Frane, valanghe, terremoti e *Supergiant Fast X-ray Transients:* le power law sono (quasi) ovunque

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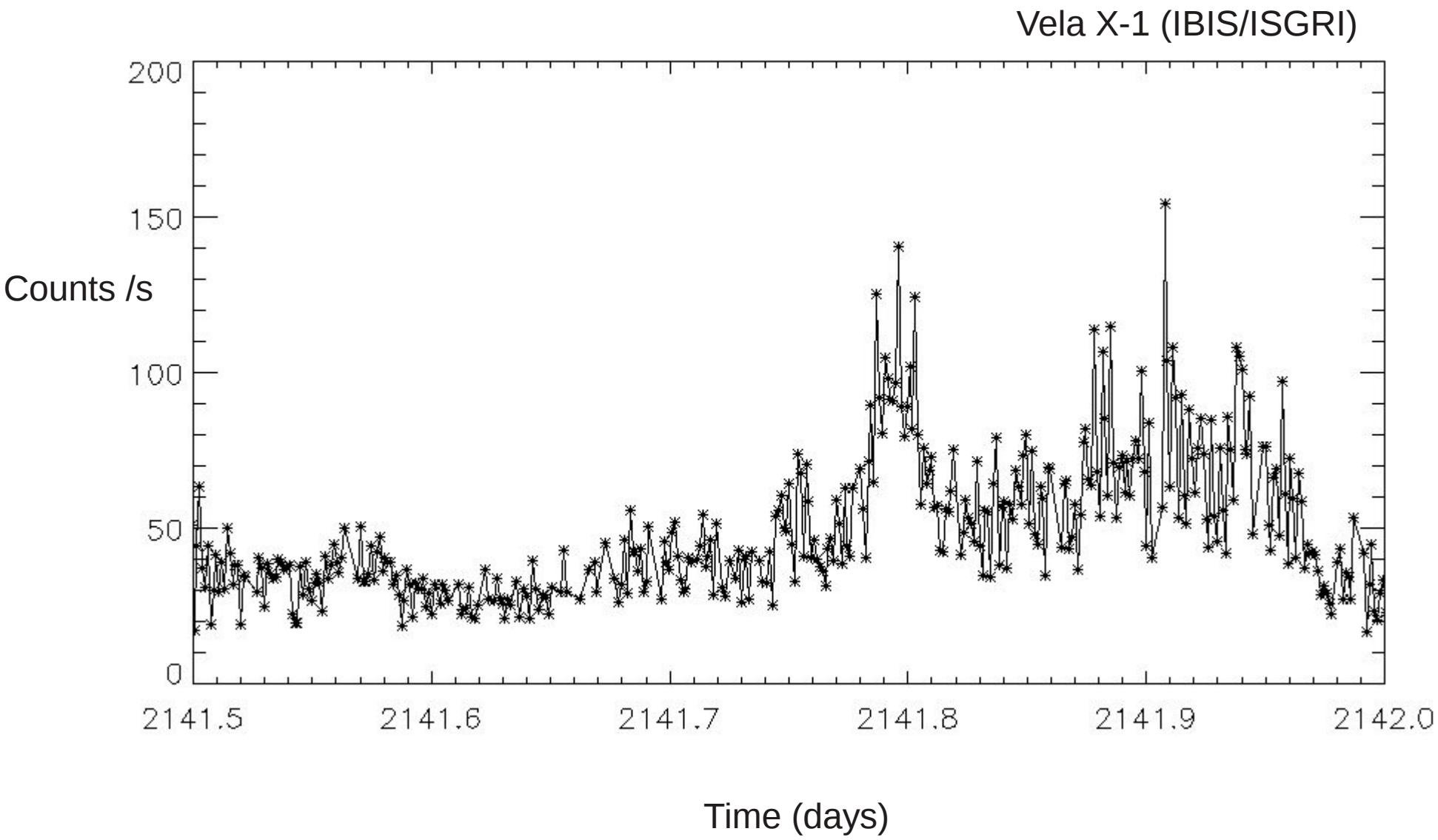
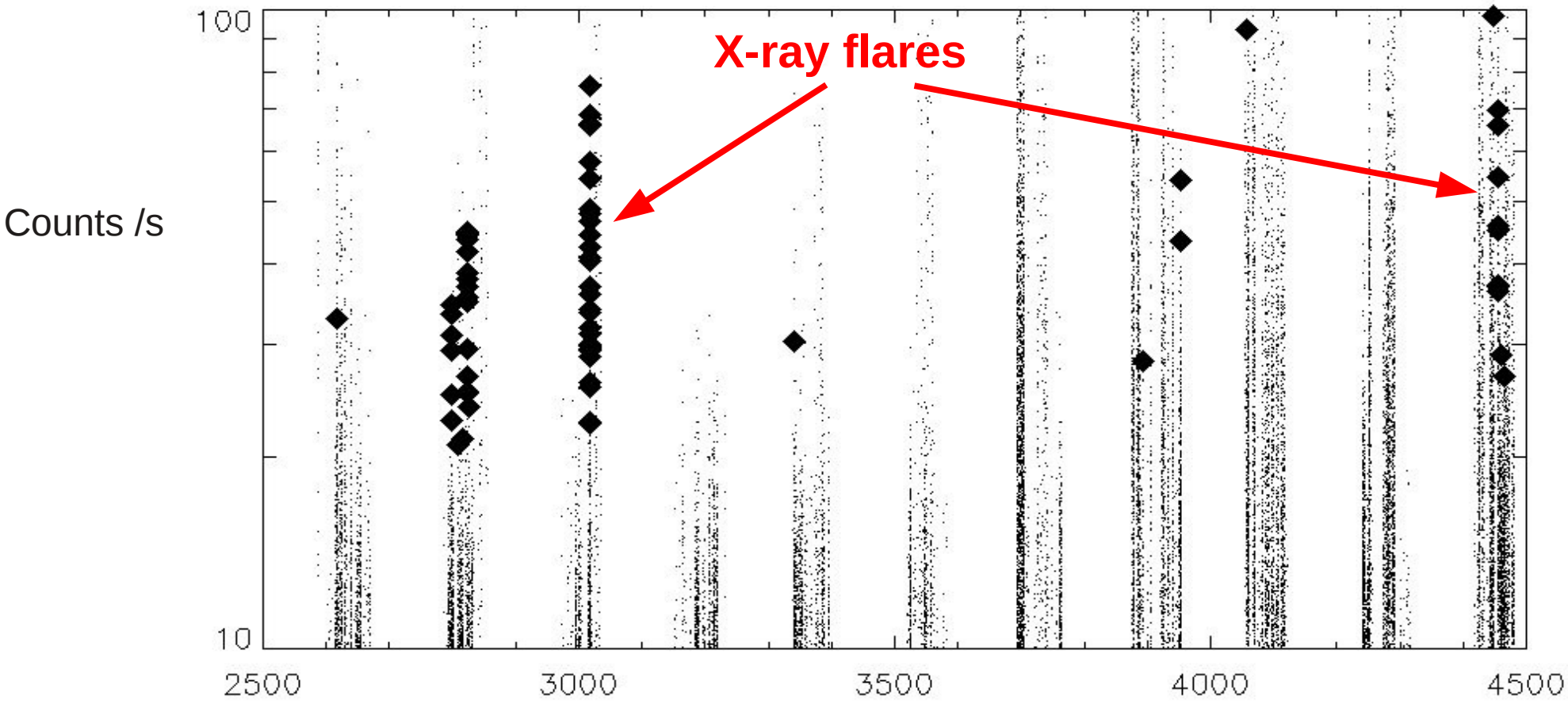
AstroSiesta 13 Feb 2014

