flares
- 8501 Recent Optical Observations of V404 Cyg
- 8500 INTEGRAL observes a bright flare and spectral changes in V404 Cyg: possible hard to soft transition ahead?
- 8499 Sub-millimetre Detection of V404 Cygni During December-2015 Outburst
- 8494 MAXI/GSC detection of a recent low-level X-ray activity and a bright hard X-ray flare from V404 Cyg
- 8489 Rapid Bright X-ray Flares from V404 Cyg During December-2015 Outburst
- 8482 The RATAN-600 monitoring of the V404 Cyg
- 8475 INTEGRAL/Swift observations of V404 Cyg back in outburst
- 8466 Observation of V404 Cyg in quiescence in 2015 November
- 8462 X-ray re-brightening of V404 Cyg observed by Swift.
- 8459 MASTER dwarf nova outbursts
- 8458 INTEGRAL IBIS/ISGRI confirms renewed activity of V404 Cyg
- 8457 GBM observations of V404 Cyg outburst
- 8455 Swift triggers on V404 Cyg
- 8454 Detection of the new activity in V404 Cyg with RATAN-600

The largest multi- λ worldwide effort for a XRB outburst (strong french implication)

V404 Cyg Collaborating

Telescope	Frequencies Wavelengths Bands Energies	Start Time	End Time	Source	Link
Swift BAT	15-50 keV	Orbitally	Orbitally	Webpage	http://swift.gsfc.nasa.gov/results/transients/week/V404Cyg/
0.4m Athens	R	2015/06/15 06:57:00	2015/06/15 08:24:00	ATEL #7650	http://users.uoa.gr/~kgaze/data/V404Cyg/V404_cyg_optical_eps
0.4m Athens	R	2016/06/10 10:33:00	2016/06/10 14:10:00	ATEL #7650	http://users.uoa.gr/~kgaze/data/V404Cyg/V404_cyg_optical_fit_eps
INTEGRAL IBIS/ISGR	20-100 keV	2015/06/17 21:29:54	2015/06/18 17:05:00	ATEL #7682	http://www.isdc.unige.ch/~lagraki/Operations/SHIB/ATELs/V404-2015-031c_hratio.gif
INTEGRAL OMC	V	2015/06/18 04:27:00	2015/06/18 11:08:00	ATEL #7682	http://www.isdc.unige.ch/~lagraki/Operations/SHIB/ATELs/V404-2015-031c_hratio.gif
				ATEL #7677	http://www.phys.lsu.edu/~rhub/V404_20160618.png
				ATEL #7681	http://littelfair.staff.shef.ac.uk/images/V404Cyg/V404Cyg.png
				ATEL #7685	http://littelfair.staff.shef.ac.uk/images/V404Cyg_UCAM_2015_05_19.png
				ATEL #7686	http://littelfair.staff.shef.ac.uk/images/V404Cyg_UCAM_2015_03_20.png
				ATEL #7689	https://www2.uea.ac.uk/departments/physics/people/klawarwarsama/v404-cyg-in-july-2015/
				ATEL #7693	http://master.sai.msu.ru/static/DI/MASTER/V404.jpg
				ATEL #7698	http://master.sai.msu.ru/static/v404cyc.jpg
				ATEL #7708	http://astro.physics.uiterbo.it/v404cyc/V404Cyg20150622_V404Cyg.jpg
				ATEL #7710	http://www.phys.lsu.edu/~rhub/V404_20160619.png
				ATEL #7714	http://40.sky.org/atel/v404cyc-20150625/
				ATEL #7718	http://www.soc.nyu.edu/~kbr/V404Cyg/V404Cyg_1c_2015.png
				ATEL #7717	http://cab.inta-ocic.es/users/albert/atal/V404_0619-0604.png
				ATEL #7719	http://watcher.talasscope.it/files/results/V404Cyg/fitphotometry_obs10.pdf
				ATEL #7721	http://cma.ira.vobispace.whes.lancoll.ac.uk/v404cyc/v404_cyg_20150625/
				ATEL #7722	http://www.observ.com.au/bf/publication/V404_Cyg1a.jpg
Fermi GBM	8 keV - 300 keV	As triggered/daily	As triggered/daily	Webpage	http://astro.phys.lsu.edu/nbm/

