Stelle di neutroni isolate
Le specie. I mostri.

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Neutron Star Spin-down

- NS magnetic fields are calculated as:

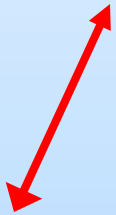
$$B = \sqrt{\frac{3c^3}{8\pi^2}\frac{I}{R^6 \sin^2\alpha} P\dot{P}} = 3.2 \cdot 10^{19}\sqrt{P\dot{P}}\ \text{Gauss}$$

where P=1/ν

- Characteristic ages are calculated as:

$$\tau = \frac{1}{n-1}\frac{P}{\dot{P}}^{n=3} = \frac{P}{2\dot{P}}$$

Crab paradigma

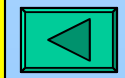


Basic picture:

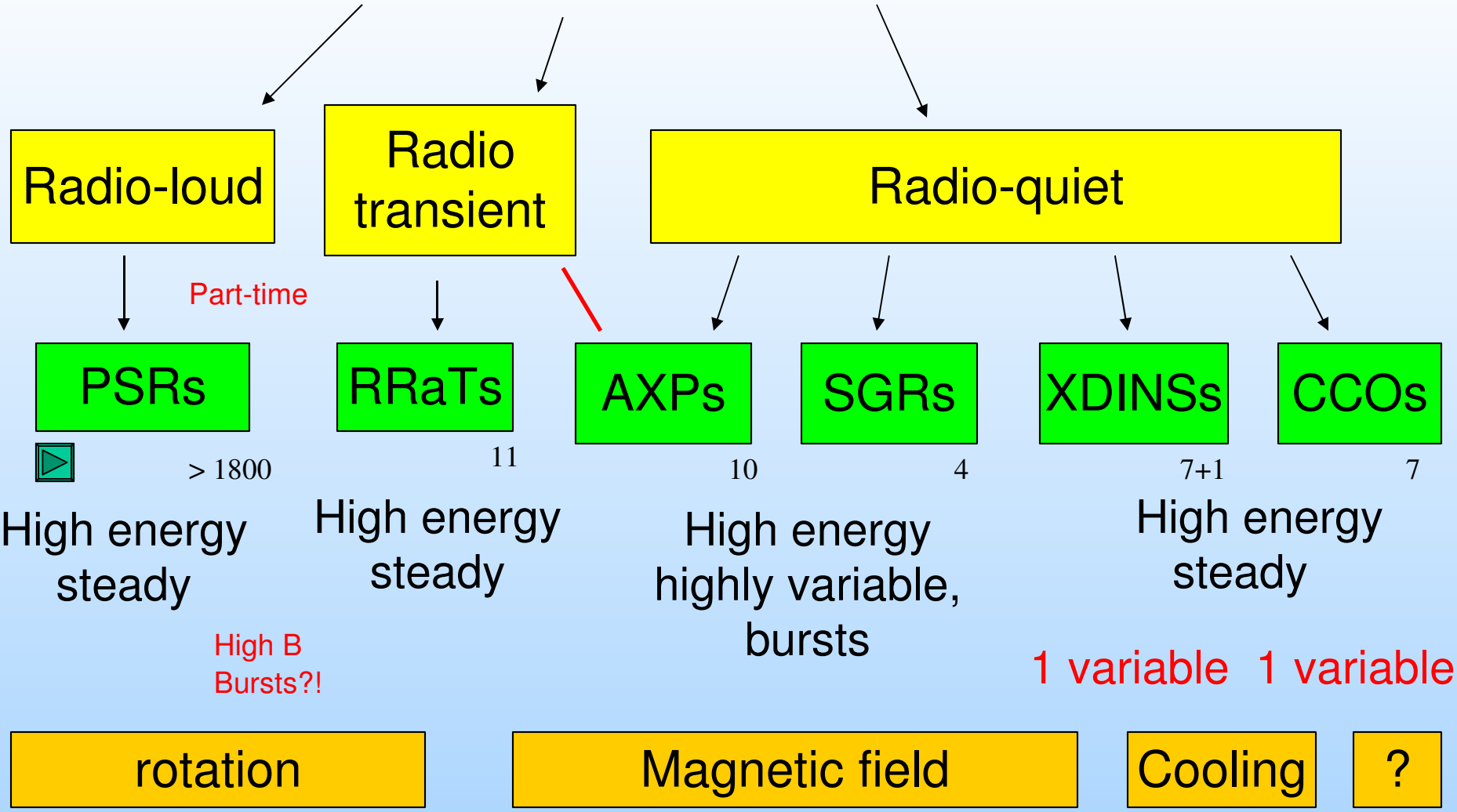
INSs are born as fast spinning (few ms) radio PSRs