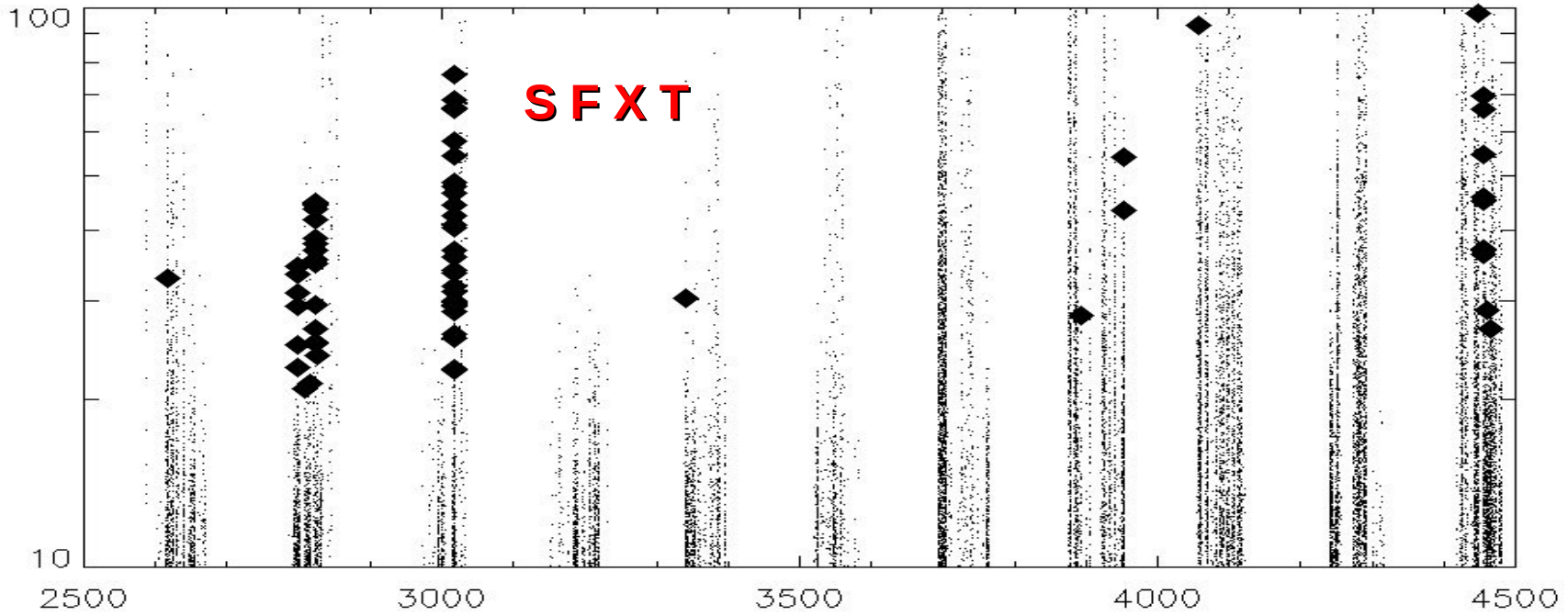
SFXTs and HMXBs

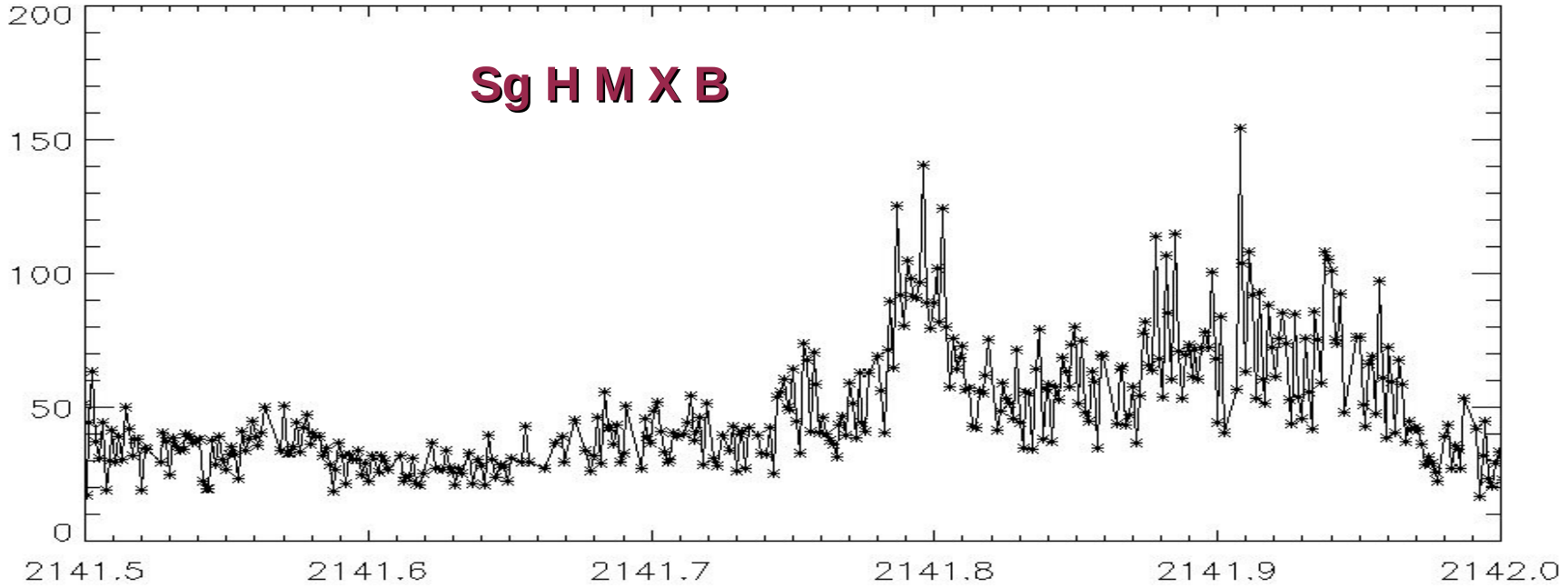


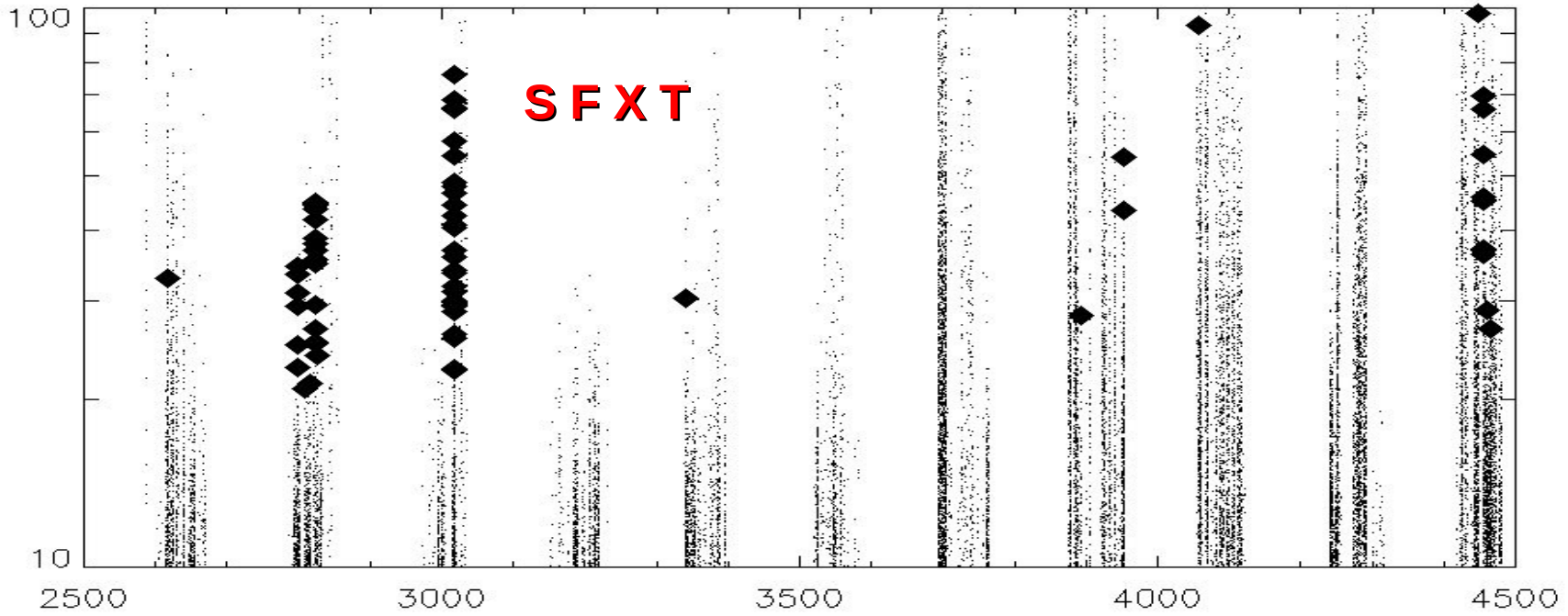
SFXTs and HMXBs

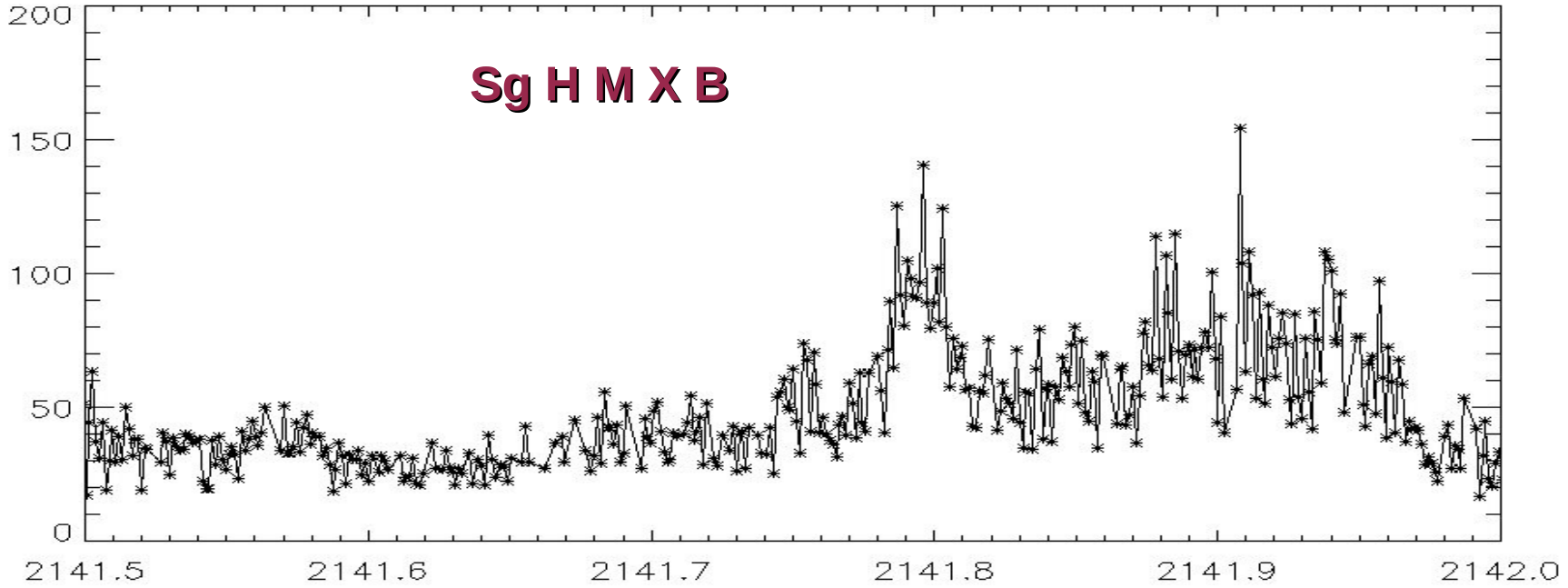
IGRJ17544-2619 (IBIS/ISGRI)

