SOFT Γ-RAY BURSTS AS MAGNETOEMISSION OF MAGNETARS AT JUNIOR AGE

PNS2014

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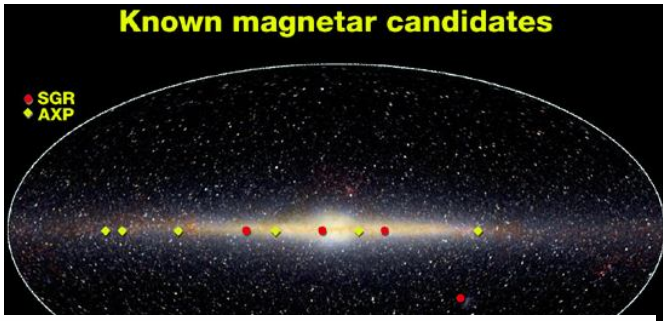
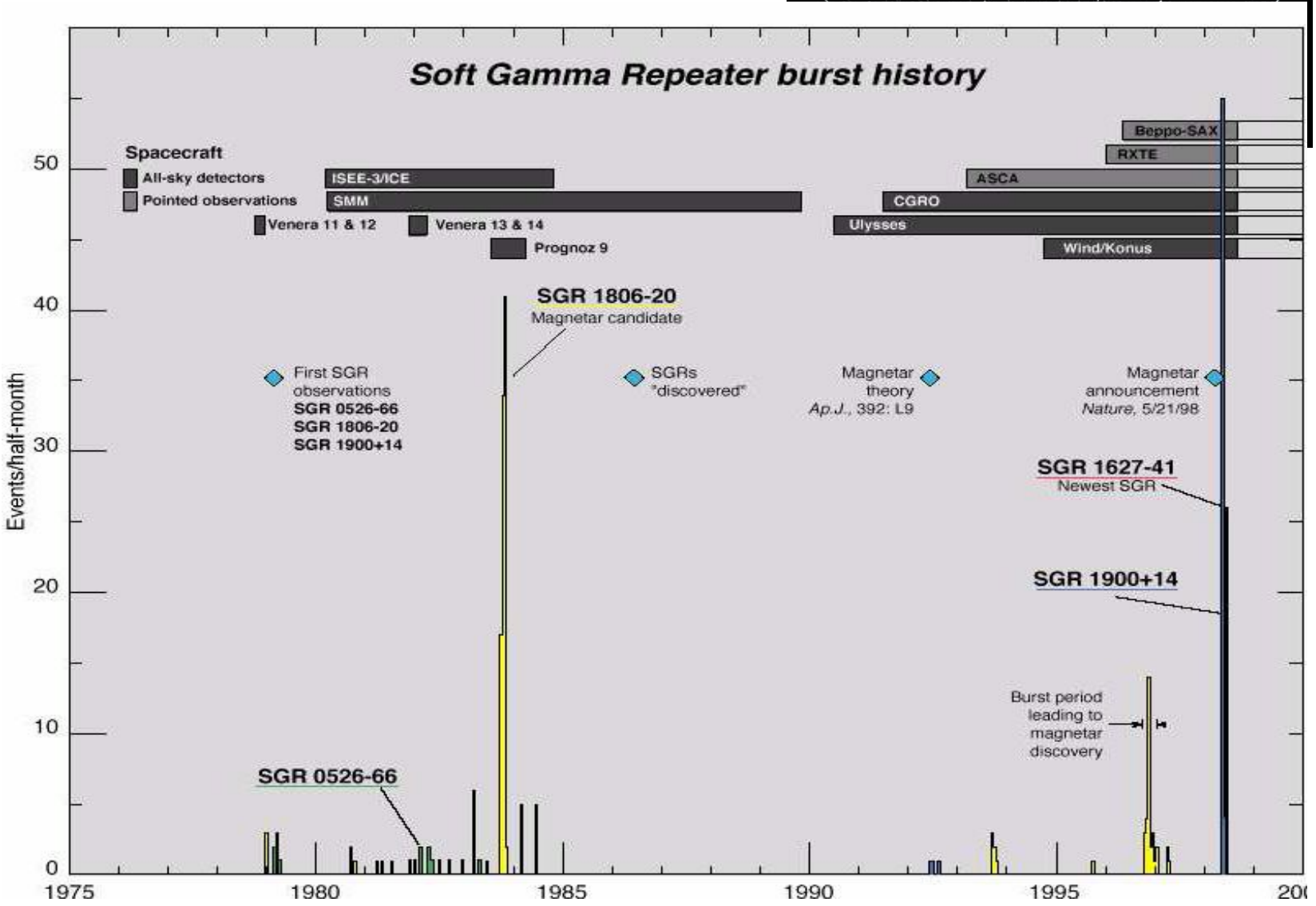
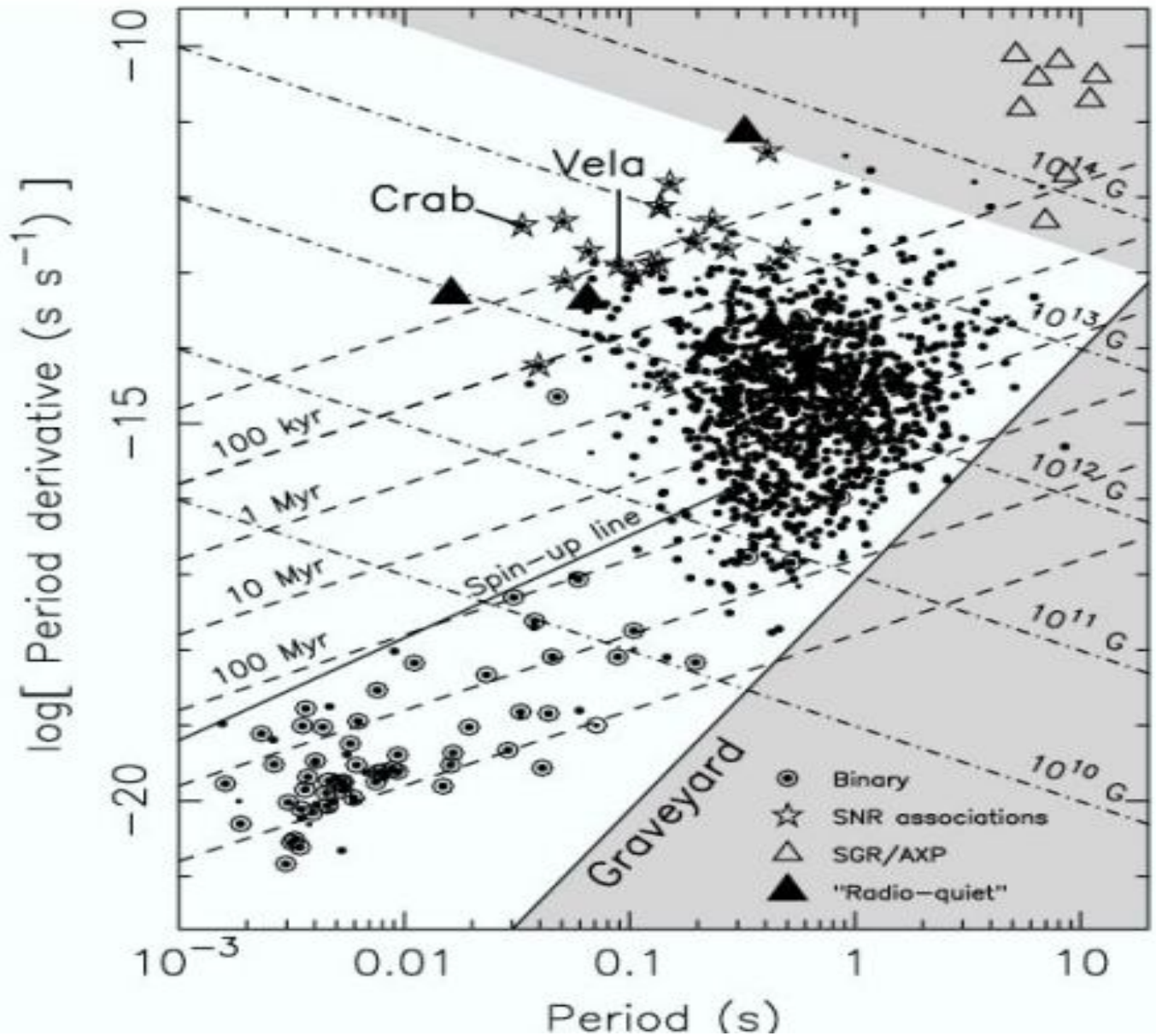
This work is supported in part by the grant SCOPES IZ73Z0_152485