PSRs spin down because of dipole radiation

→From young (energetic) to old (faint) PSRs



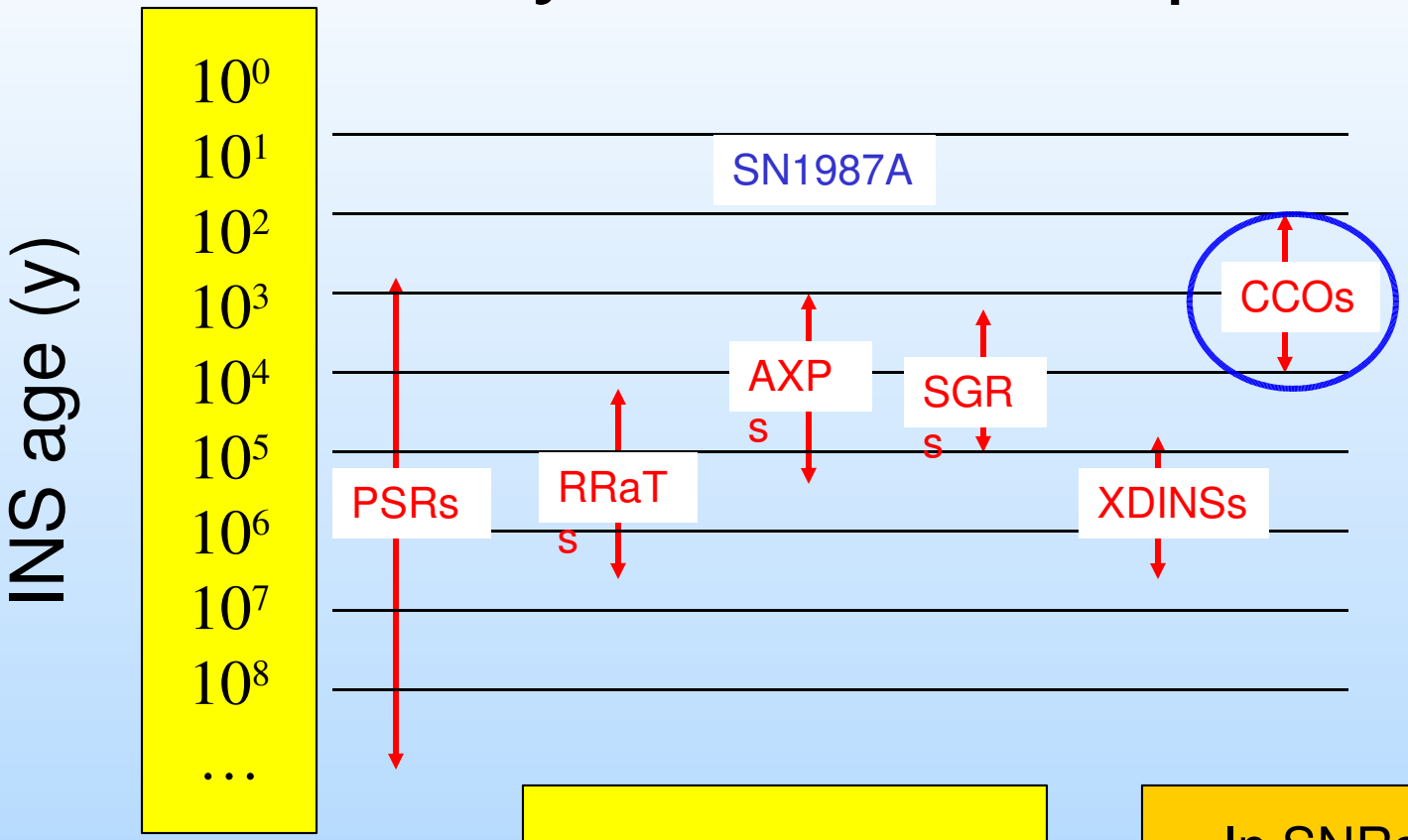
Isolated Neutron Stars



Different formation conditions → different populations?