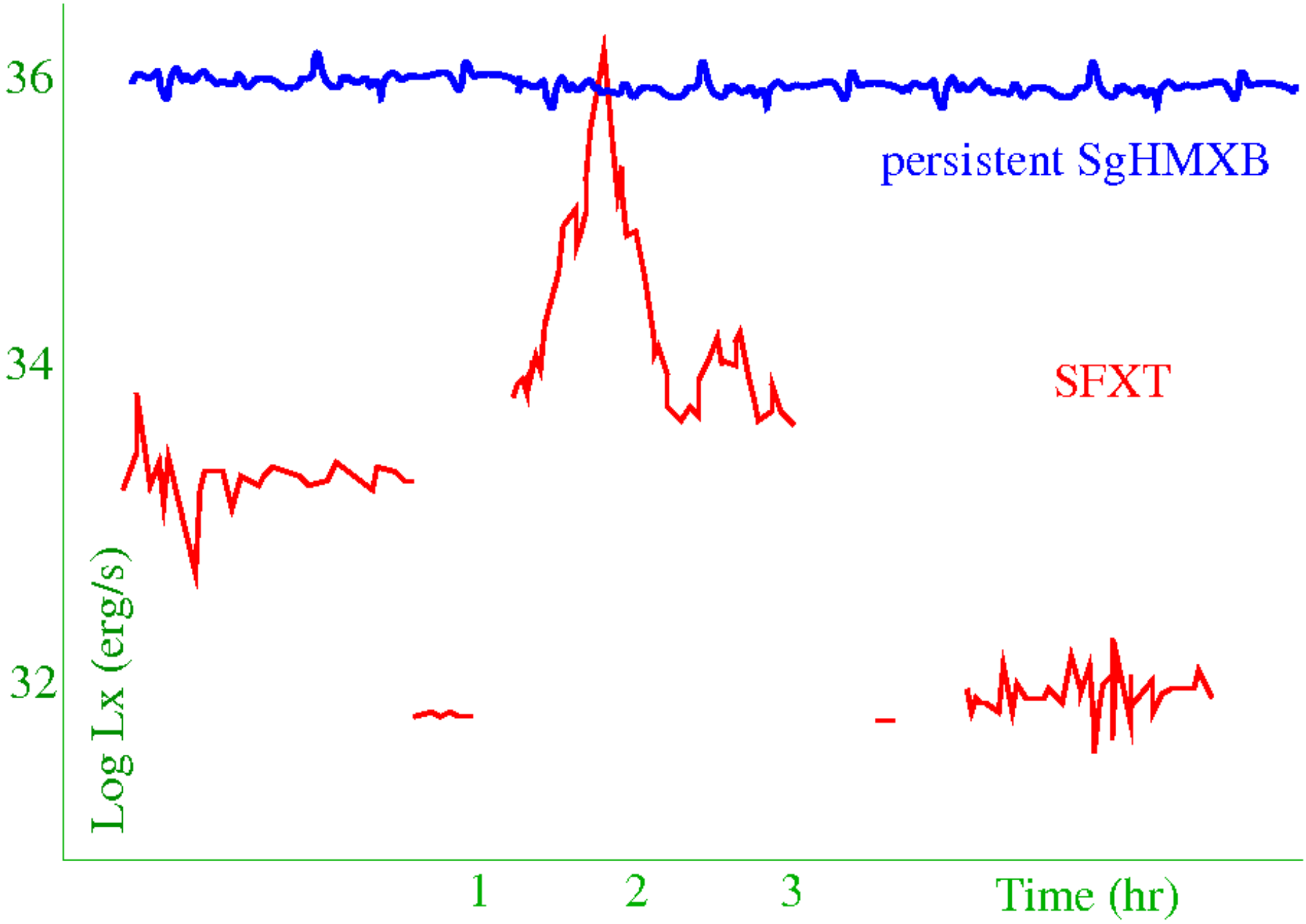



SFXT
100
10
2500
3000
3500
4000
4500

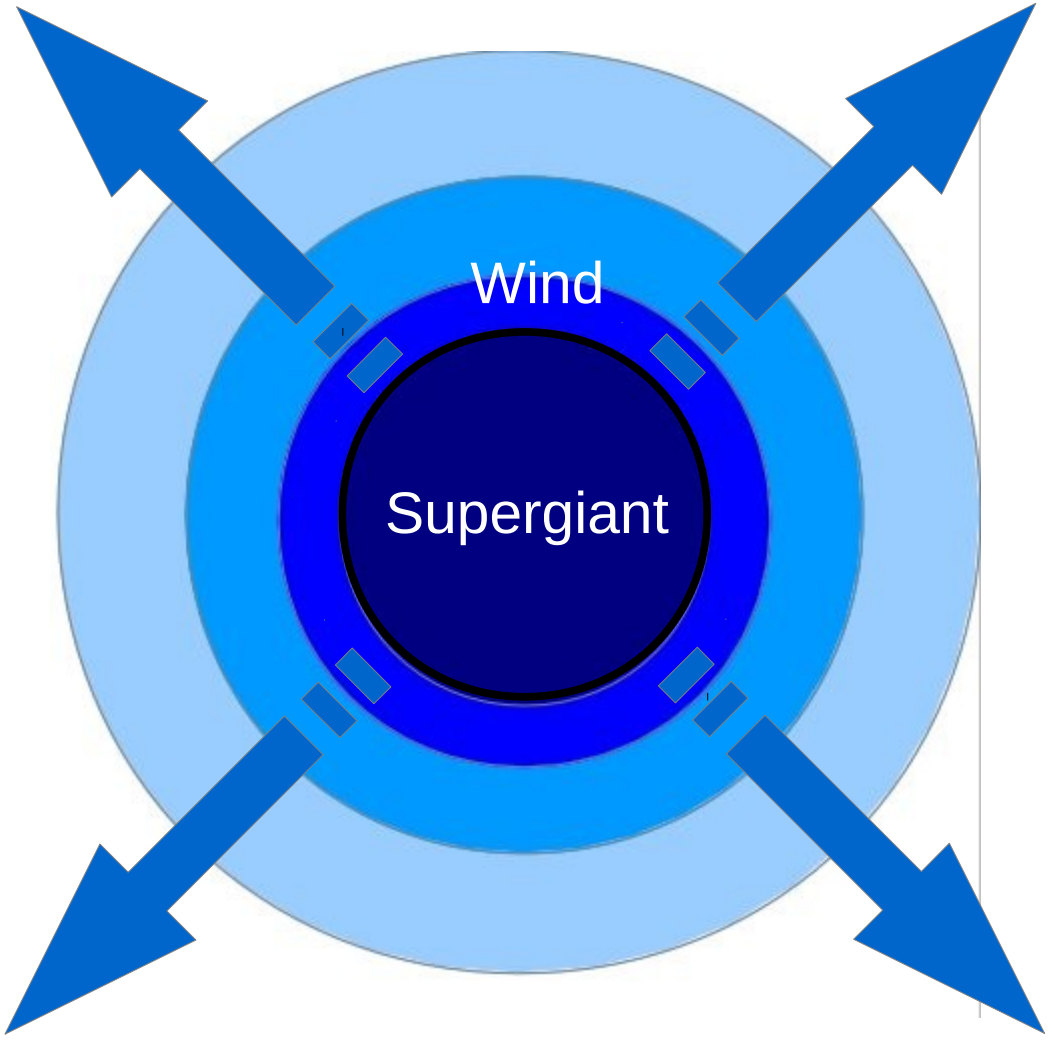

Sg HMXB
200
150
100
50
0
2141.5
2141.6
2141.7
2141.8
2141.9
2142.0

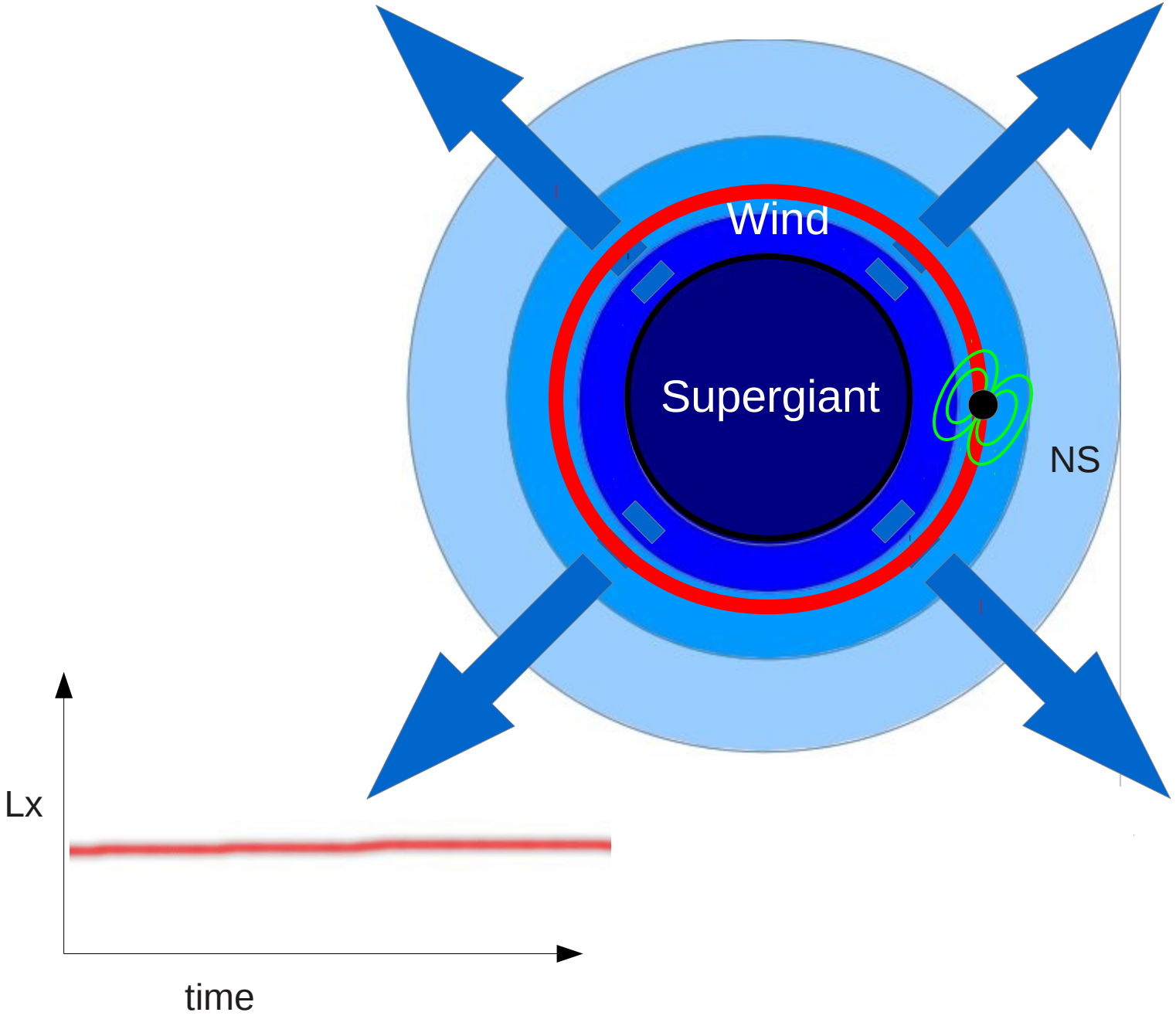

SFXT
100
10
2500
3000
3500
4000
4500

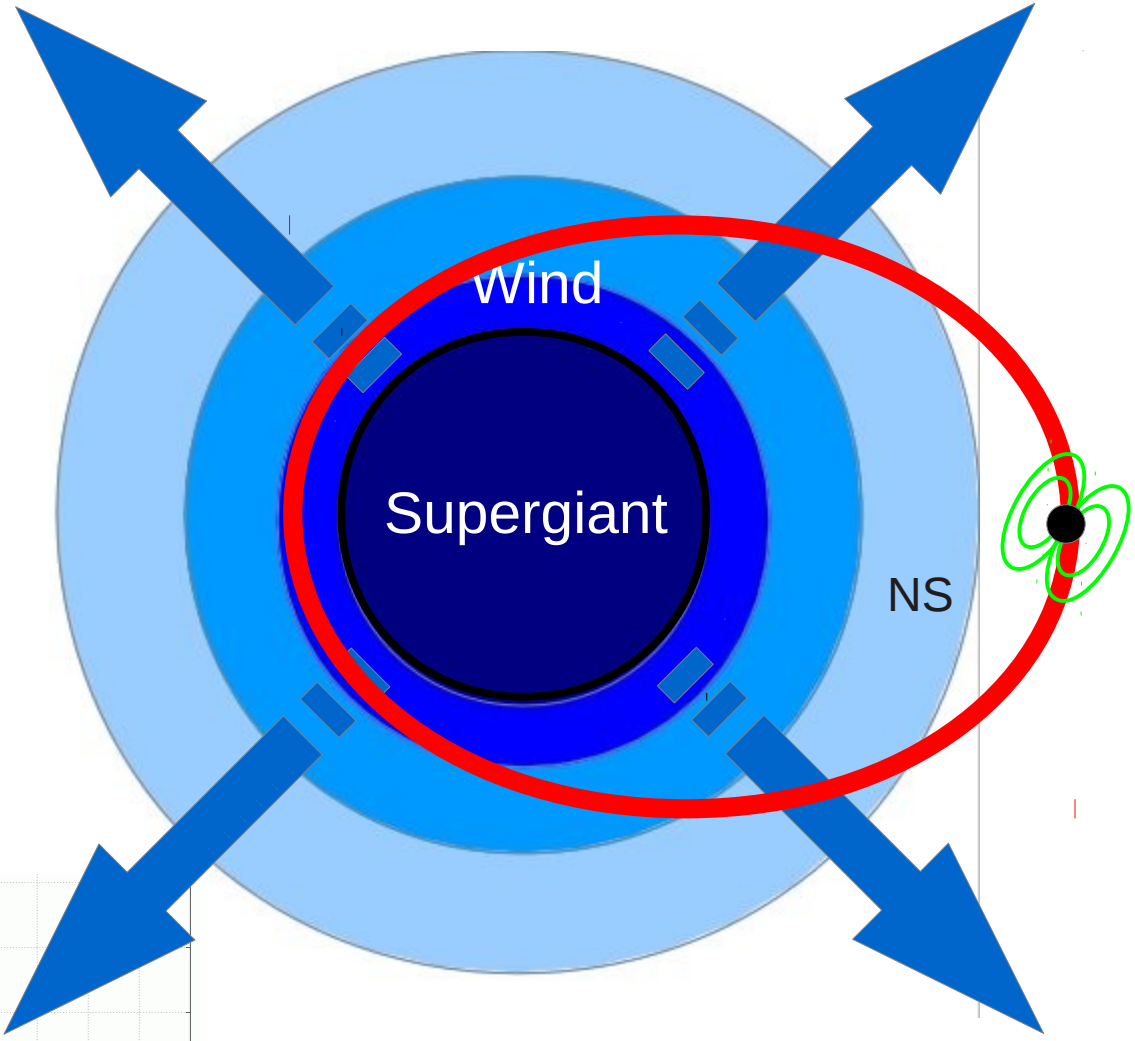

Sg HMXB
200
150
100
50
0
2141.5
2141.6
2141.7
2141.8
2141.9
2142.0

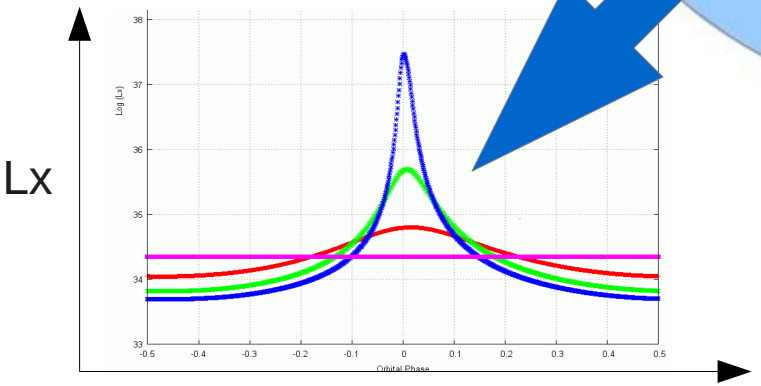

36
34
32
Log Lx (erg/s)
persistent SgHMXB
SFXT
1
2
3
Time (hr)

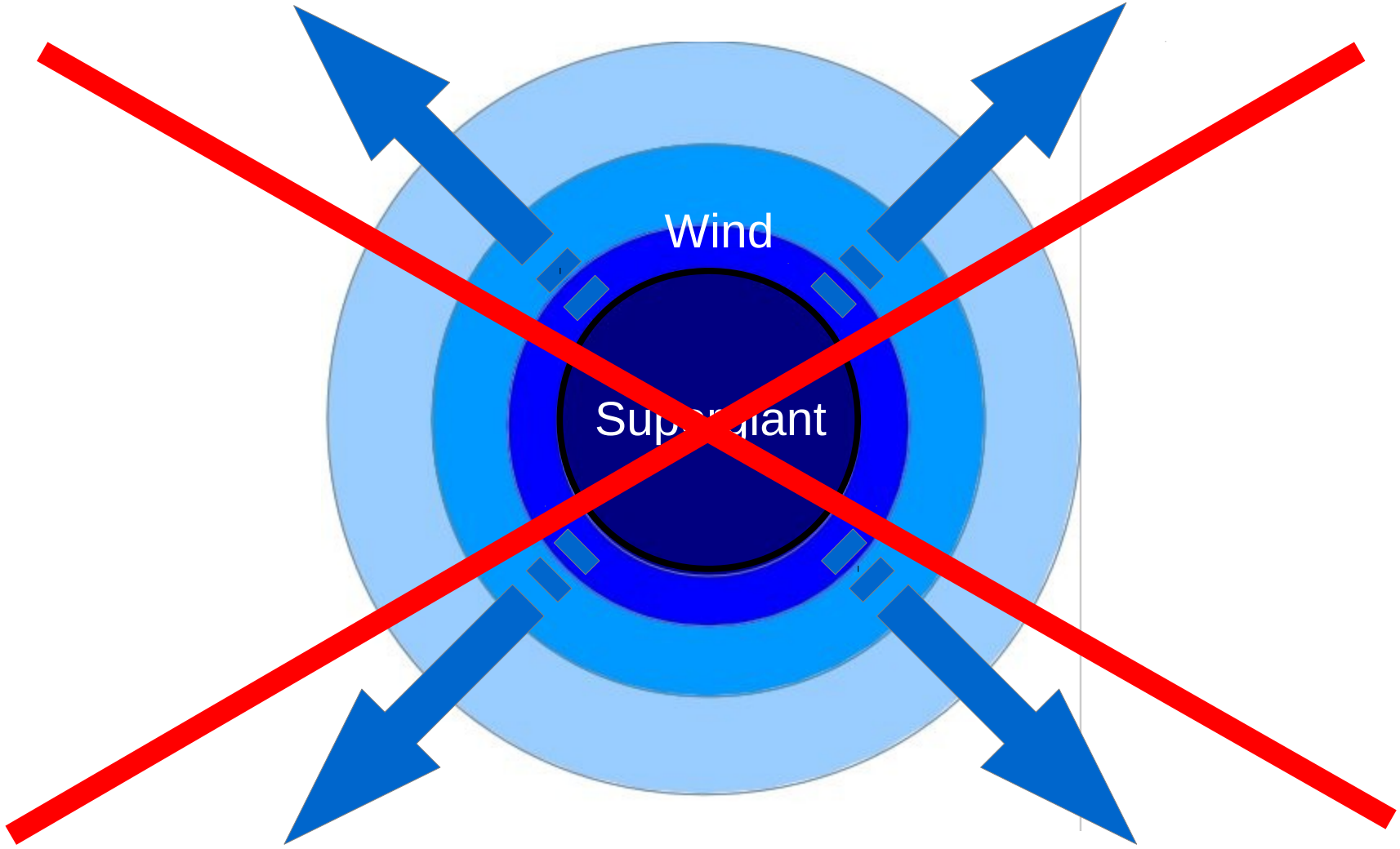
SFXTs and persistent HMXBs have similar companions