Magnetar Story

12 candidates



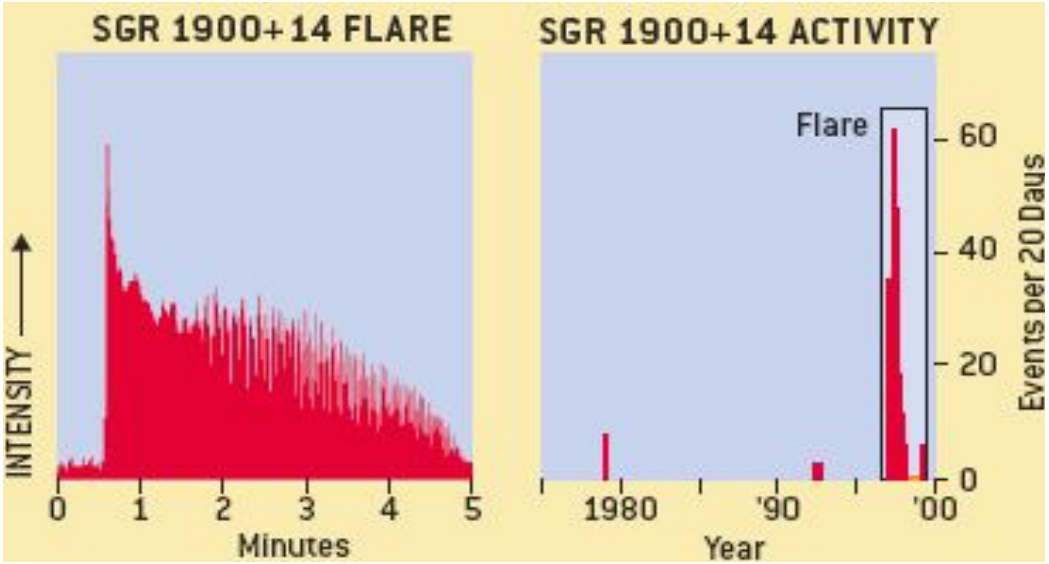



Vela
Crab
10^{14} G
10^{13} G
10^{12} G
10^{11} G
10^{10} G
100 kyr
1 Myr
10 Myr
100 Myr
Spin−up line
Graveyard
Binary
SNR associations
SGR/AXP
"Radio−quiet"
log[Period derivative (s s^{-1})]
−10
−15
−20
10^{-3}
0.01
0.1
1
10
Period (s)

Magnetar Story

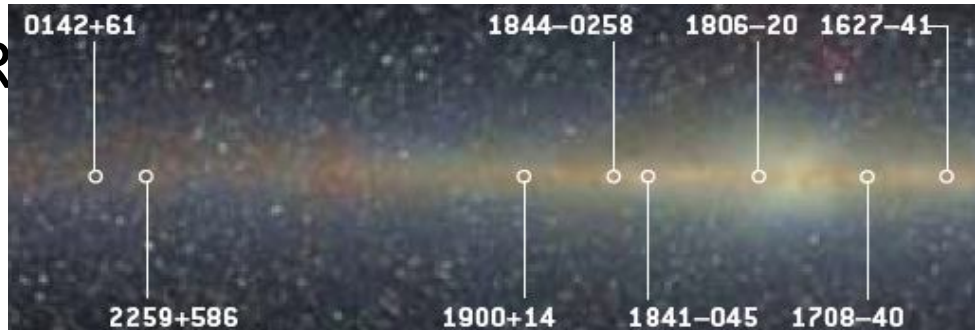
Giant Flare

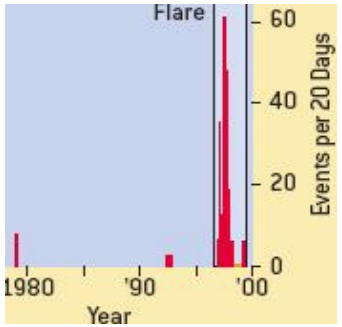
NAME	YEAR OF DISCOVERY	ROTATION PERIOD (seconds)
SGR 0526–66	1979	8.0
SGR 1900+14	1979	5.16
SGR 1806–20	1979	7.47
SGR 1801–23*	1997	?
SGR 1627–41	1998	?
AXP 1E 2259+586	1981	6.98
AXP 1E 1048–59†	1985	6.45
AXP 4U 0142+61	1993	8.69
AXP 1RXS 1708–40†	1997	11.0
AXP 1E 1841–045	1997	11.8
AXP AXJ1844–0258	1998	6.97
AXP CXJ0110–7211†	2002	5.44