One population evolves into another ?

Any evolution of species ?



A 1000 y old INS
may manifest as
a PSR
a CCO
an AXP

In SNRs within 5 kpc

~11 PSRs (8 + 3 PWN)

6 CCOs

1 AXP

What are CCOs?

1E 1207.4-5259 in G296.5+10.0

P=424 ms

Pdot < 2×10^{-16} s/s

Erot < 1.3 $\times10^{32}$ erg/s

τ > 27 My B < 3×10^{11} G

(Gotthelf & Halpern 2007)

CXOU 185238.6+004020 = PSR J1852+0040 in Kes 79

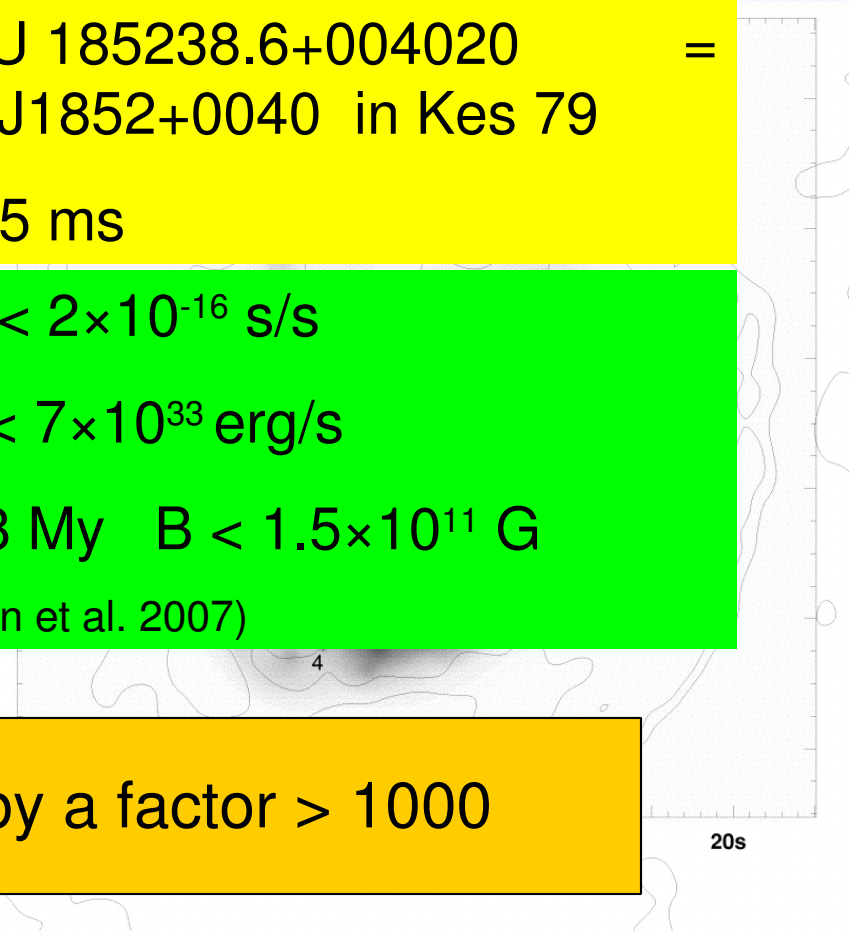
P=105 ms

Pdot < 2×10^{-16} s/s

Erot < 7×10^{33} erg/s

τ > 8 My B < 1.5×10^{11} G

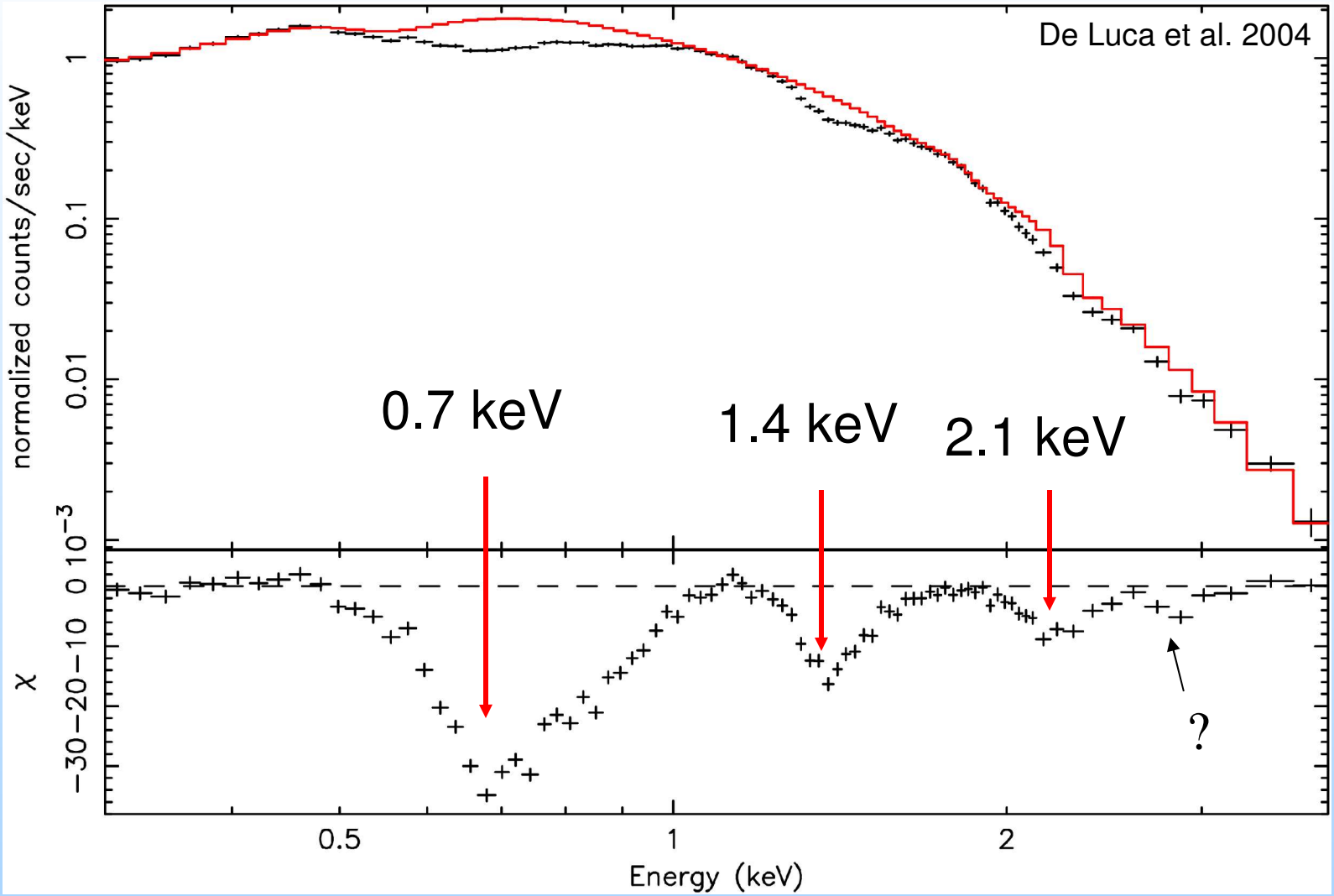
(Halpern et al. 2007)



τ exceeds age of SNR by a factor > 1000

2 CCOs are
born-slow INSs, with low dipole B-field
"anti-magnetars"

Unique spectrum of 1E1207



Multiple absorption lines

Low-B scenario consistent with interpretation as e^- cyclotron features

Other CCOs: three tests

Cas A — O-rich SNR

Currenly not variab… …w %)
Fesen et al.2006

Violent flare … …ars ago ?!?
Krause …

Not pul… PF<13%
Mereg… 2002

IR-Optical: $F_K/F_X < 1.7\times10^{-3}$
Fesen et al.2006

Magnetar ?

Pup A — O-rich SNR

Not variable (<few…
Becker & Hui 2005

pulsating ?!…
PF~5%… …cker, 2005

IR-C… …ta just received

Low-B or magnetar ??

Vela Jr. — (non-ther… …CNR)

Not variable (<few%… De Luca et al., 2007b

Not pulsating…
De Luca et al…

Hα nebu… …e - F_K/F_X~5×10^{-4}
Pellizzoni et a… …Mignani et al. 2007

Low-B or magnetar ??