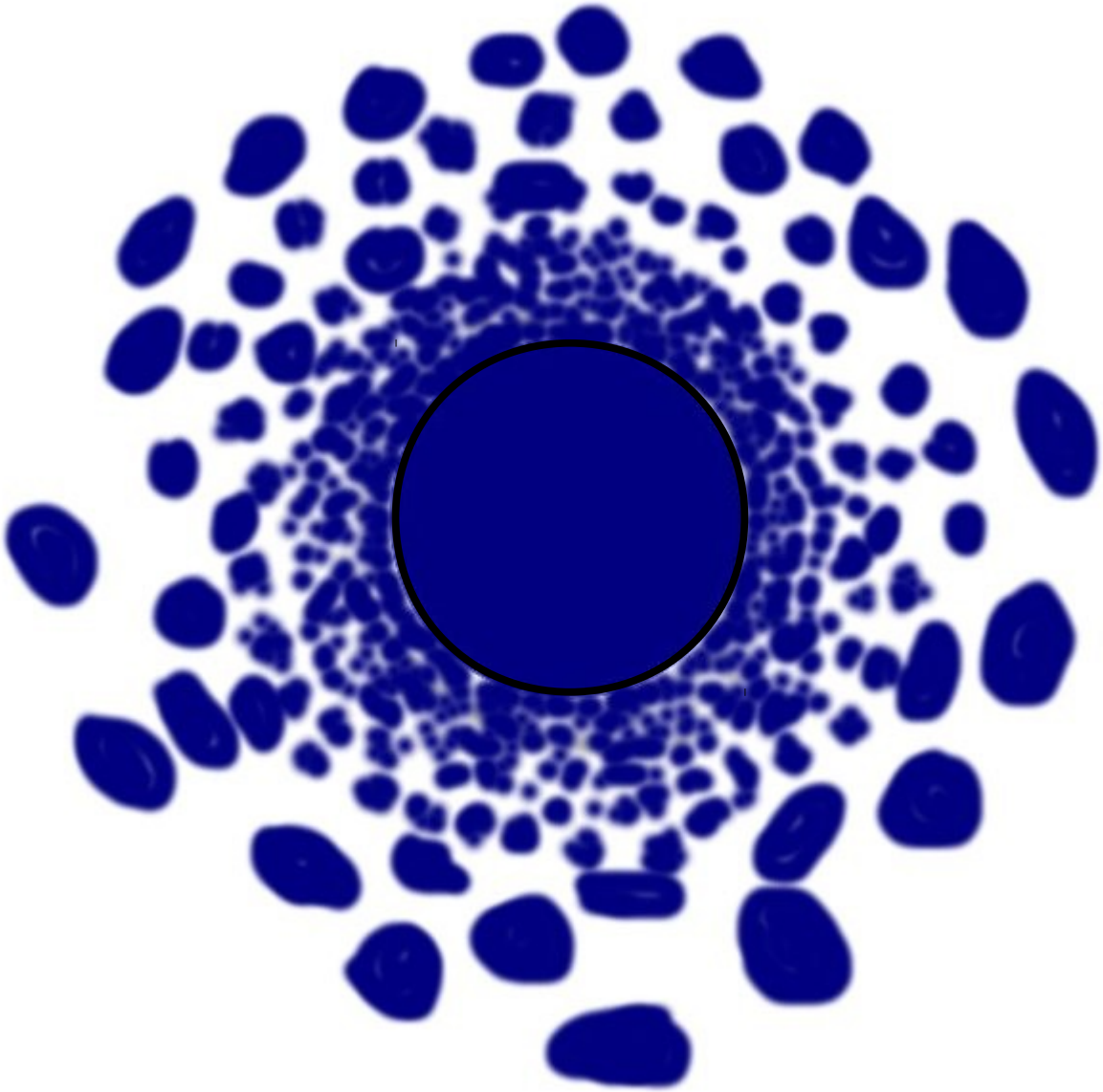

Wind
Supergiant
NS
Lx
time

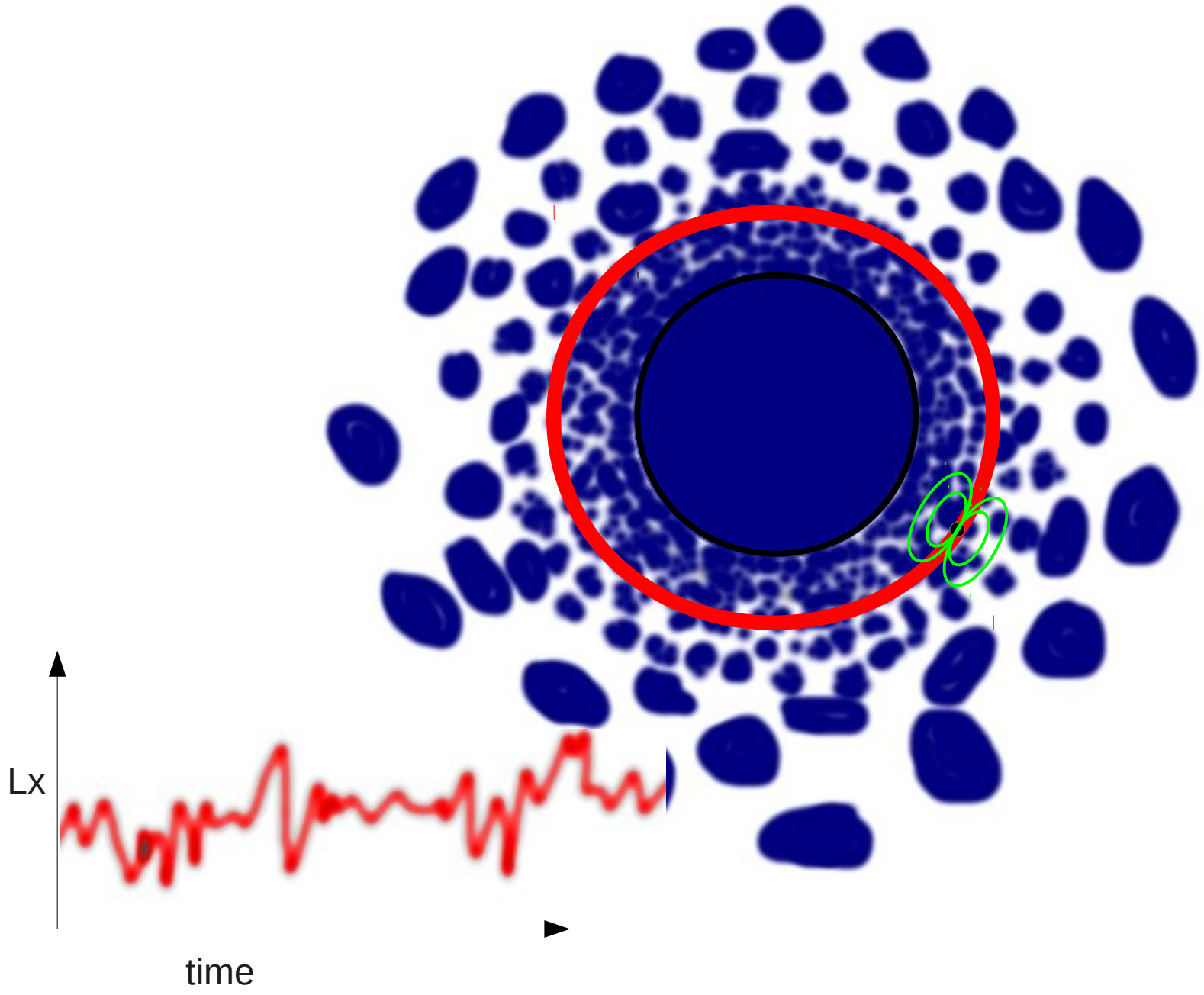

Wind
Supergiant
NS

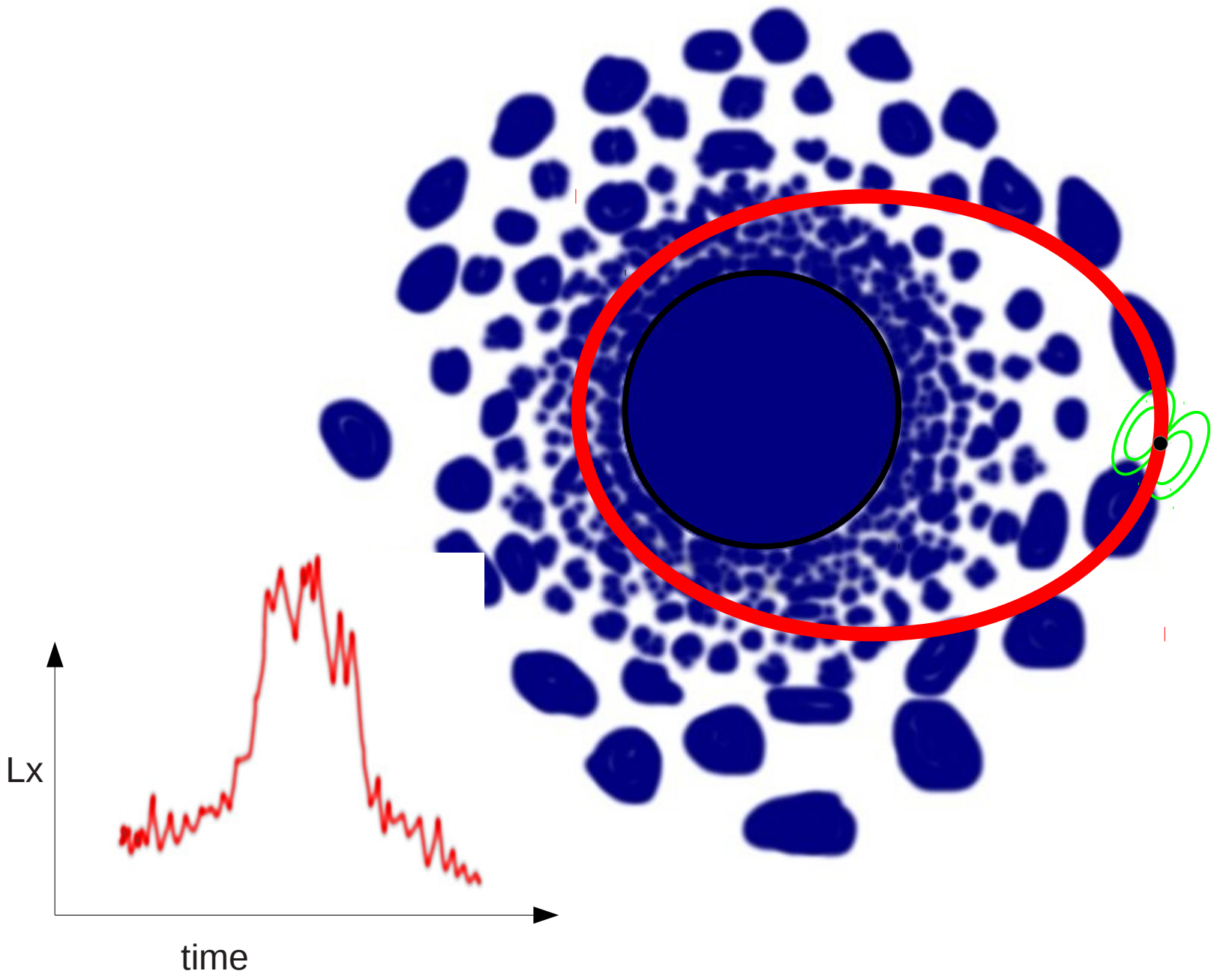

Lx
time

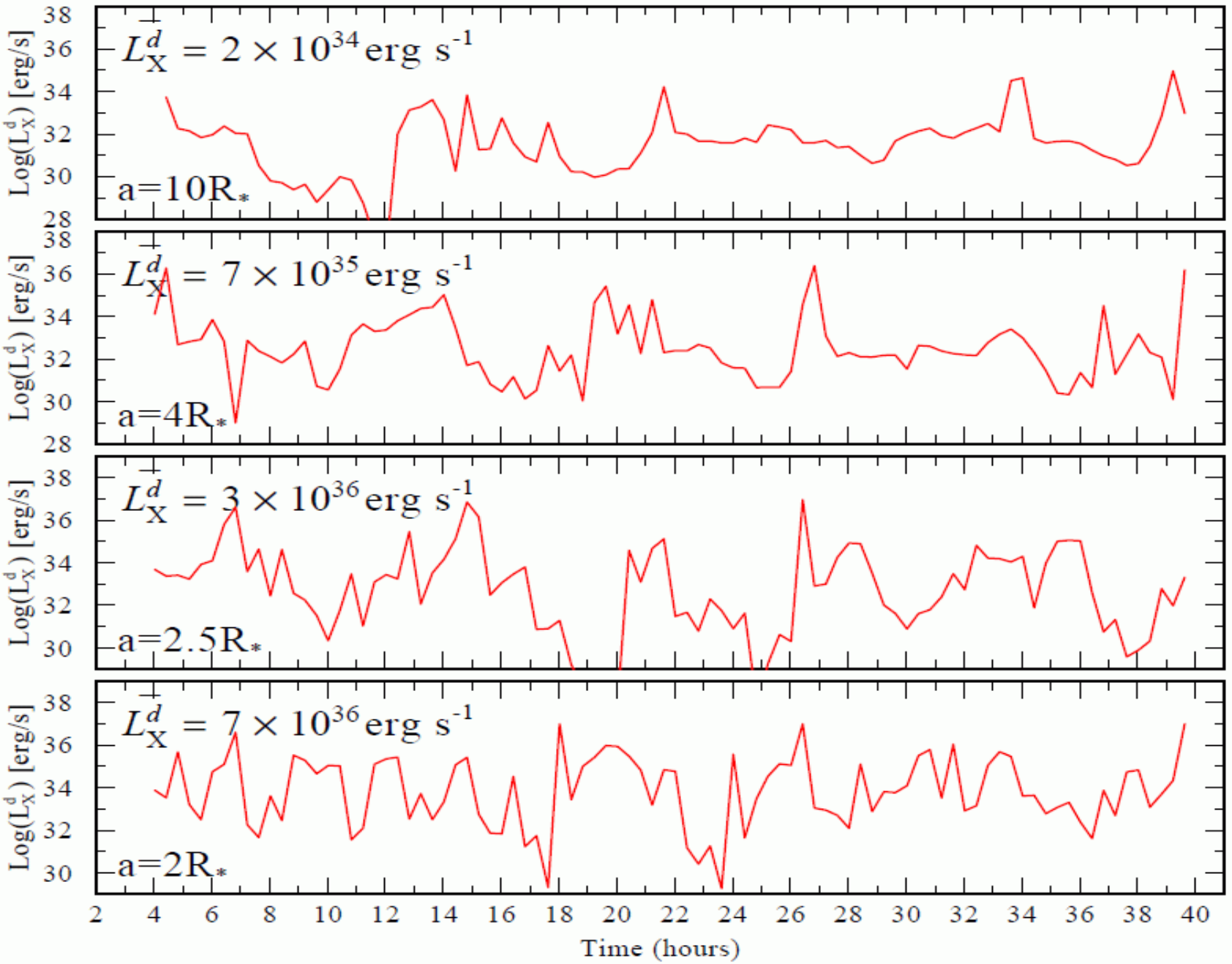


winds in blue supergiants are inhomogeneous

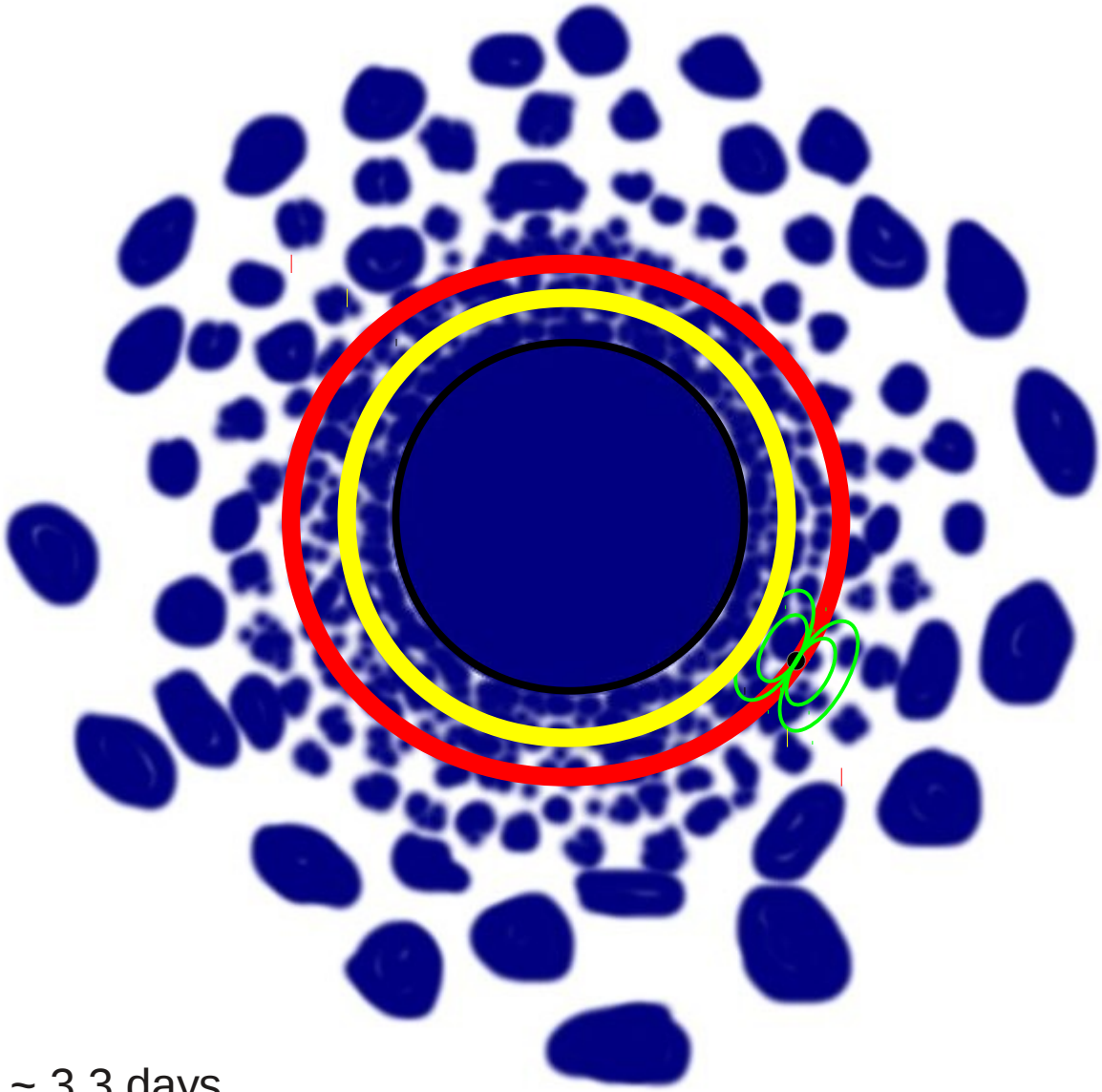



Lx
time


Lx
time

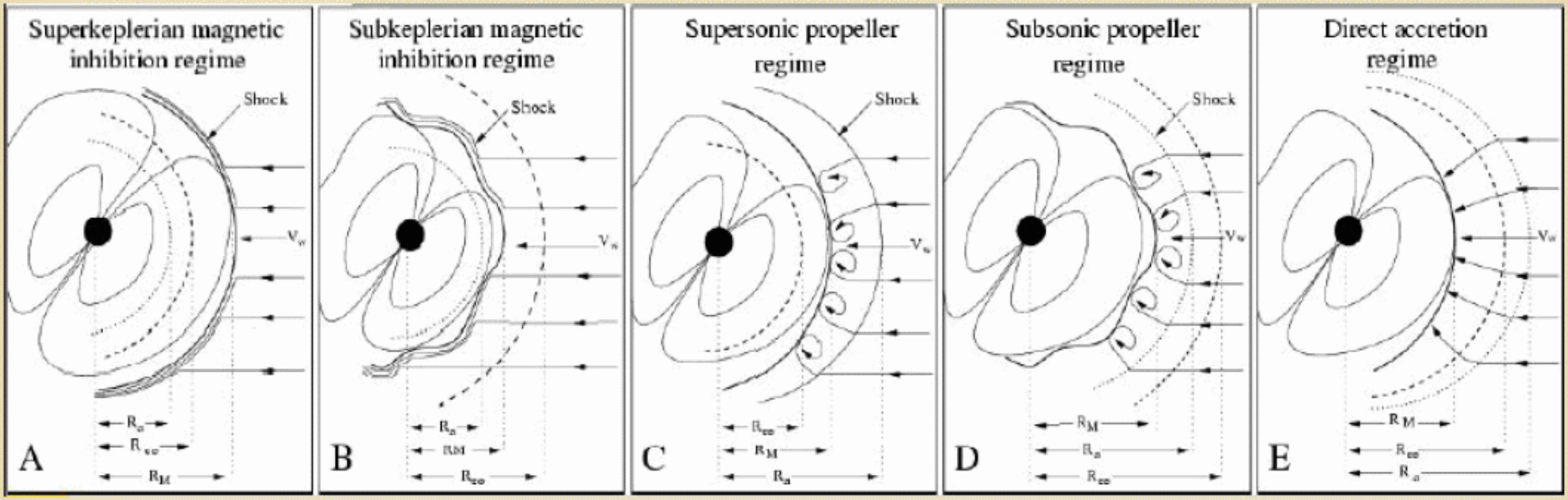