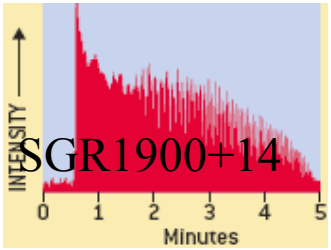


Short Bursts

SGR



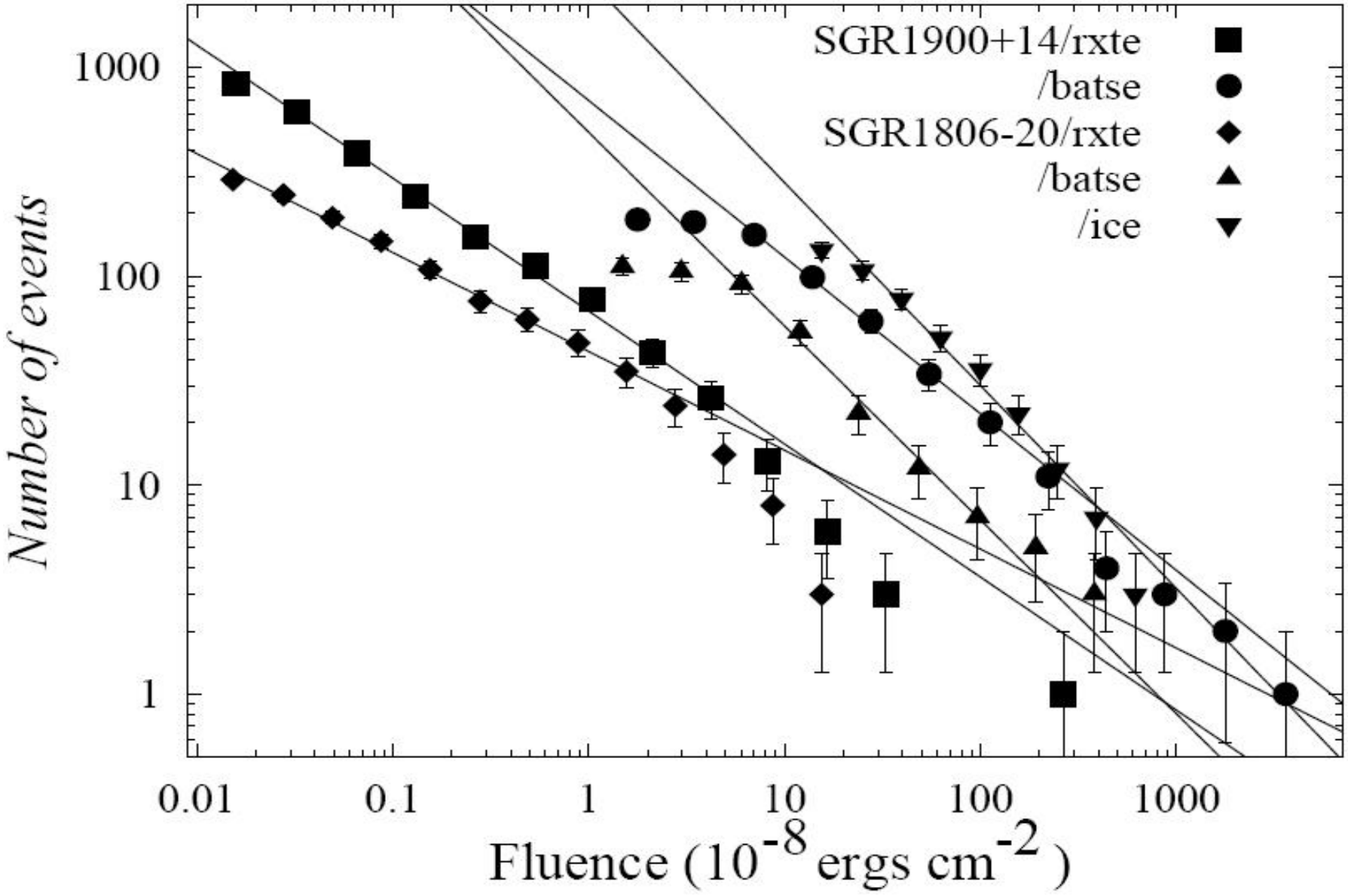




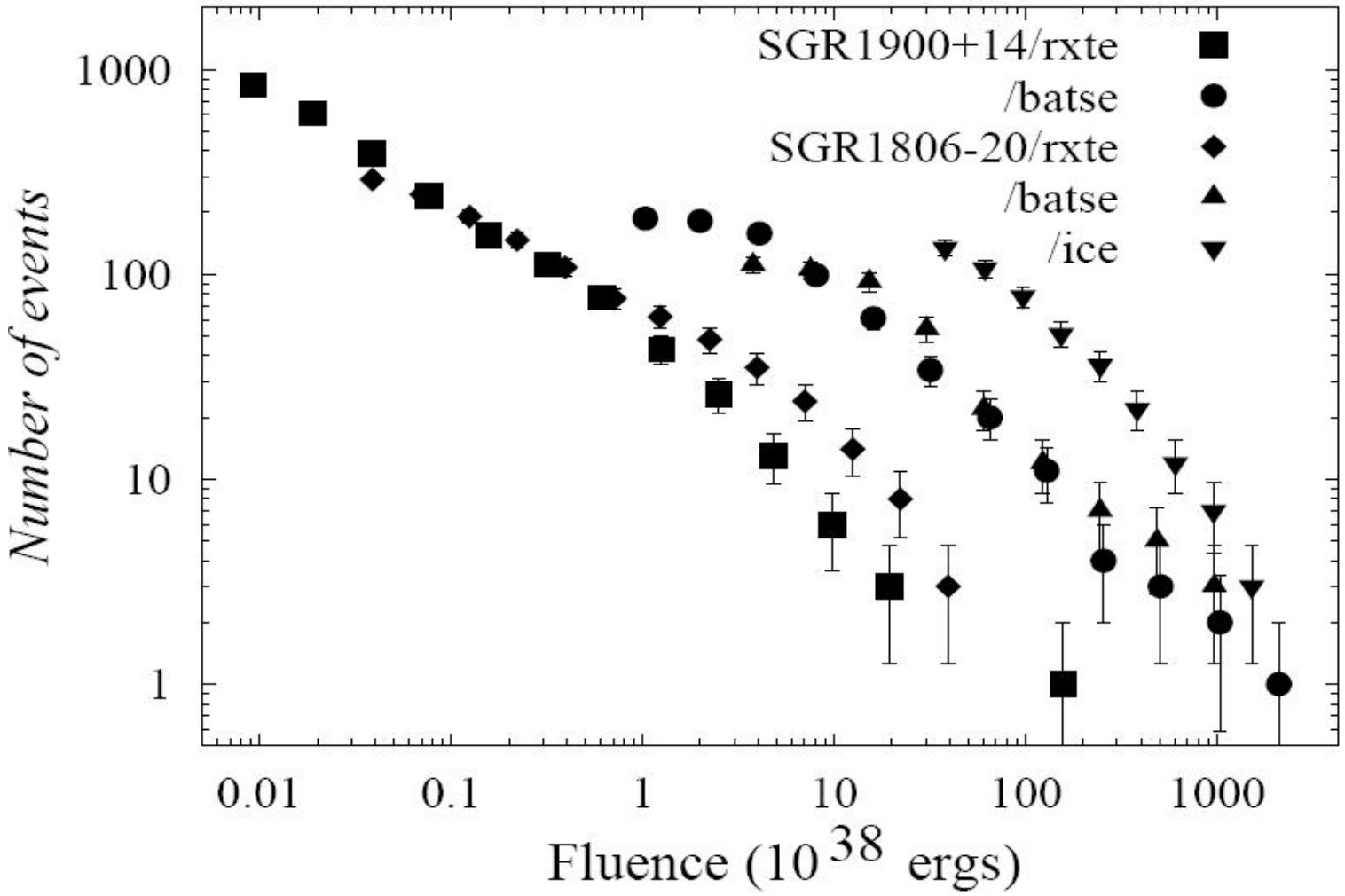
SGR: activity (powered by Magnetic Field)