G347.3-0.5 — (non-the… …al SNR)

Not variable (<few…

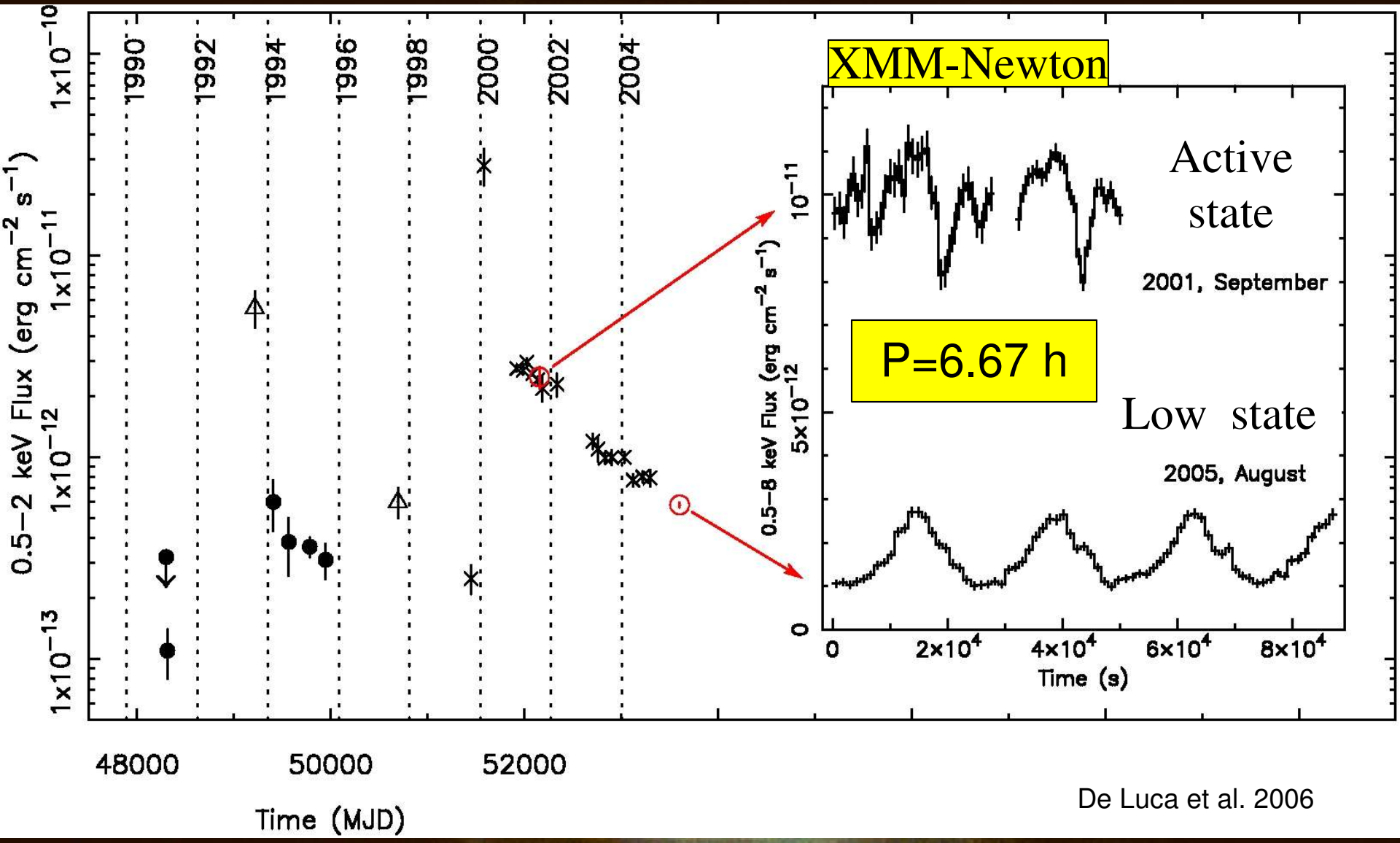
Not pulsating…

IR-Optic… …10^{-4}

(De Luca e… …)