Oskinova et al. 2012



IGRJ16479 Porb ~ 3.3 days
IGRJ17544 Porb ~ 4.9 days
Vela X-1 Porb ~ 8.9 days

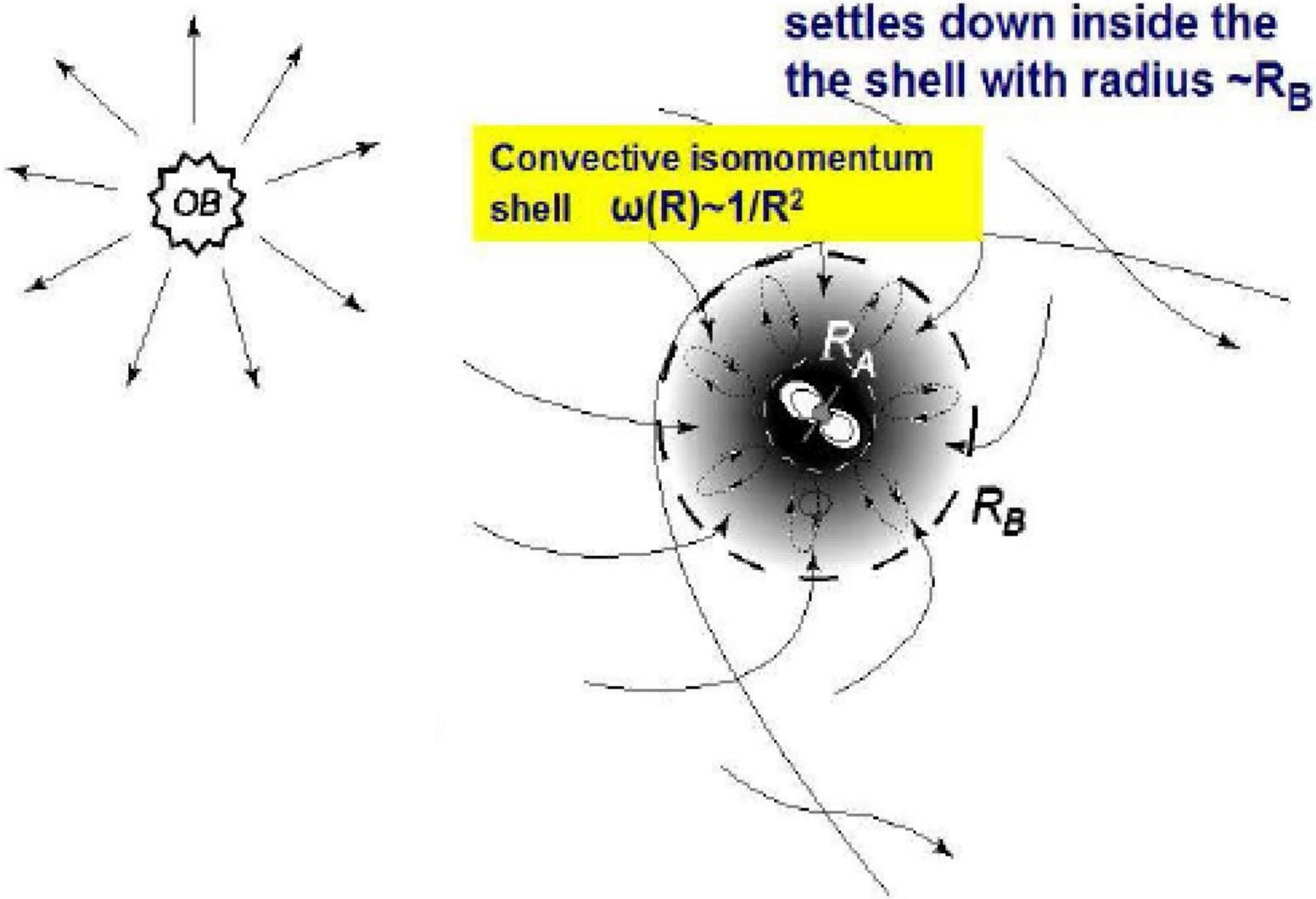
Centrifugal or magnetic barriers ?



Grebenev & Sunyaev 2007
Bozzo et al. 2008

In this model (magnetic barrier at work) SFXTs should host MAGNETARS with slow pulsations (~1000 s) (Bozzo et al. 2008)