- Tens of multi- λ ToOs :
=> 50 ATELS published on June 30th (2 weeks of outburst)
=> Another 15 in the first week of July, while the source was already entering into quiescence

V404 Cyg Collaborating

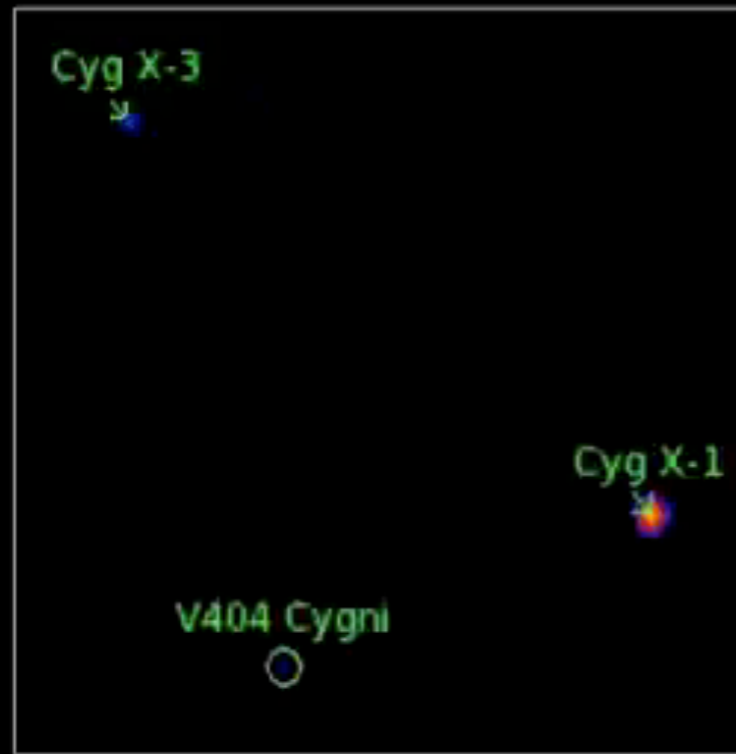
Current GMT:

Telescope	Frequencies Wavelengths Bands Energies	PI	Allocation Remaining	~ Today's Transit (UT)	6/24 Transit (UT)	7/1 Transit (UT)	7/8 Transit (UT)	7/15 Transit (UT)
LOFAR	115 - 189 MHz	Broderick (Oxford)	1 (6h) long observation and 6 (20 min) monitoring runs	6/24/2015 14:49:00				
VLA	1 - 2 GHz	Miller-Jones (Curtin)	12 (0.25 hr) Priority C Tracks	10:17	09:25	08:57	08:29	08:01
VLA	4 - 8 GHz	Miller-Jones (Curtin)	12 (0.25 hr) Priority C Tracks	10:17	09:25	08:57	08:29	08:01
VLBA	8.4 GHz	Miller-Jones (Curtin)	36 hrs at Priority B	NA	NA	NA	NA	NA
VLA	18 - 26 GHz	Miller-Jones (Curtin)	12 (0.25 hr) Priority C Tracks	10:17	09:25	08:57	08:29	08:01
AMI	15 GHz	Mooey (Oxford)	Daily	NA	02:15	01:47	01:19	00:51
NOEMA	97 GHz / 140 GHz	Tetarenko (Alberia)	3 (8 hour) Priority A Tracks; 2	02:42	01:52	01:24	00:56	00:28
SMA	230 GHz	Tetarenko (Alberia)	2 (8 hour) Priority B Tracks	13:28	12:38	12:08	11:40	11:12
JCMT	350 GHz / 670 GHz	Tetarenko (Alberia)	8.5 hours	NA	12:38	12:08	11:40	11:12
TCS (Terente)	near IR H(?)	Shchoval/IAC effort	4-9 and 13-14 July allocated	04:18	03:27	02:59	02:31	02:03
	Opt. Photom. (BVR)							
0.5m (La Palma)		Dillon/Hardy (Sheffield)	Every night the weather perm	04:18	03:27	02:59	02:31	02:03
CBA	Opt. Photometry	Citizen Scientists		NA	NA	NA	NA	NA
AAVSO	Opt. Photometry	Citizen Scientists		NA	NA	NA	NA	NA
INTEGRAL OMC	Optical V	Publio/Rodriguez	Nearly Continuous	NA	NA	NA	NA	NA
Swift UVOT	Optical U		Easily Requested	NA	NA	NA	NA	NA
HST	time-resolved FUV spec	Knigge (Southampton)	July 10 12:12 - 19:23 UT	NA	NA	NA	NA	NA
HST	time-resolved NUV spec	Knigge (Southampton)	July 11 13:37 - 18:09 UT	NA	NA	NA	NA	NA
HST	time-resolved FUV spec	Knigge (Southampton)	July 12 11:56 - 18:08 UT	NA	NA	NA	NA	NA
Swift XRT	0.5-10 keV		Easily Requested	NA	NA	NA	NA	NA
INTEGRAL JEMX	3 keV - 35 keV	Publio/Rodriguez	Nearly Continuous	NA	NA	NA	NA	NA
Swift BAT	15 - 50 keV	Publio/Rodriguez/Cadotte...	Easily Requested	NA	NA	NA	NA	NA
INTEGRAL IBIS	15 keV - 10 MeV	Publio/Rodriguez	Continuous	NA	NA	NA	NA	NA
INTEGRAL SPI	18 keV - 8 MeV	Publio/Rodriguez	Continuous	NA	NA	NA	NA	NA
GTC	Opt. Spectroscopy	Casares (IAC)	0.5 hr until July 3		04:18	03:27	02:59	02:31
WHT+ISIS		Casares (IAC)	0.5 nights July 7 & 10	04:18	03:27	02:59	02:31	02:03
WHT+ISIS		Casares (IAC)/Jonker (SRON)	July 18 / 19	04:18	03:27	02:59	02:31	02:03
LCGT	Opt photometry	Froning	simultaneous with HST, other?					
IRTF/SpEX	time-resolved NIR (and mid-IR?) spec	Knigge/Tokunaga	1 hr slots; exact times TBD					
Calar Alto 2.2m/FANIC	NIR photometry	Knigge/Meisenheimer	27 & 28 June; 0:00 UT and 03:00 UT					
Fermi GBM	8 keV - 40 MeV	Publio/Jenke	Continuous	na	na	na	na	na