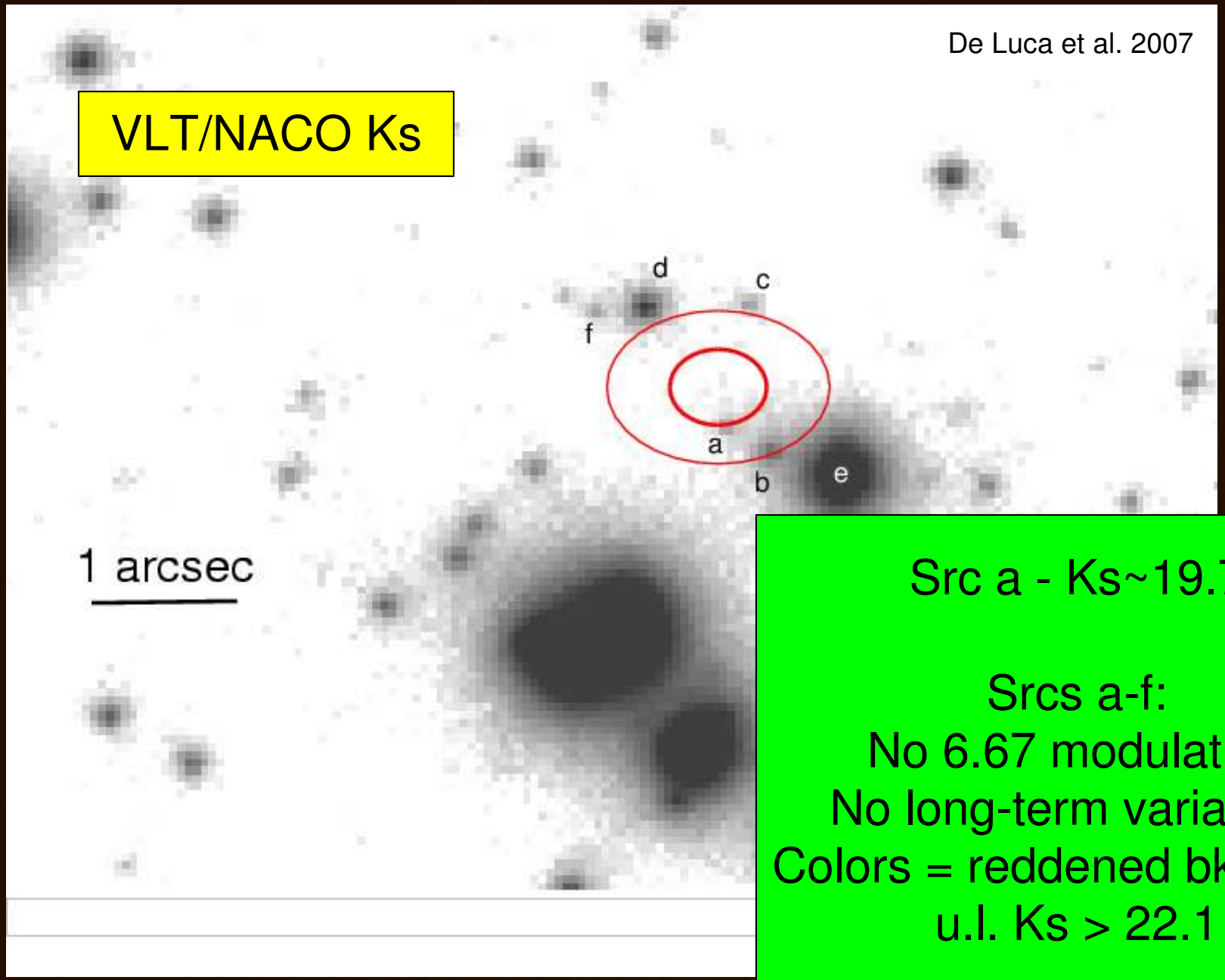
Low-B or magnetar ??

Monstrum: 1E1613-5055 in RCW103



De Luca et al. 2006

A deep look in the IR



Src a - Ks~19.7

Srcs a-f:
No 6.67 modulation
No long-term variability
Colors = reddened bkg stars
u.l. Ks > 22.1

Young binary pictures

A 2 ky old compact object + a non-collapsed star

First LMXB in a SNR !