Subsonic settling accretion without shock near magnetosphere



RTI below a critical temperature

Shakura et al. 2012

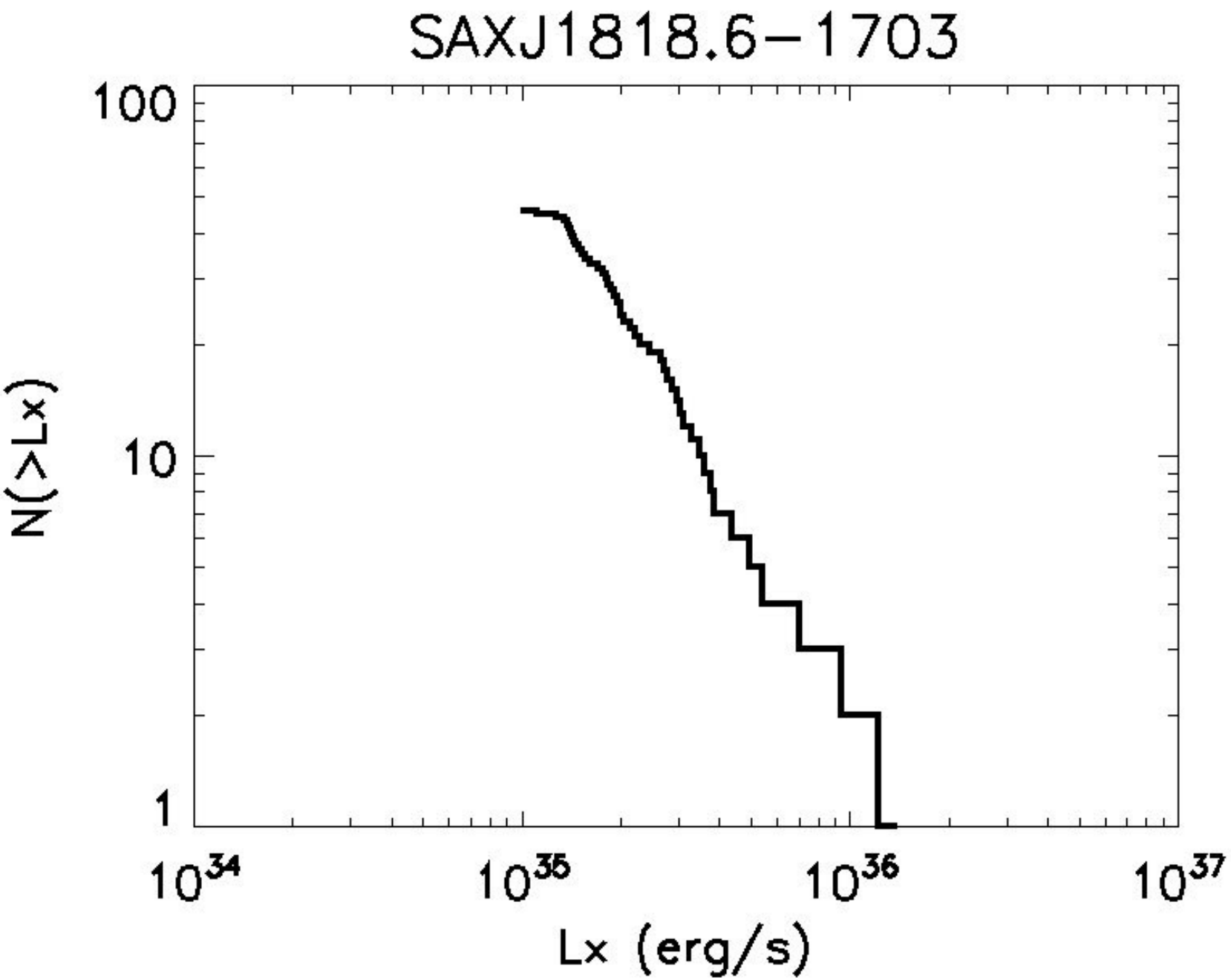
INTEGRAL Public Archive

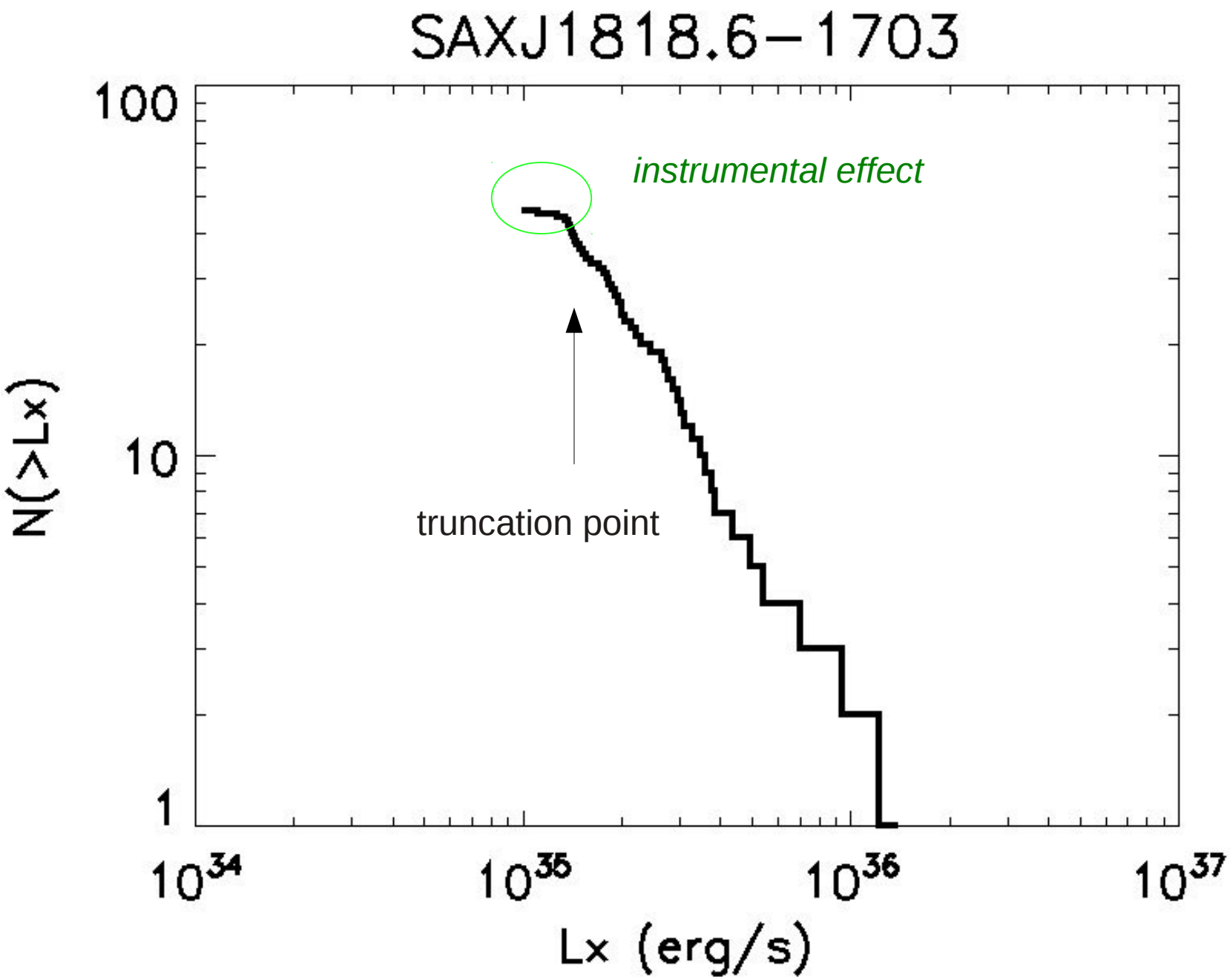
GOLIA (10 years of data) @ IASF

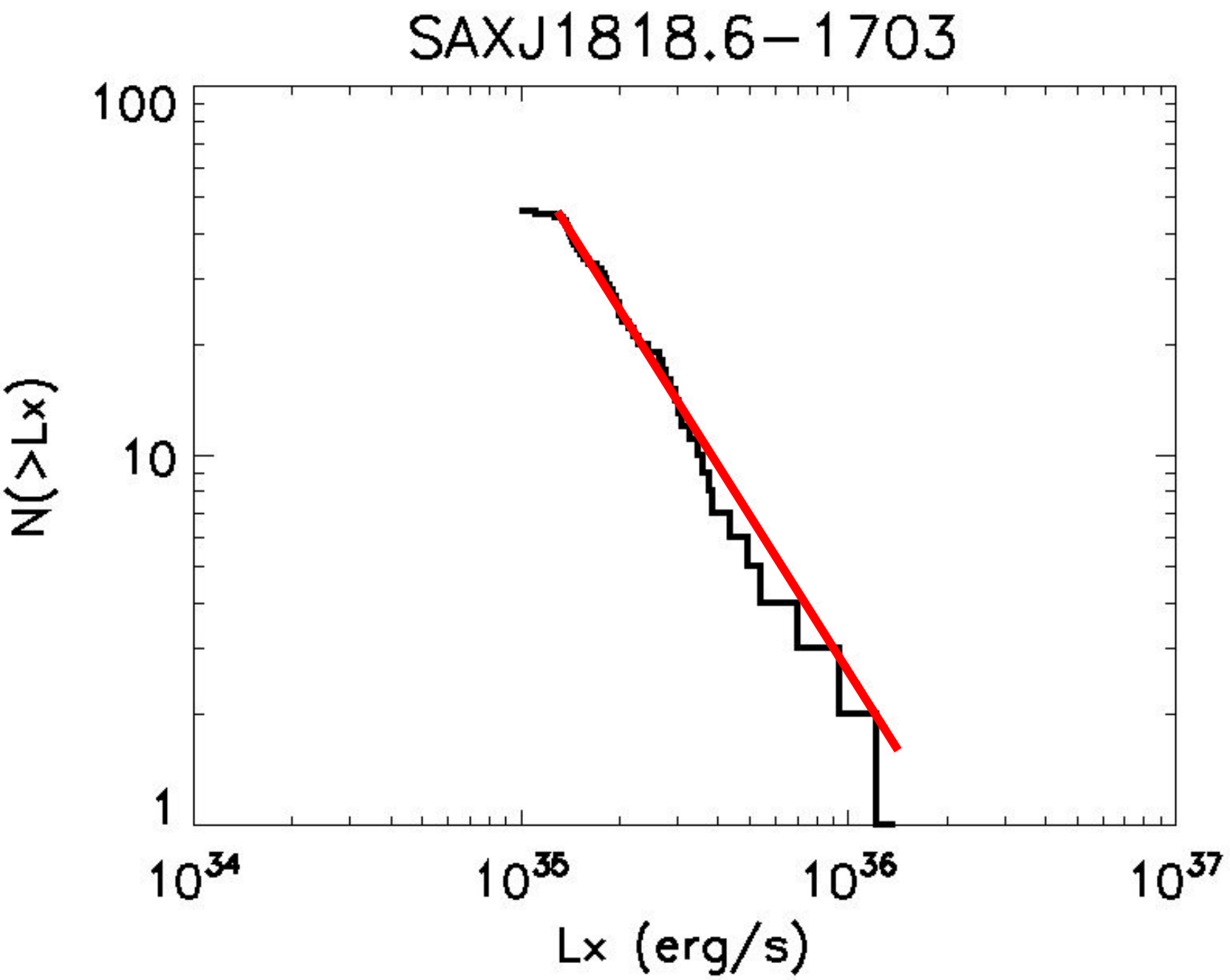
Ada's astrosiesta

INTEGRAL Public Archive

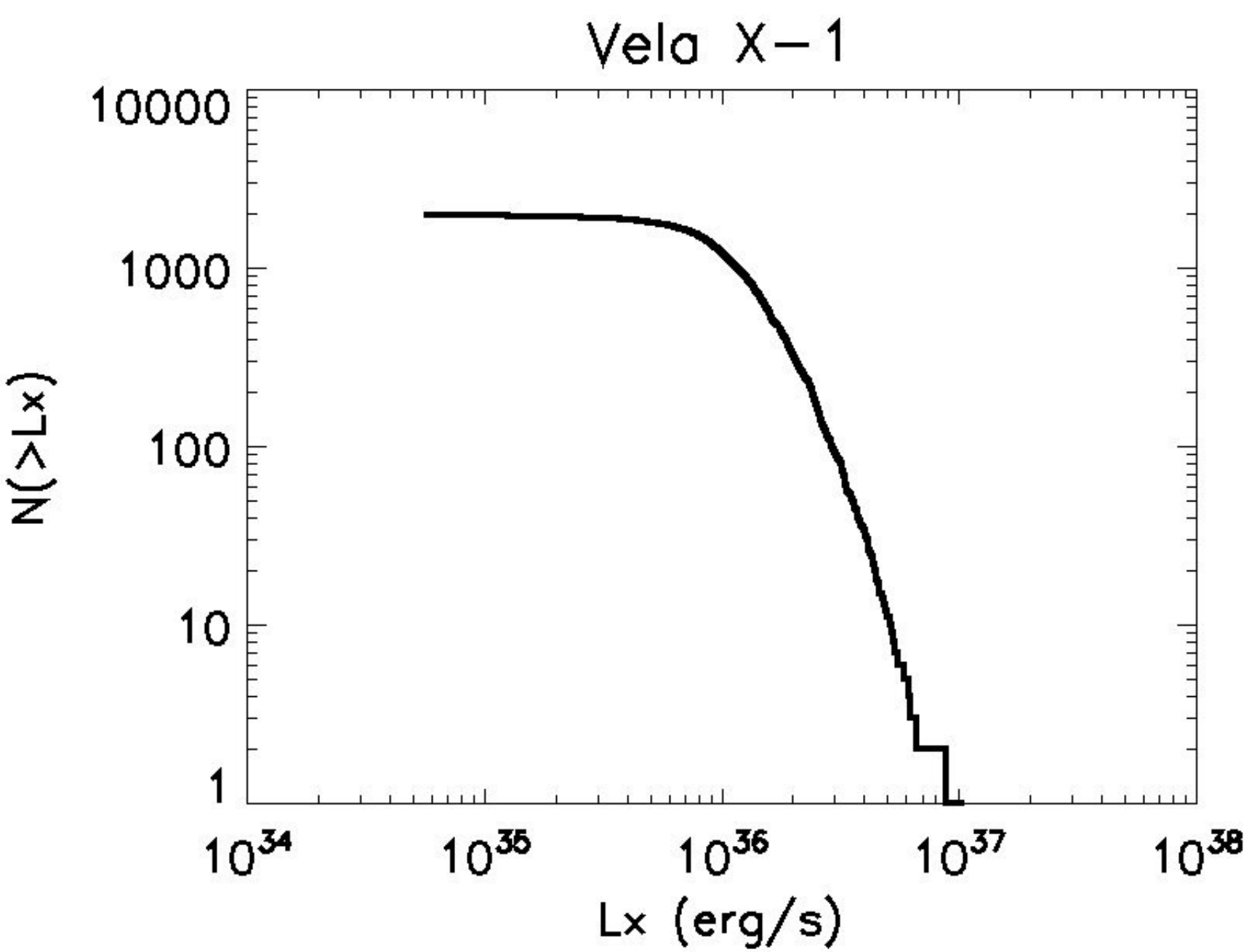
Cumulative Luminosity Distributions
at hard X-rays
of **all known SFXTs**
&
3 classical sgHMXBs
(Vela X-1, 4U1700-37, 4U1907+09)

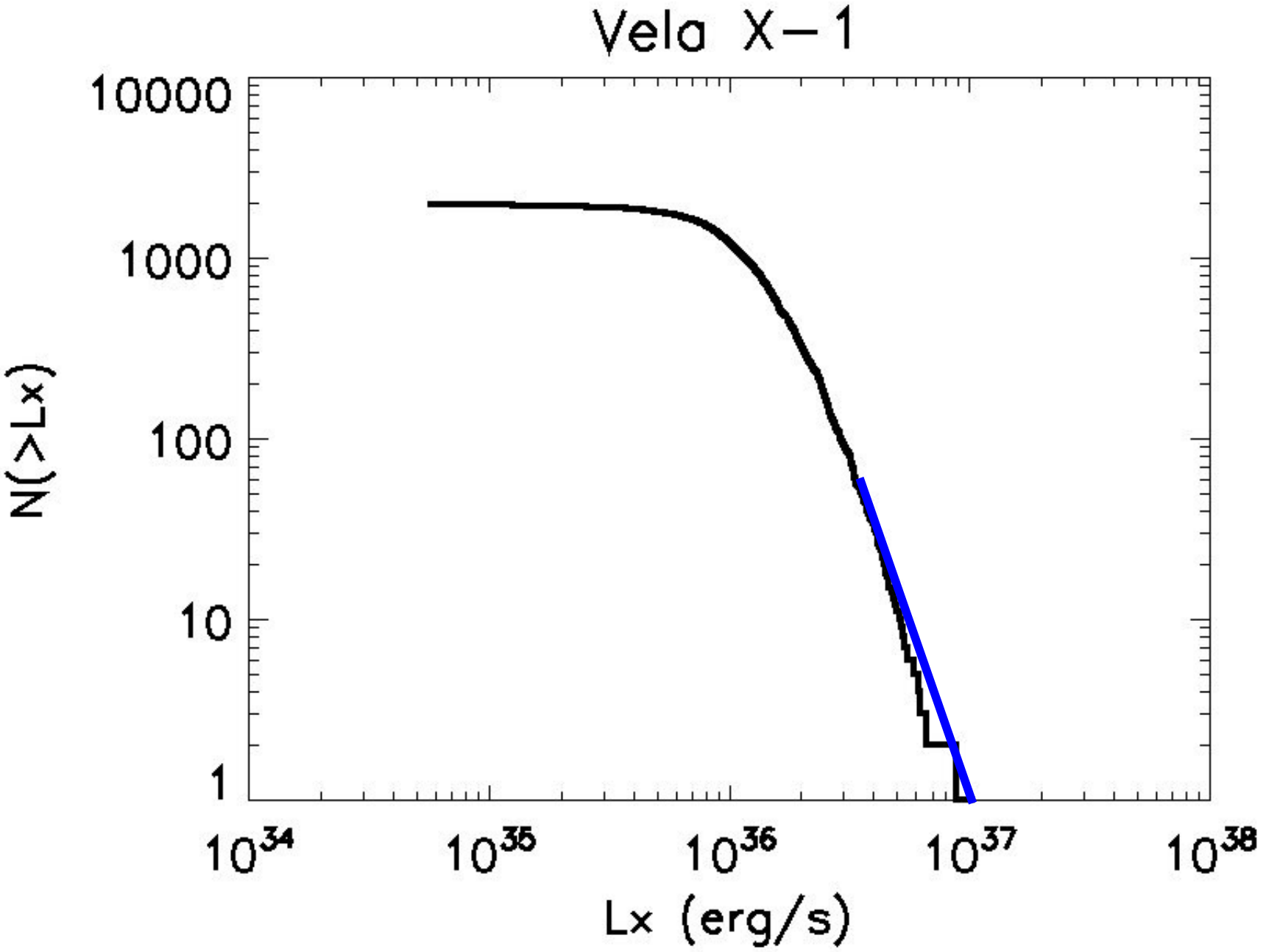

SAXJ1818.6−1703
100
10
1
N(>Lx)
10^34
10^35
10^36
10^37
Lx (erg/s)


SAXJ1818.6−1703
100
10
1
N(>Lx)
instrumental effect
truncation point
10^34
10^35
10^36
10^37
Lx (erg/s)