Type	Persistent	SGR-burst	Giant Fl
Intensity (erg)	10^{35}-10^{36}/s	10^{38}-10^{42}	$\sim 10^{44}$
Duration (s)	–	$\sim$0.1	$\sim$100
Spectrum	Power Law & OTTB:	$\frac{\exp\{-E/T\}}{E}$	Power Law at
Energies (keV)	2–10	20-40	$\sim 10^3$
hardness ratio $\frac{[4-10]}{[1.8-4]}$(keV)	0.74 ± 0.02	2.1 ± 0.6	

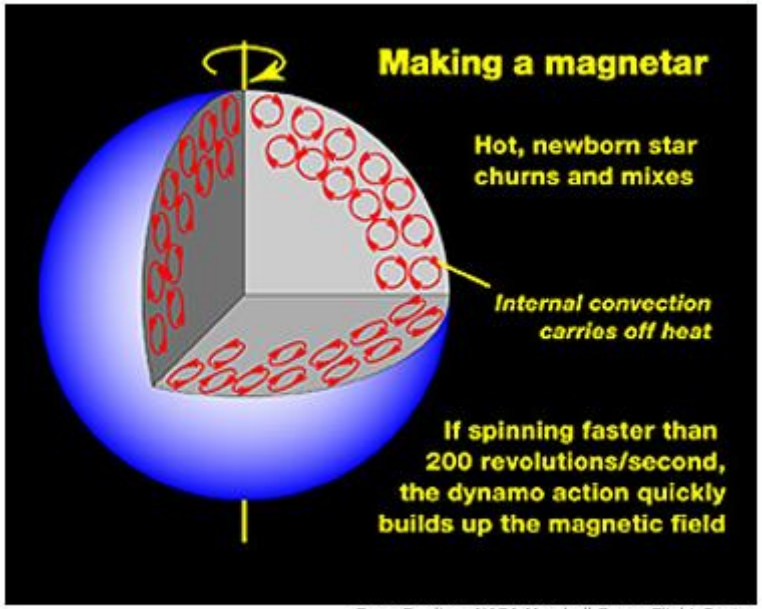
Burst Statistics: Fluence

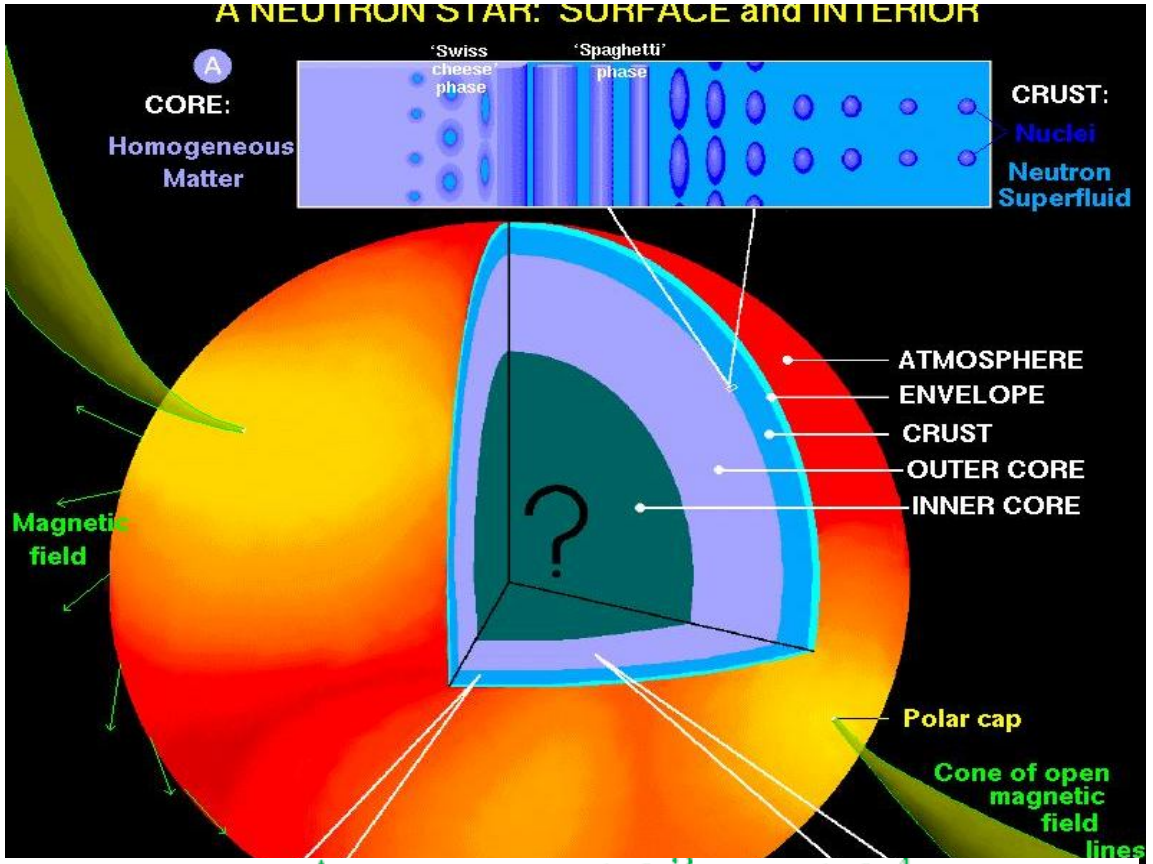


Burst Statistics: Fluence



Magnetar





- Neutron Stars

Age: $\sim 10^3 - 10^4$ years