Optical/IR data allow for a M6-M8 companion

1) 6.67 hr periodicity: orbital period X-rays: accretion

1E very different from standard LMXBs (but: old systems)

"Double" accretion process ? (low B, slow P) (De Luca et al.2006)

2) 6.67 hr periodicity: spin period of the NS

Analog of Polar/Intermediate Polar featuring a magnetar

10^{15} G B-field required to brake NS (Pizzolato et al.2007)

X-rays: magnetar emission (+ accretion ?)

Isolated object scenario

~~A BH~~

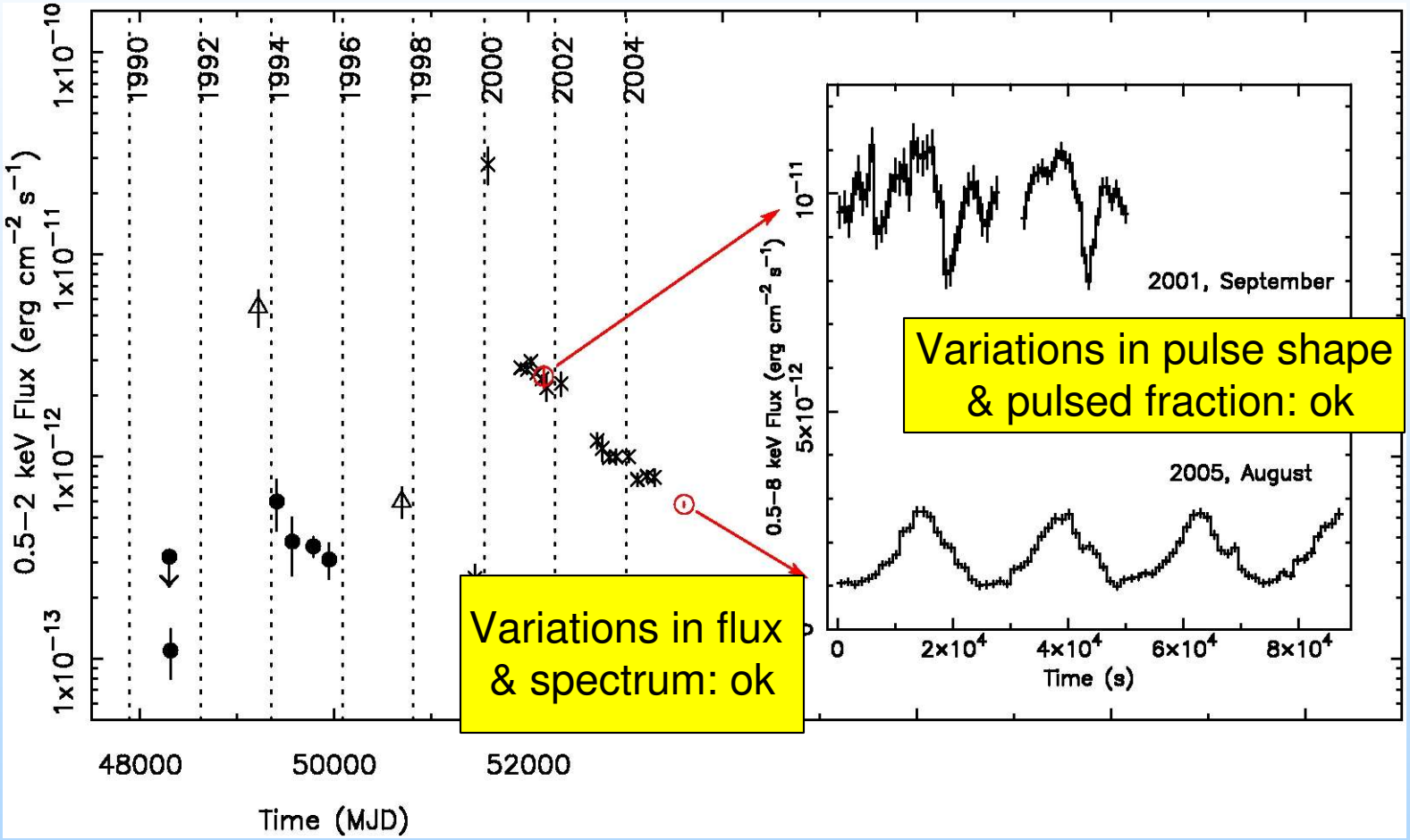
~~A freely precessing NS~~

~~A normal INS very slow at birth~~

No viable explanations to periodicity and/or long-term evolution

A “braked” magnetar ?!?