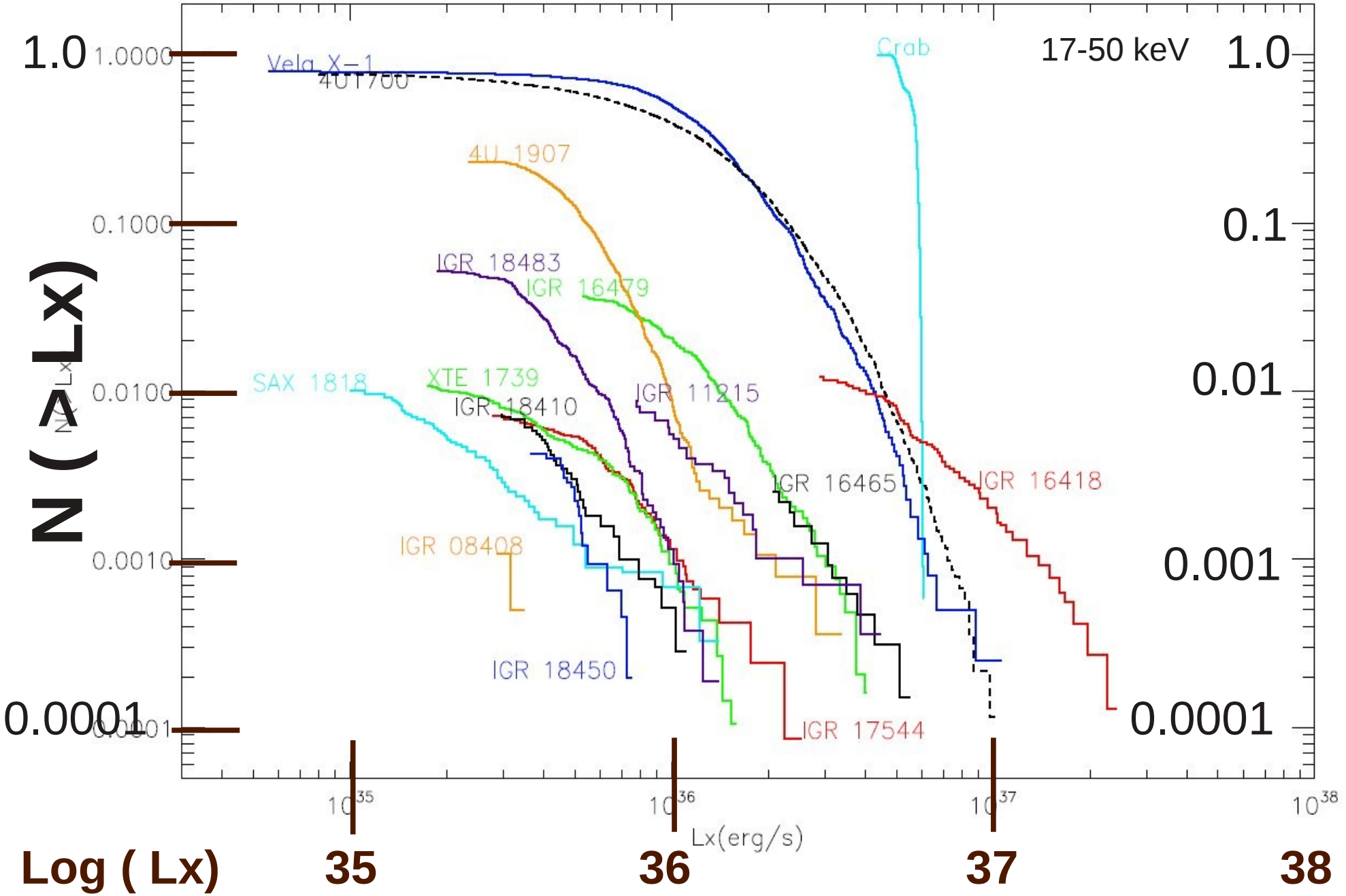
Power law slope = 1.39 +/- 0.28


Vela X−1
10000
1000
100
10
1
N(>Lx)
10^34
10^35
10^36
10^37
10^38
Lx (erg/s)