Period&Spin-down: $P \approx 5 - 8$ s & $\dot{P} \simeq 10^{-10} s\ s^{-}$

* Magnetic field:
at negligible accretion & wind

$B_{\rm dipole/surf} \sim 10^{15}$ G

$B_{\rm crust} \gtrsim 10^{16.5}$ G

\# $B_{\rm i} \approx 10^{17.5}$ G $(1{\rm ms}/P_{\rm i})$

Magnetic field estimates (virial theorem)

Magnetic and gravitational forces

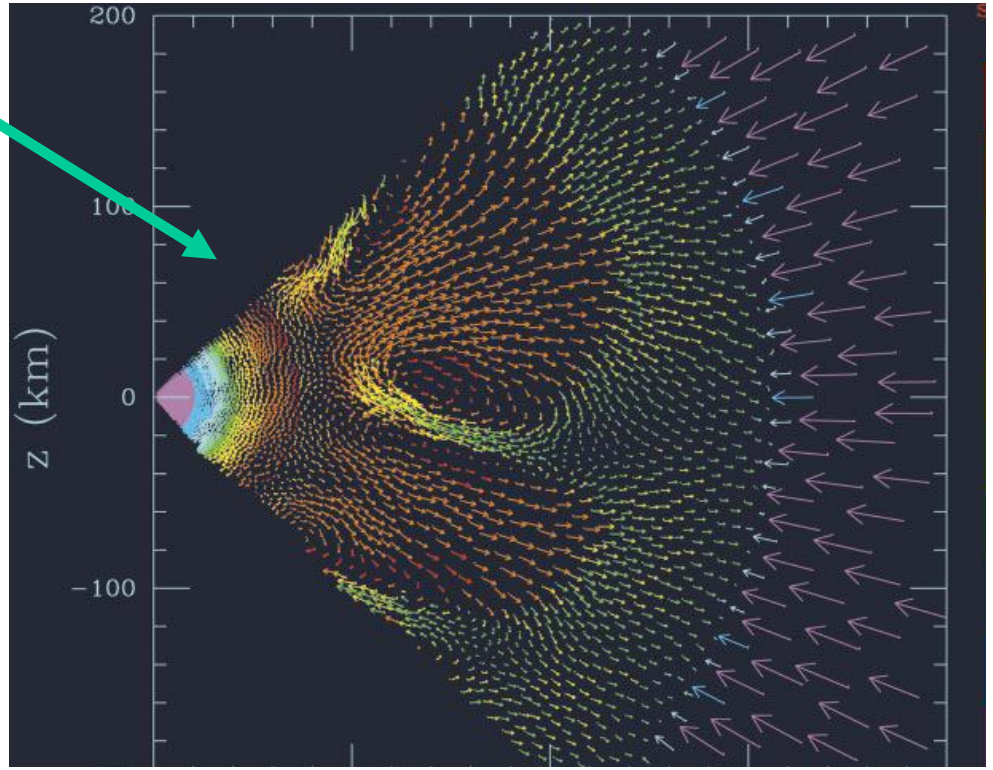
$$dB^2/dR \sim 8\,GM\,n(R)/R^2$$

$4\pi R^2\, n(R) = dM/dR$

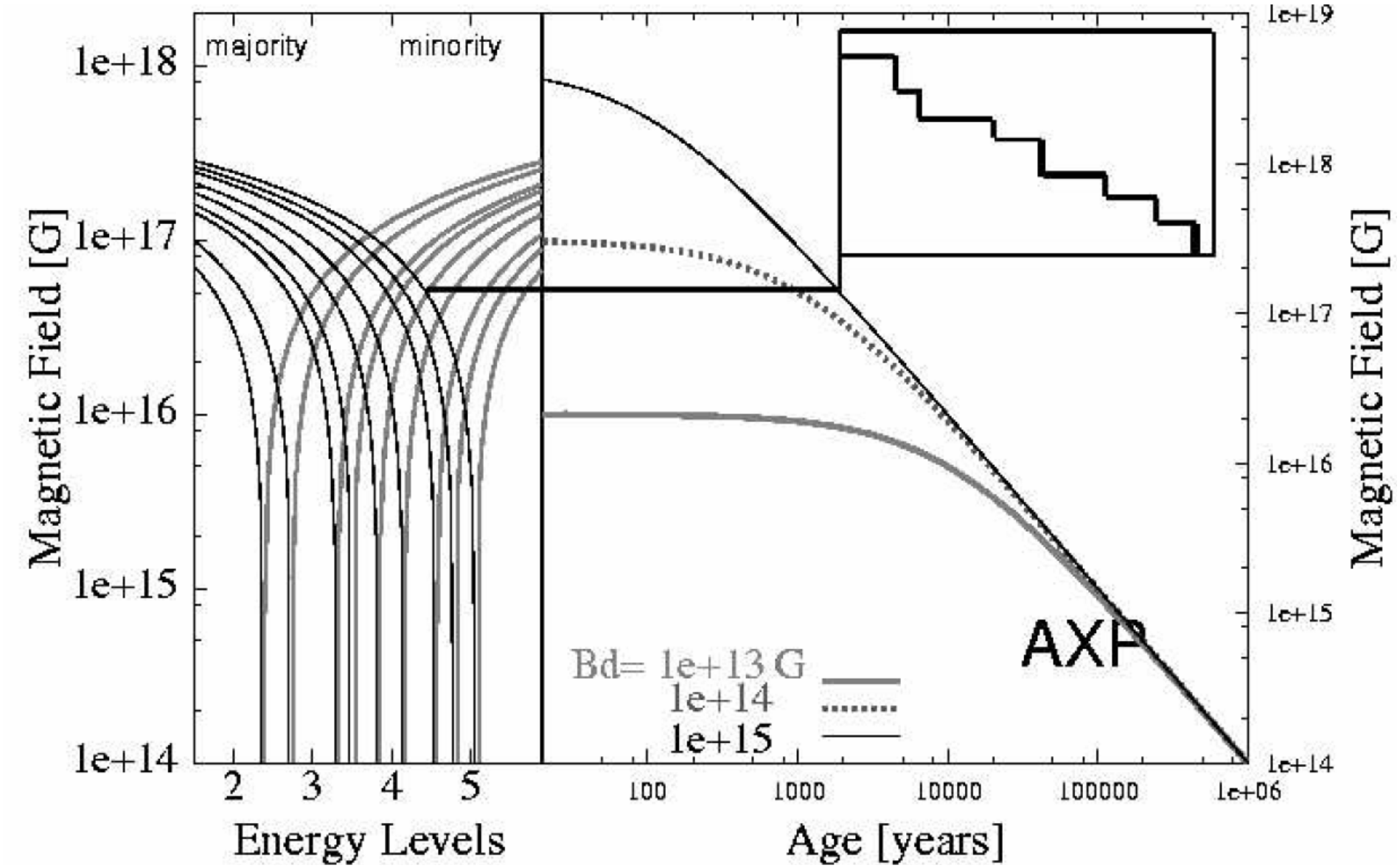
B~$10^{1.5}$TeraTesla $(M/M_o)(10km/R)^2$