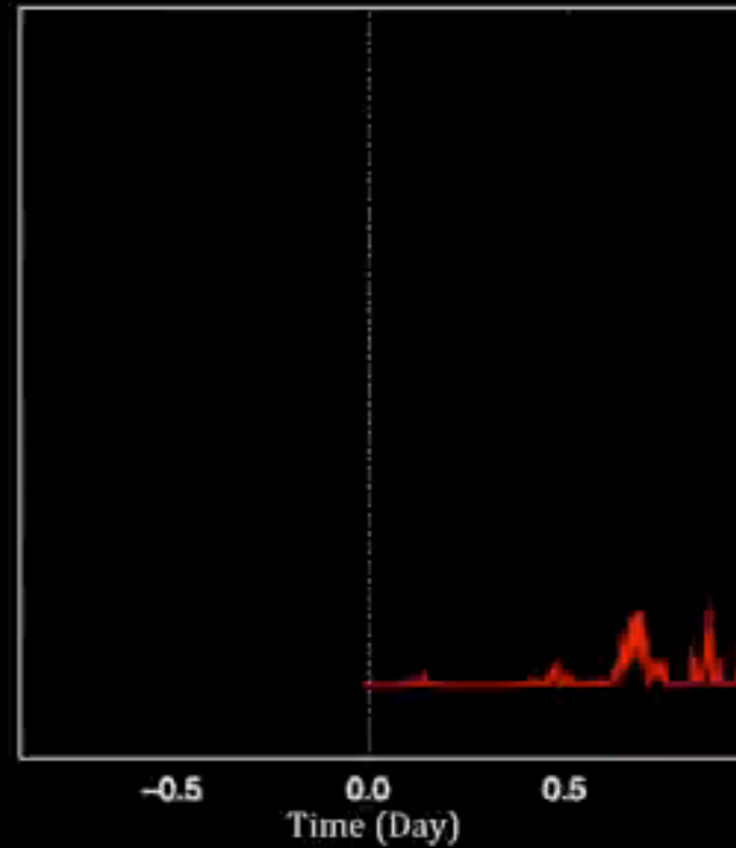
Tentative federation of the community

Early alerts permit fine monitoring

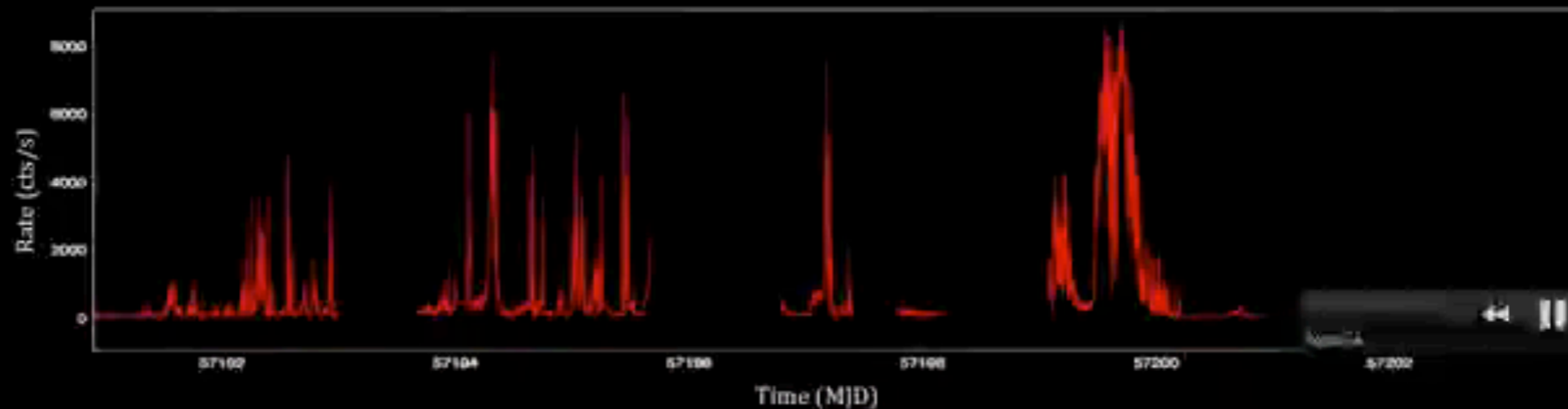
FOV



Timing



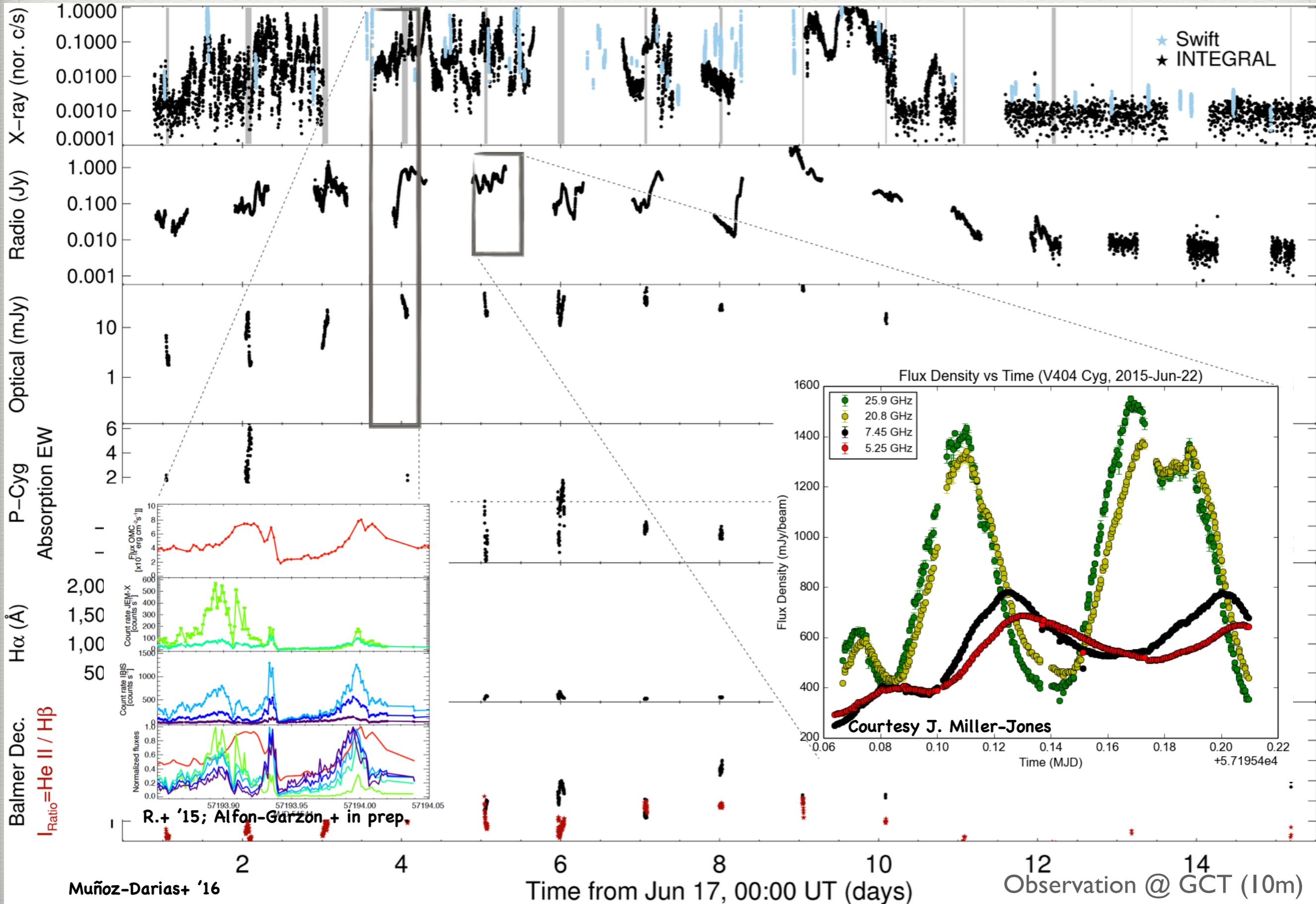
Temporal coverage



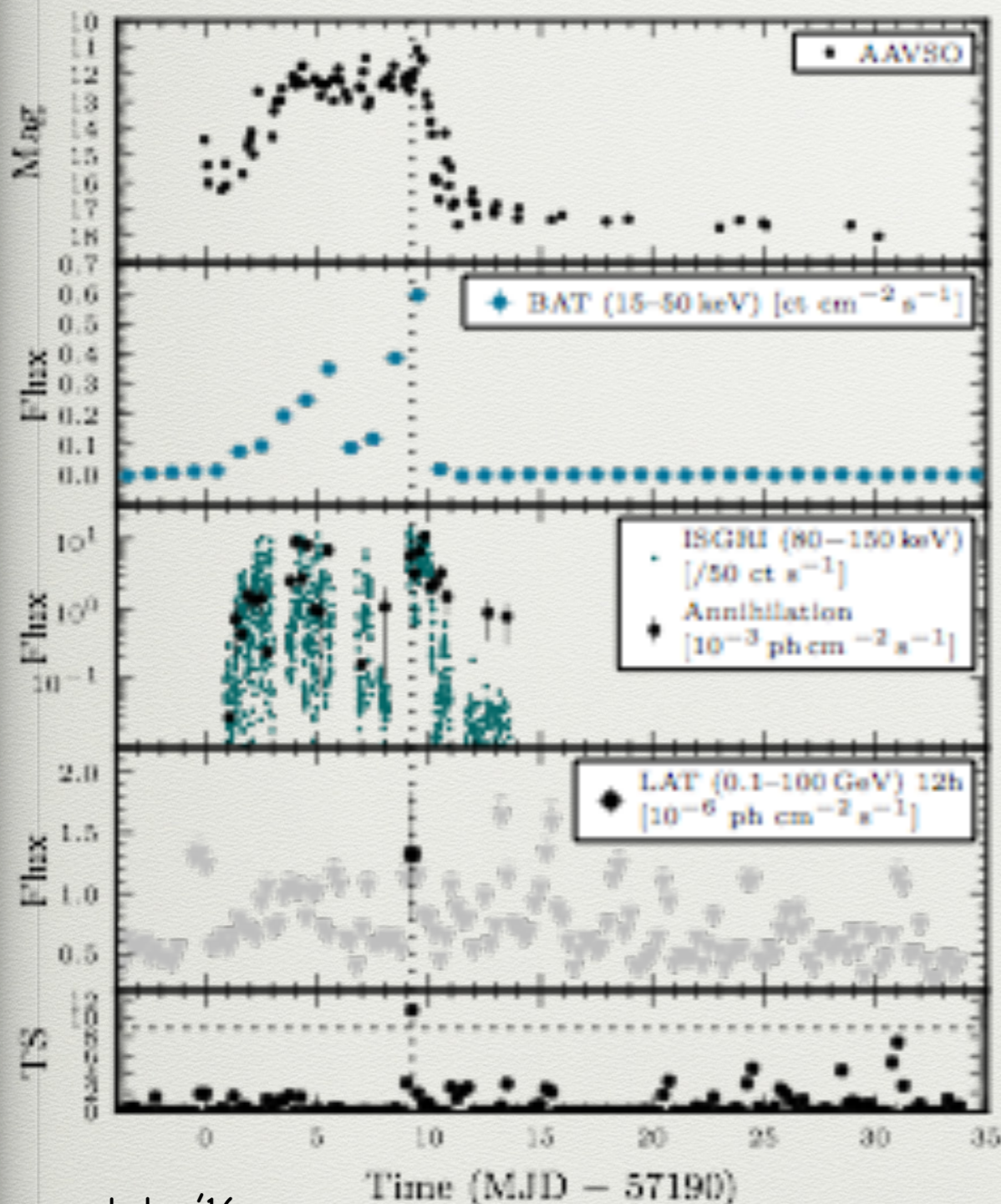
+spectra

Credit: Vincent Chambouleyron (CEA)

And specific focus on peculiar transitions



Few selected results



Loh+ '16

- 50 Crab flares at 20 keV: brightest X-ray source, > 20 keV spectra have similar shape (R.+ '15)
- Detection of a variable 511 keV line (Siegert+ '16): e^-/e^+ jet, pair plasma production
- Detection with Fermi @ GeV + 511 keV line \Rightarrow origin related to jet (Loh+ '16)
- Multi- λ flaring activity \Rightarrow evacuation of inner accretion disc before ejection (Radhika+ '16)