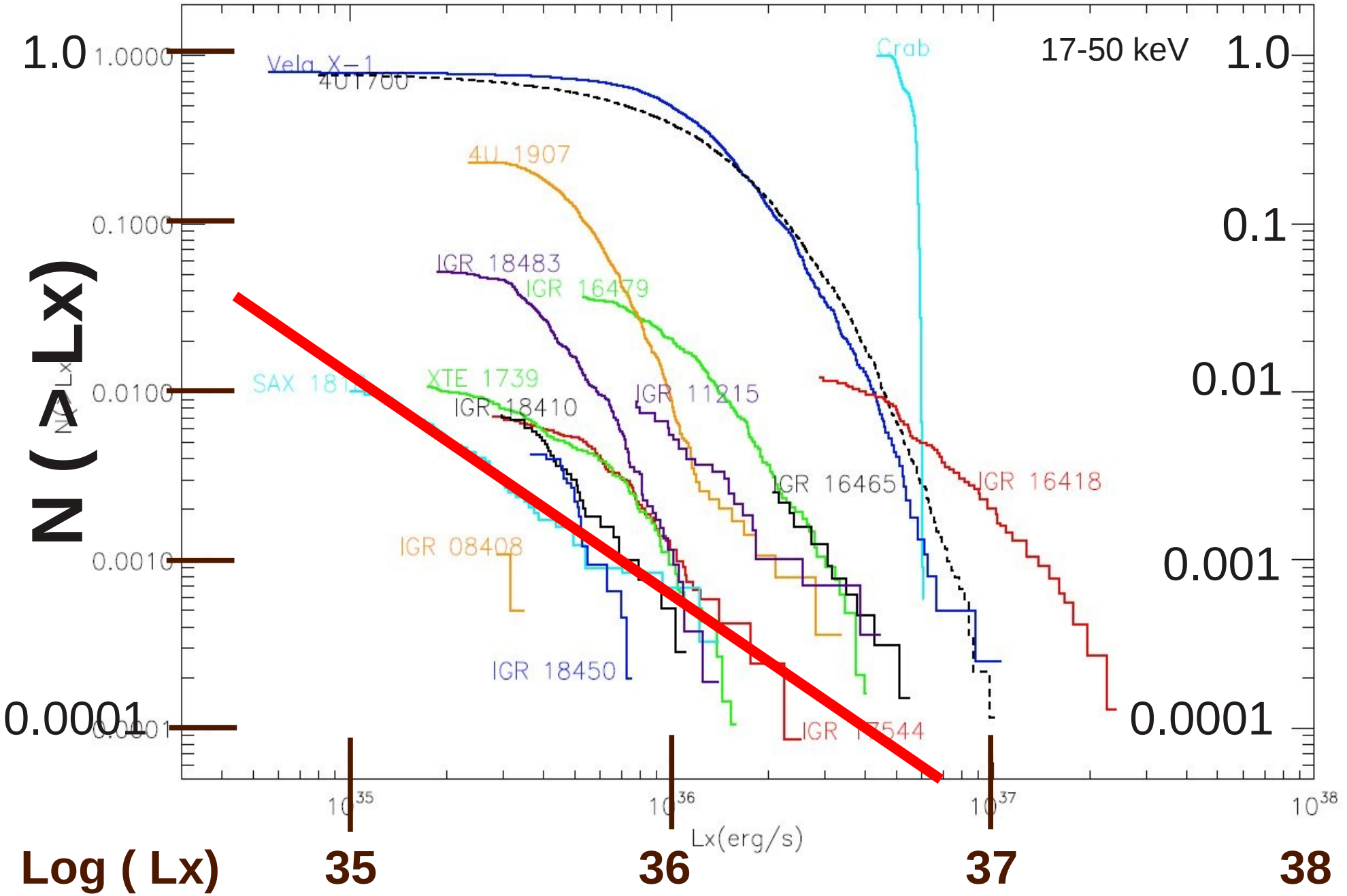
Power law slope = 4.1 +/- 1.2

Cumulative luminosity distributions



Paizis & Sidoli 2014

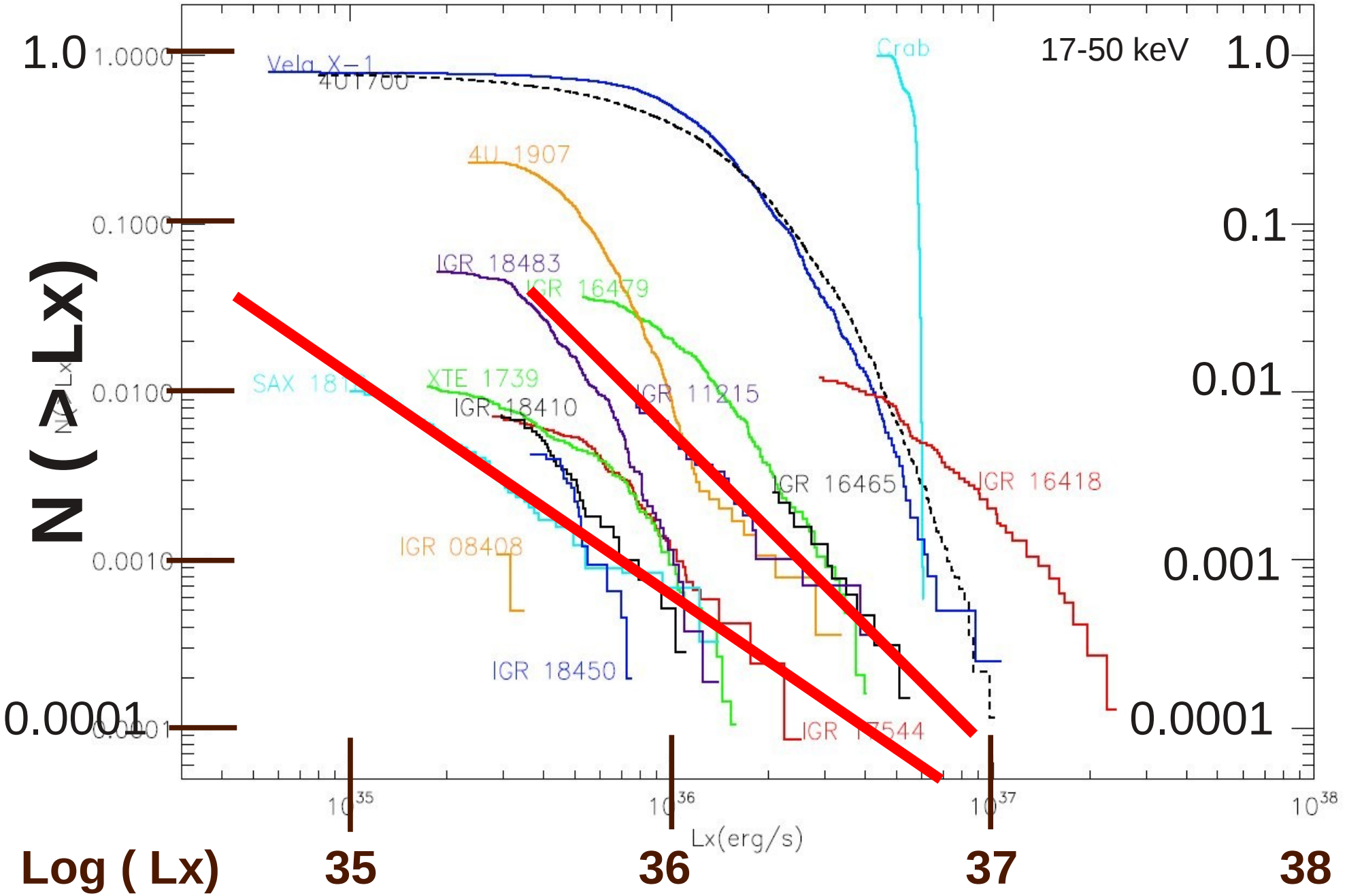
Cumulative luminosity distributions



Log (Lx) **35** **36** **37** **38**

Paizis & Sidoli 2014

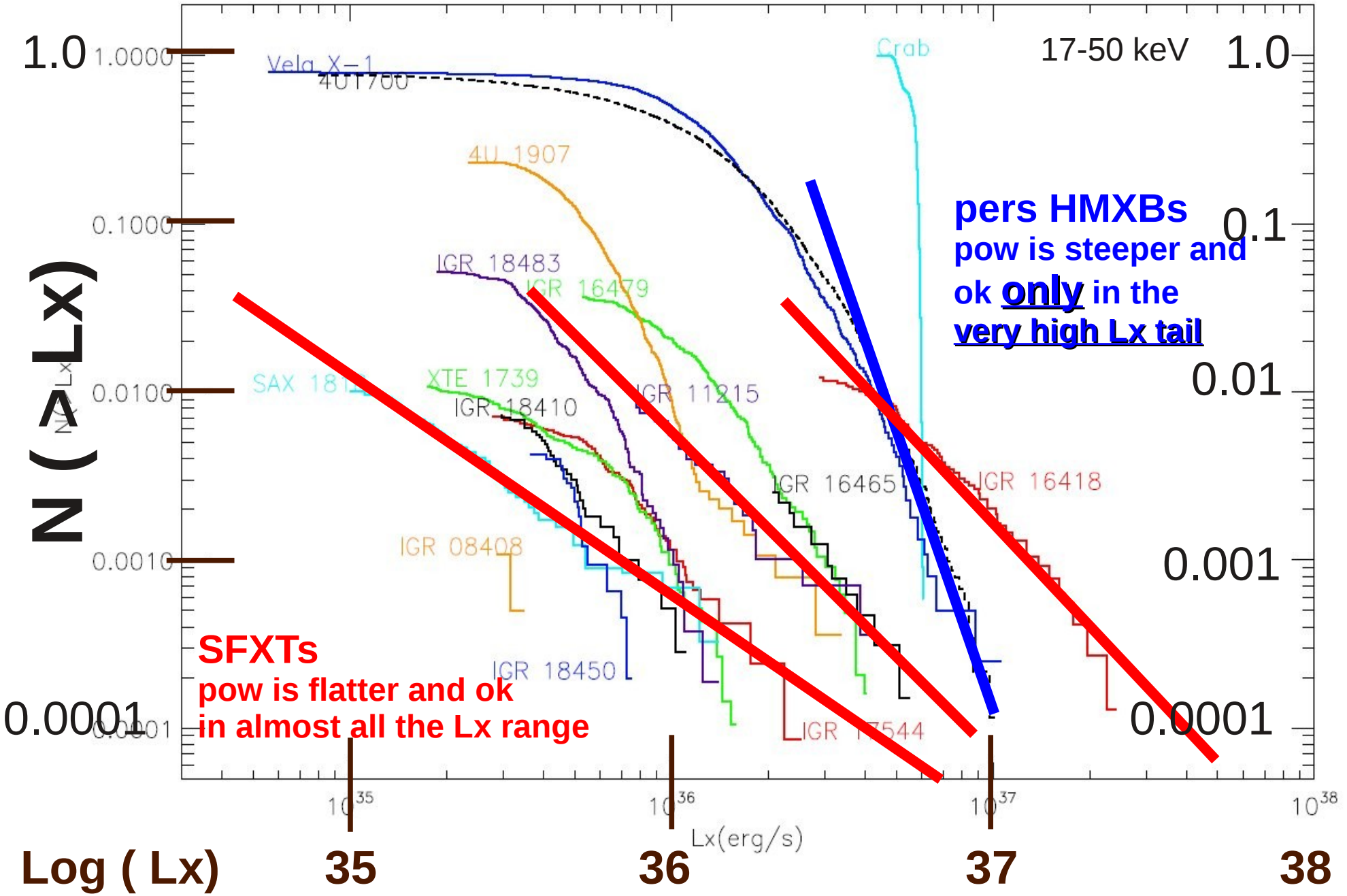
Cumulative luminosity distributions



Log (Lx) **35** **36** **37** **38**

Paizis & Sidoli 2014

Cumulative luminosity distributions



Paizis & Sidoli 2014

Power law are (almost) everywhere

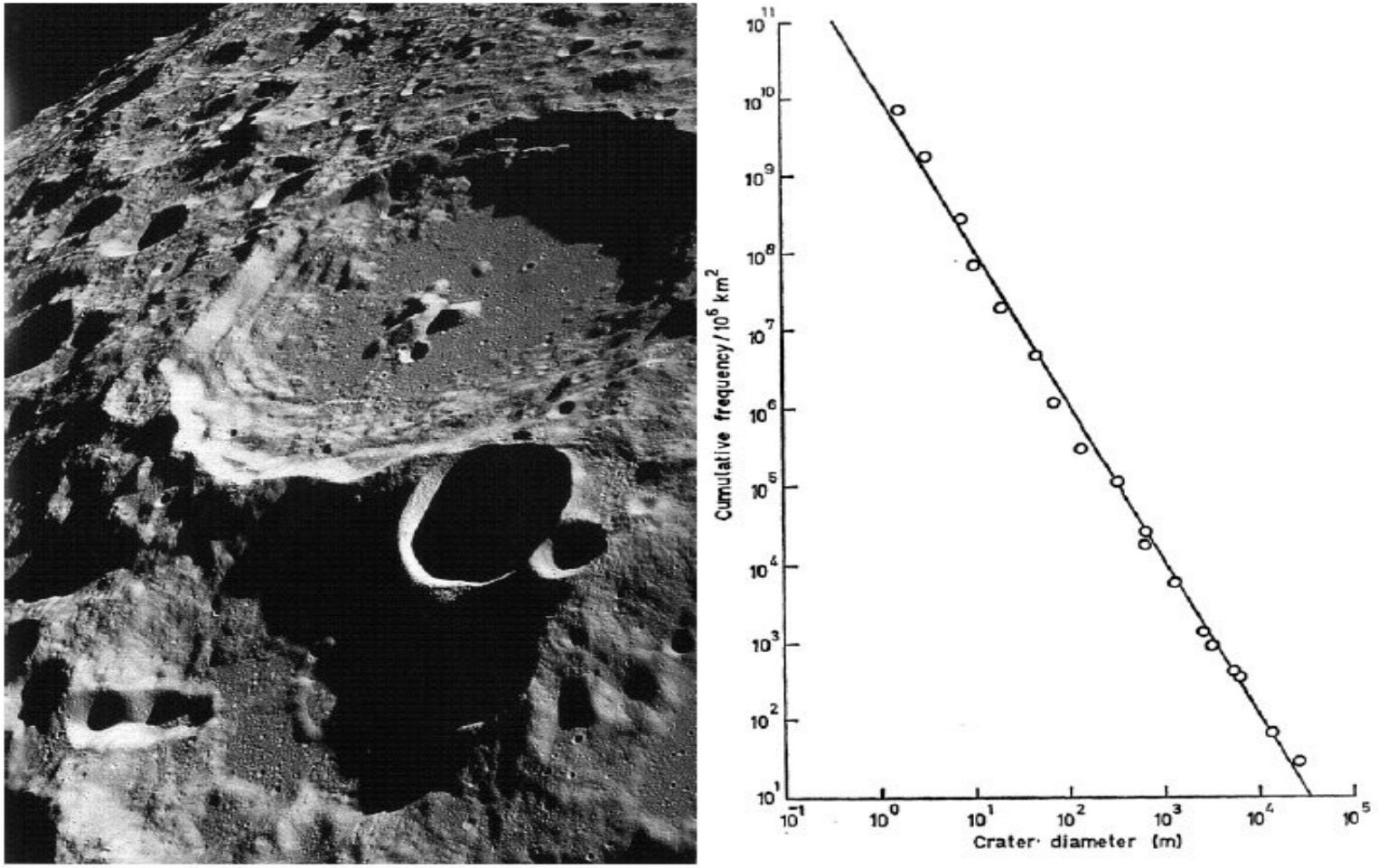
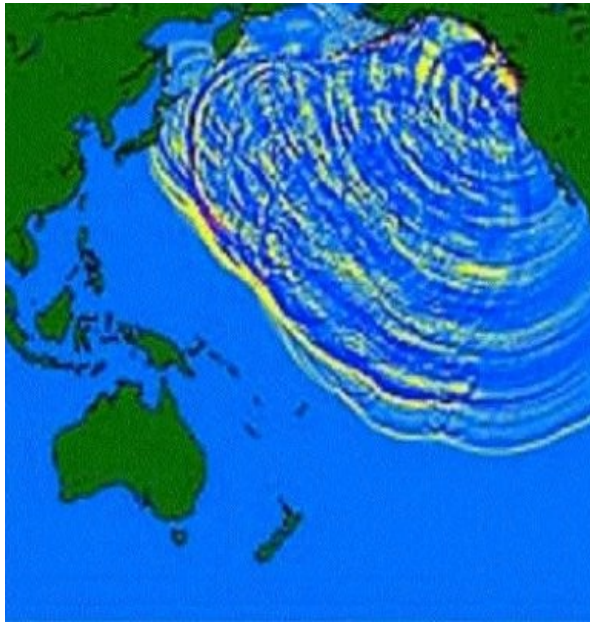


Fig. 13.3: *Left:* The lunar crater Daedalus, about 93 km in diameter, was photographed by the crew of Apollo 11 as they orbited the Moon in 1969 (NASA photo AS11-44-6611). *Right:* Cumulative frequency distribution of crater diameters measured from *Ranger 8* in the lunar *Mare Tranquillitatis* (Cross 1966).

Lunar craters

Power law are (almost) everywhere



Earthquakes

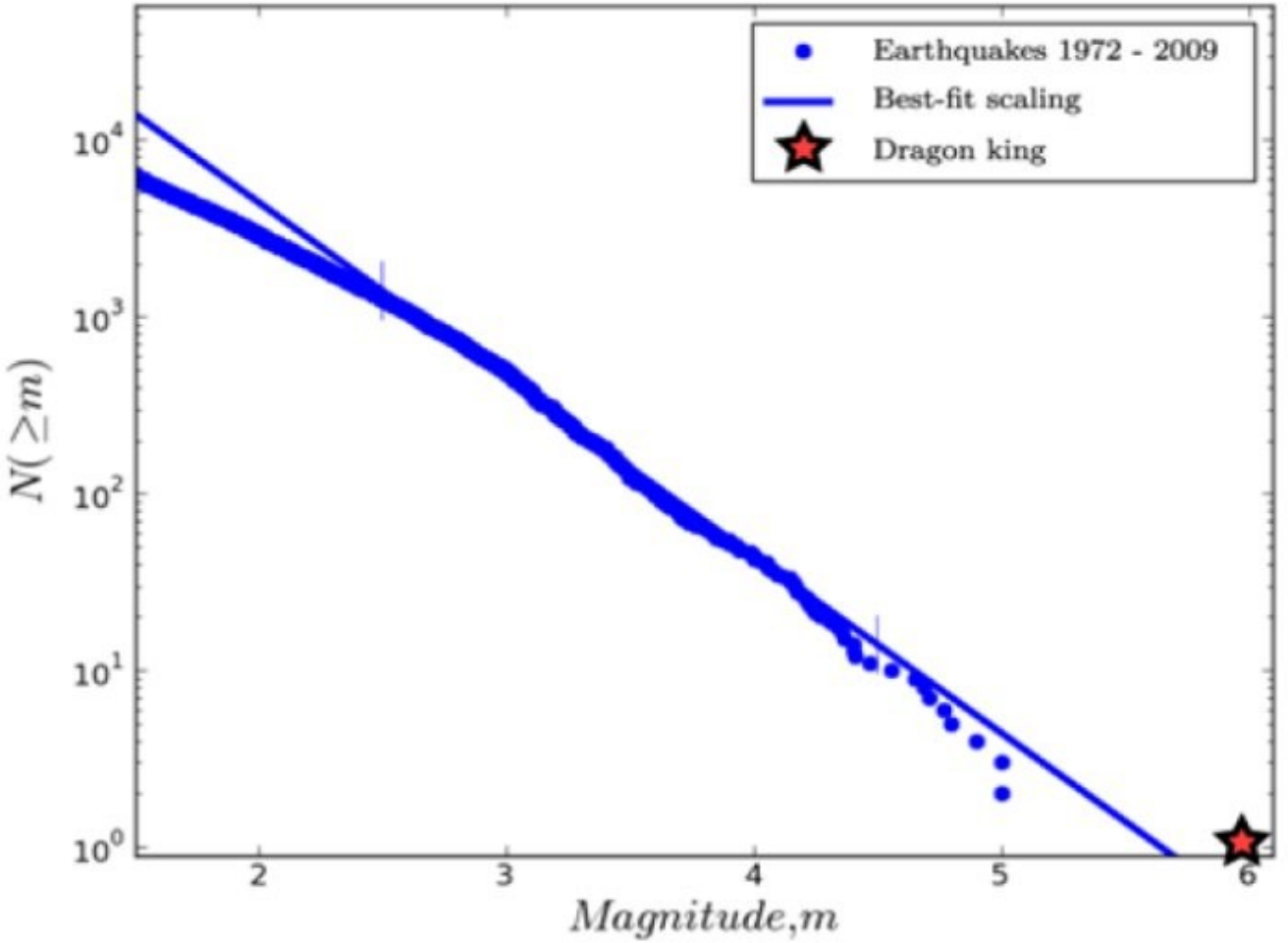


Fig. 1.7: Cumulative number of earthquakes with magnitude greater than m as a function of m for the Parkfield earthquake cycle 1972 to 2009. The best-fit scaling is shown as the blue line. The m = 5.95 Parkfield earthquake is shown as a "dragon-king" (identified as the red star). Reprinted from Sachs et al. (2012) with permission.

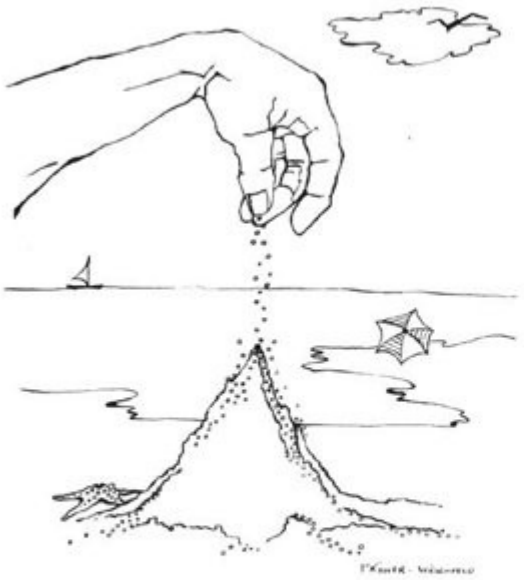
Power law are (almost) everywhere

Snow avalanches

Power law are (almost) everywhere

Landslides

Power law are (almost) everywhere



Per Bak's sand pile

Power-law distributed avalanches in a rice pile

Sandpiles

La piramide di sabbia risponde alla continua aggiunta di granelli di sabbia innescando piccole e grandi valanghe (in modo imprevedibile), mantenendo uno **stato critico**, una forma a cono "preferita" (criticita' auto-organizzata) → SOC

Power law are (almost) everywhere

Distribuzioni cumulative power-law-like rappresentano una proprieta' tipica di sistemi cosiddetti SELF-ORGANIZED CRITICAL SYSTEMS (**SOC**).

Il sistema evolve verso uno stato CRITICO in cui un evento minore puo' cominciare una reazione a catena che puo' coinvolgere anche un gran numero di elementi che compongono il sistema (formando **VALANGHE**), una volta che si raggiunga una **SOGLIA TIPICA *per l'INSTABILITA'***.
A questo punto si ha l'innesco dell'**evento CATASTROFICO**, mediante il quale il sistema rilascia energia e preserva il suo stato, la sua configurazione preferita.

Lo stato CRITICO si manifesta sotto forma di distribuzione a **legge di potenza** della frequenza degli eventi “valanga”.
Lo stesso processo produce eventi su tutte le scale, dai meno ai piu' energetici.

Conclusioni

I flares nei SFXTs possono considerarsi eventi di VALANGA?

E' suggestivo che alcune delle proprieta' del modello di Shakura et al. vadano in questa direzione:

- instabilita' che si innesca a un valore critico della temperatura
- innesco del collasso della shell di materia accumulata sopra la magnetosfera
- evento catastrofico → bright flare

Bibliografy

- Paizis & Sidoli 2014, MNRAS in press (arXiv1401.6861)
- Shakura, et al., 2012, MNRAS 420, 216
- Aschwanden, 2013, “Self-Organized Criticality”, Open Academic Press