R_{NS}~ 10Km; ΔR~ 1Km

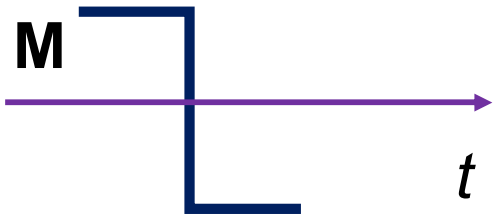
B_ν~10^1 - 10^2 TeraTesla

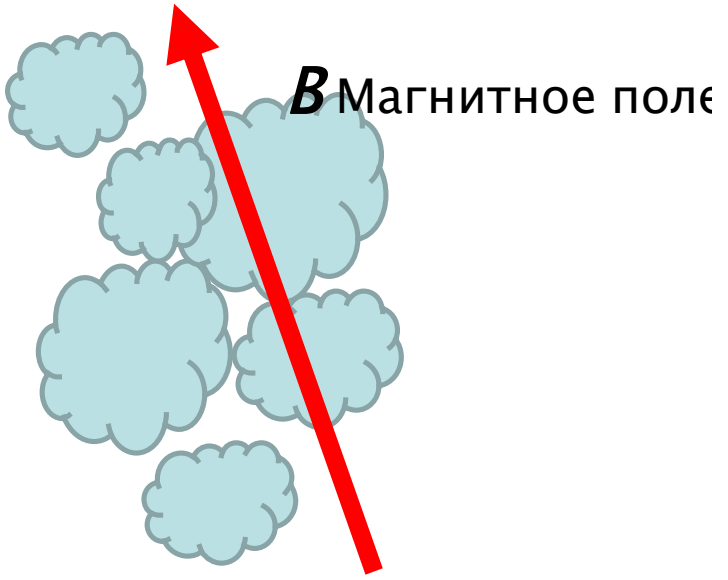


Магнитный отклик ядер



Model





$$\mathcal{H} = -\sum_{ij \in \mathrm{nn}} J_{ij} m_i m_j - \sum_i (H - \eta \mathcal{P} + f_i) m_i$$