- Optical analysis \Rightarrow a sustained disc wind regulating the outburst (Muñoz-Darias+ '16) but flares due to disk reprocessing (Kimura +'16)

Take away message

- High throughput/ narrow field instruments (VLA, ALMA, VLT, HST, Chandra, XMM, et al...) => deeper into the physics of accreting sources/ Several important results over the past 20 years
- This would have **not** been **possible without alerts** on outburst / state transitions / flares / unpredictable behaviour **from wide field/all sky monitors**
- 2020 is the era of large radio array and sky surveys / alerts in radio/optical with a very high expected discovery space
 - => Need for all sky monitor at X/gamma rays **ASM type monitor**
 - => Need for the possibility to quickly react to alerts **mission design**
 - => Need to federate over common/automatized strategies given the expected high number of alerts (SKA, LSST, multi-messengers, ...) **selection of alerts required, criteria?**

Take away message (2)

- Transients phenomena cover different time scales : long declining ourburst (days to weeks) to fast events (SN, magnetars flares or Fast Radio Burts)
 - => Good/very good time resolution necessary (not to be neglected in the instrument definition/data storage/alert system/follow-up strategy)
 - => Alerts/strategy
 - => HTRA (High Time Resolution Astrophysics) domain
 - => Performant/dedicated instruments needed

NICER on ISS

NICER : Neutron star Interior Composition ExploreR



2017, June 14th

<https://heasarc.gsfc.nasa.gov/docs/nicer>