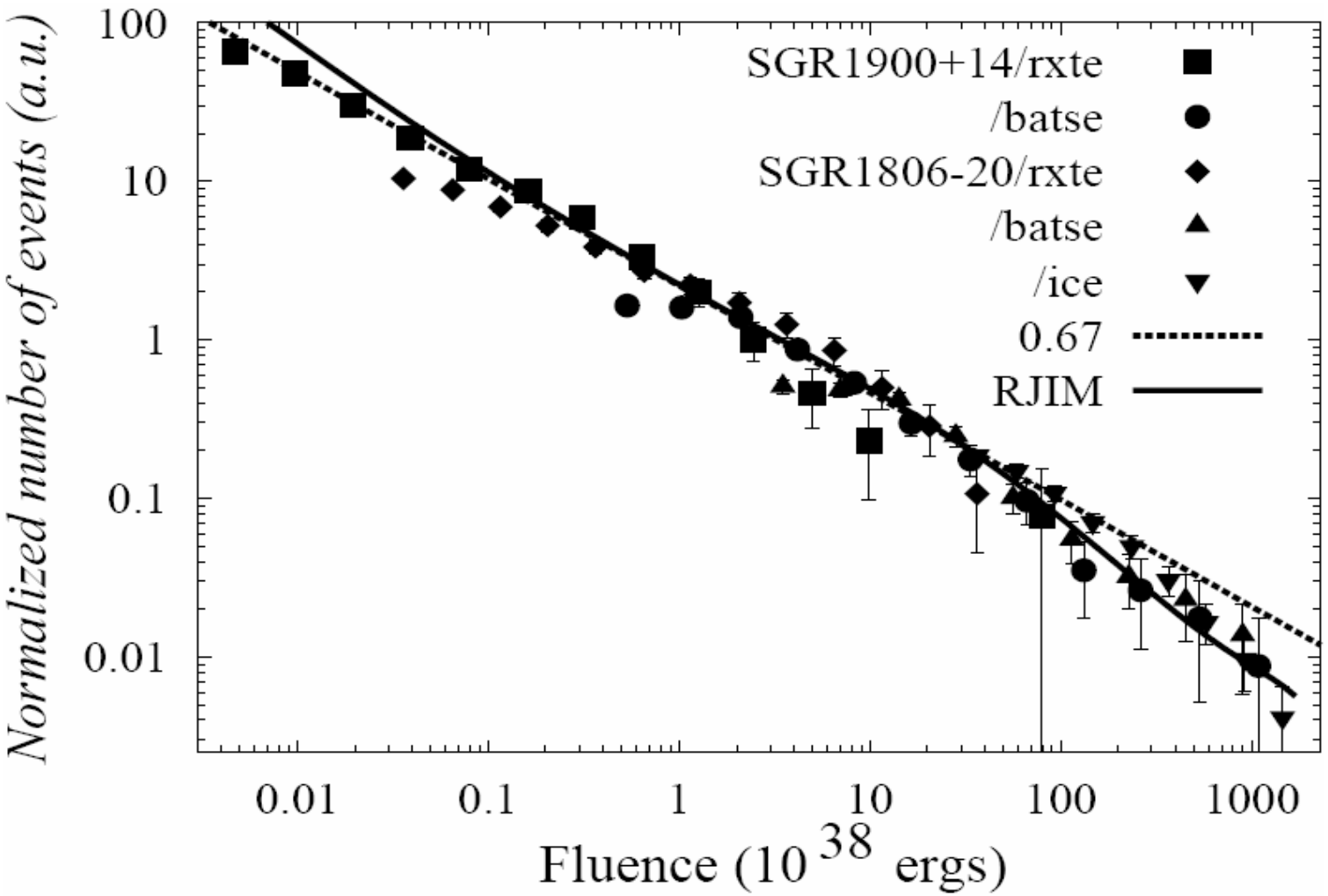
- Energy Release upper limits

$$\mathrm{E_{max}} \approx B * \Delta M * S_{max}$$

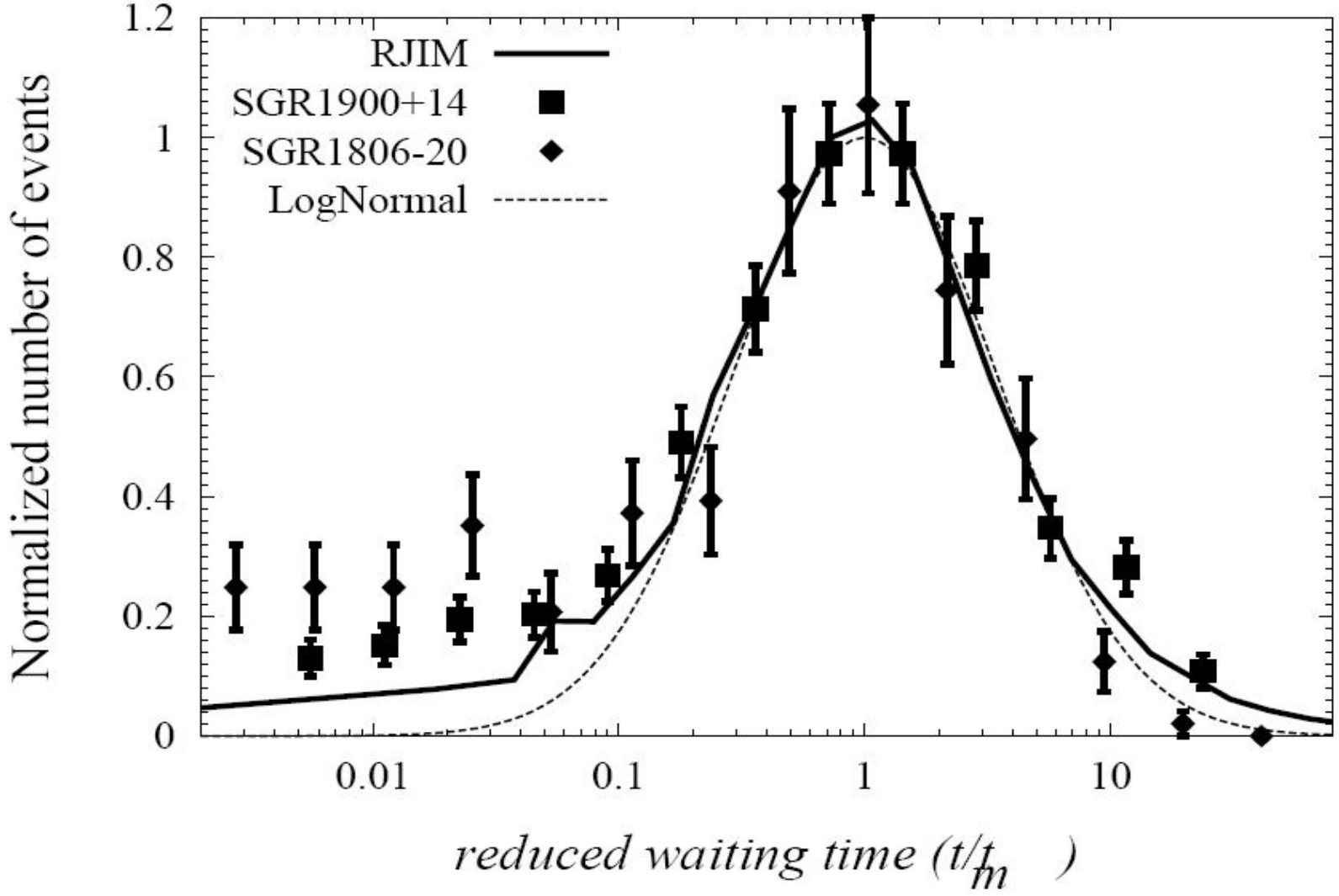
$$\approx 10^{16.5} * 10^{13}\ \mathrm{G}^2 * (100\mathrm{m})^3 \approx 10^{41.5}\mathrm{erg}$$

$$\approx 10^{16.5} * 10^{13}\ \mathrm{G}^2 * \mathrm{km}^3 \approx 10^{44.5}\mathrm{erg}$$

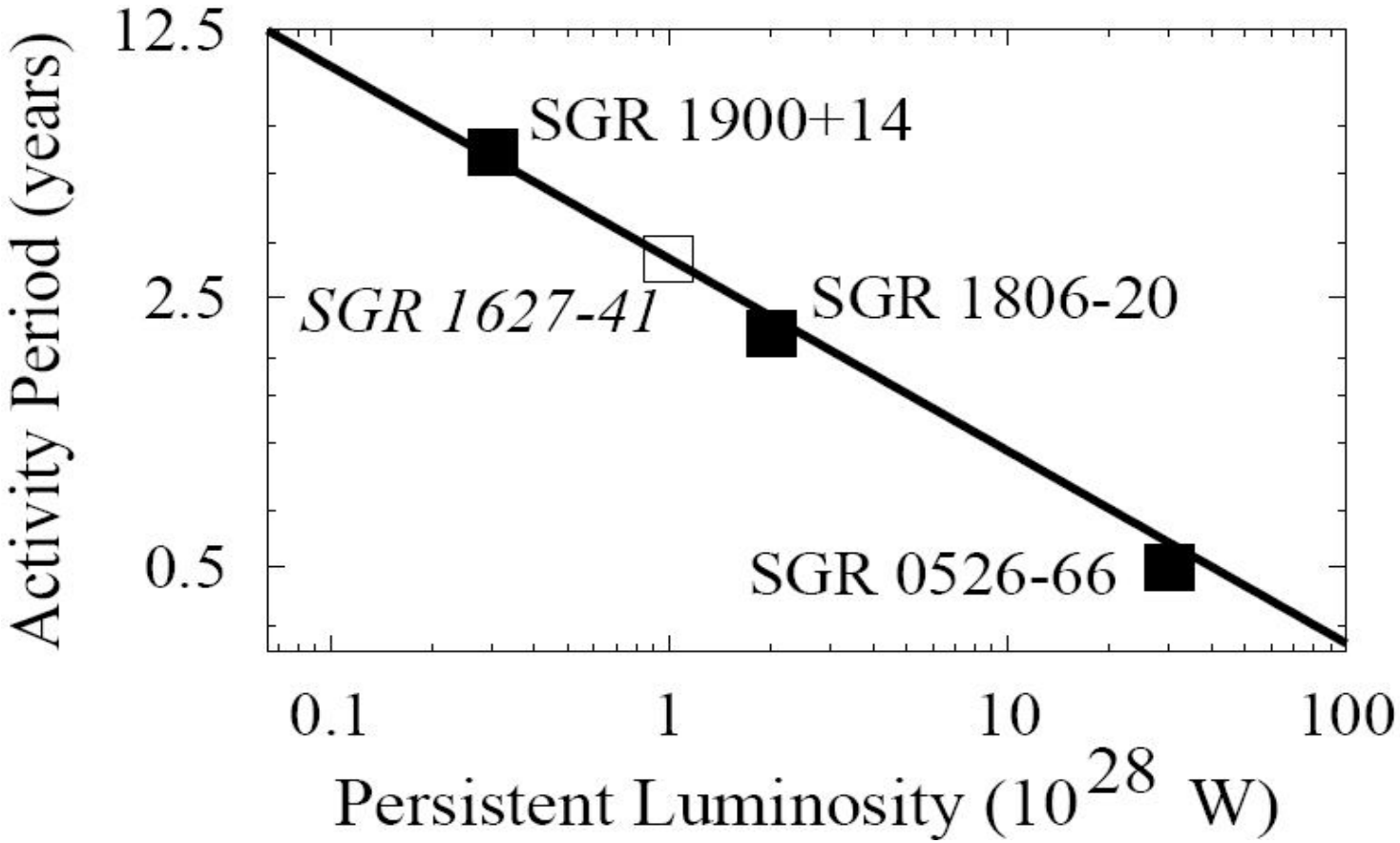
Burst Statistics: Fluence



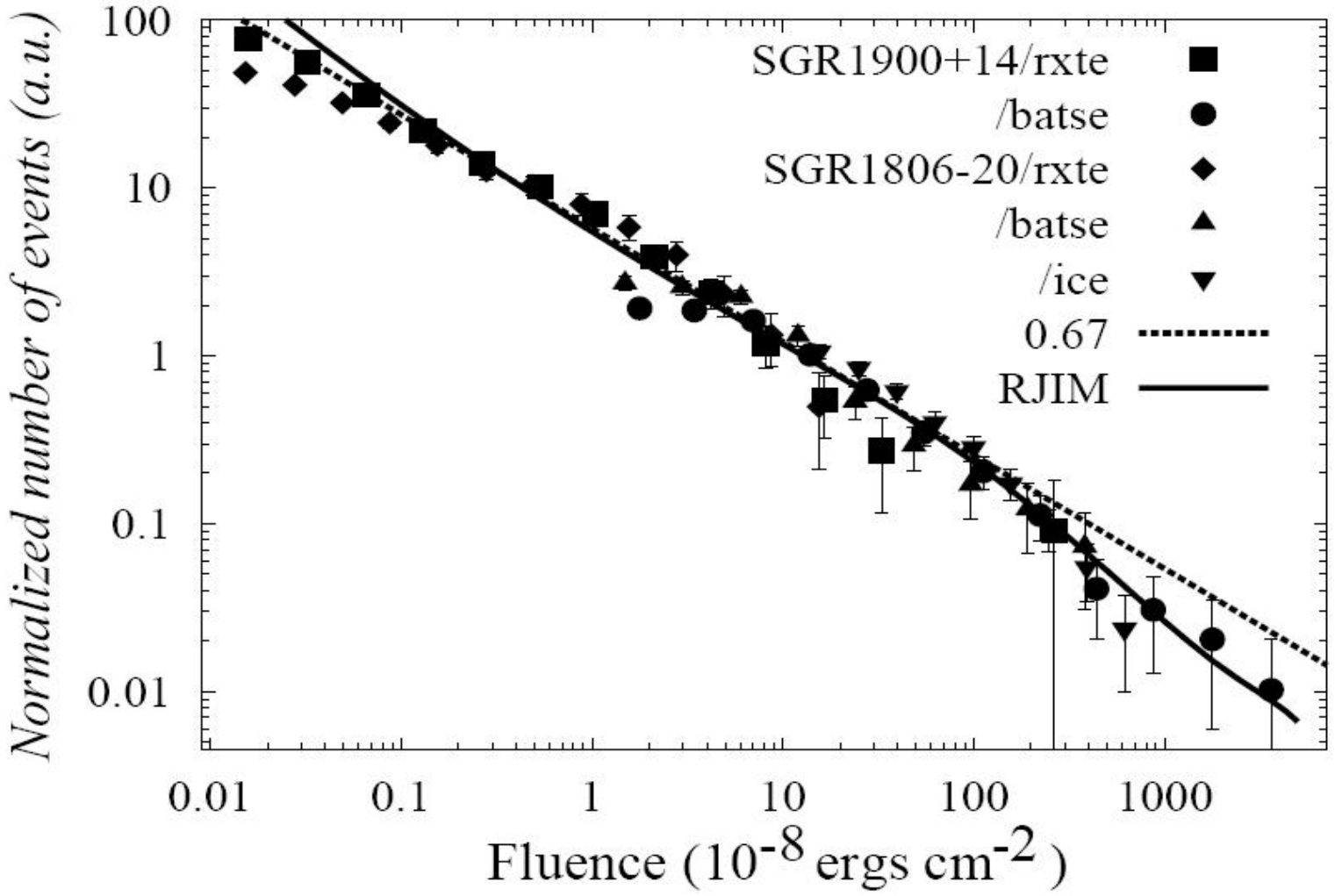
Waiting time



Period Activity



Burst Statistics: Fluence



SUMMARY

Magnetoemission of

Magnetar

Crust

Release of **Magnetic energy**

storred in barion degrees of freedoom

Relaiable description of all the observational data