1E1613 as an isolated magnetar



Spectral shape & luminosity: ok

But AXPs & SGRs have P~2-12 s

Quenching the rotation of a magnetar

Propeller effect by a SN debris disc

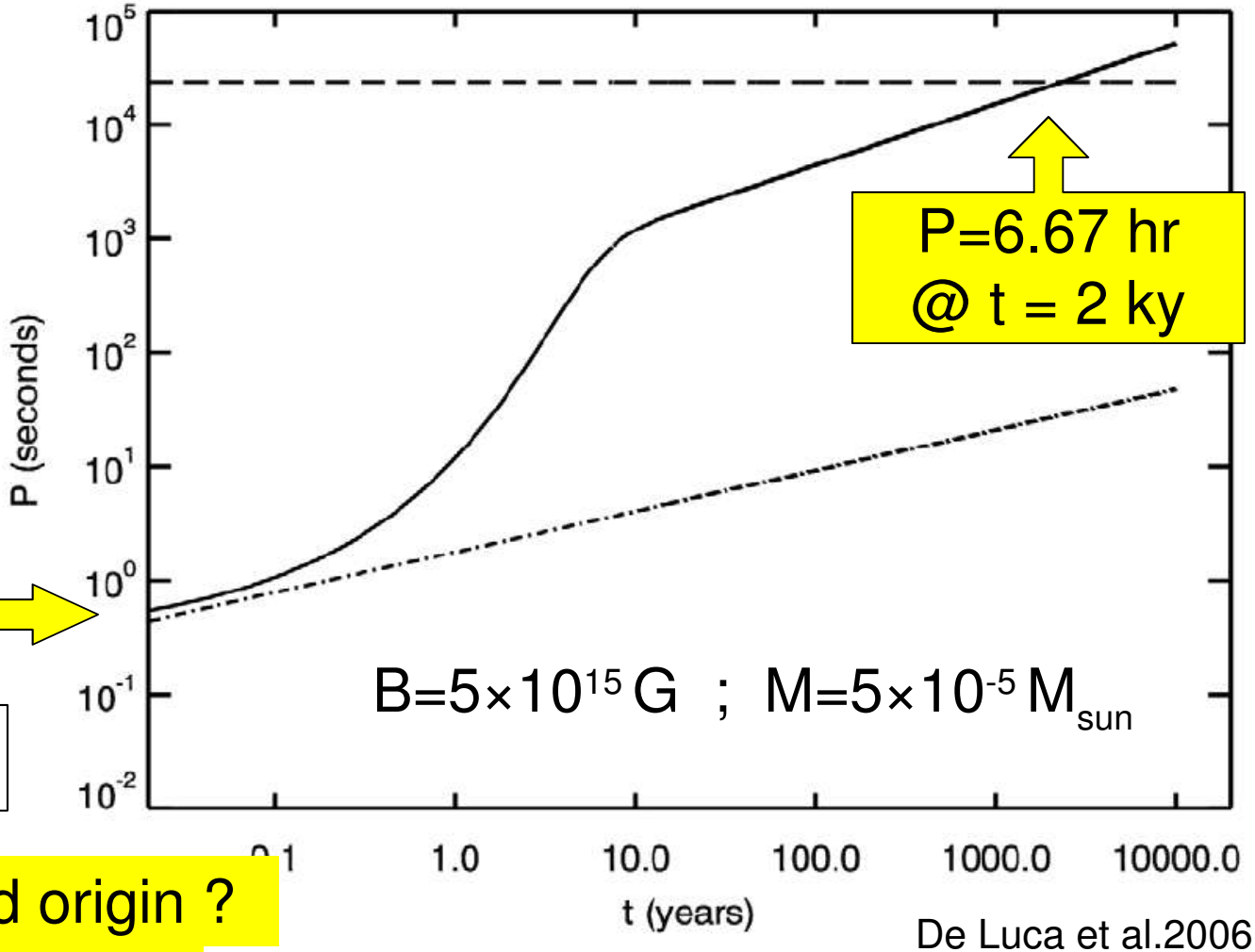
(Chatterjee et al., 2000; Francischelli et al., 2002)

SN debris discs do exist !

(Wang et al., 2006)

P_0 ¿ 0.3 s

But see Li (2007)

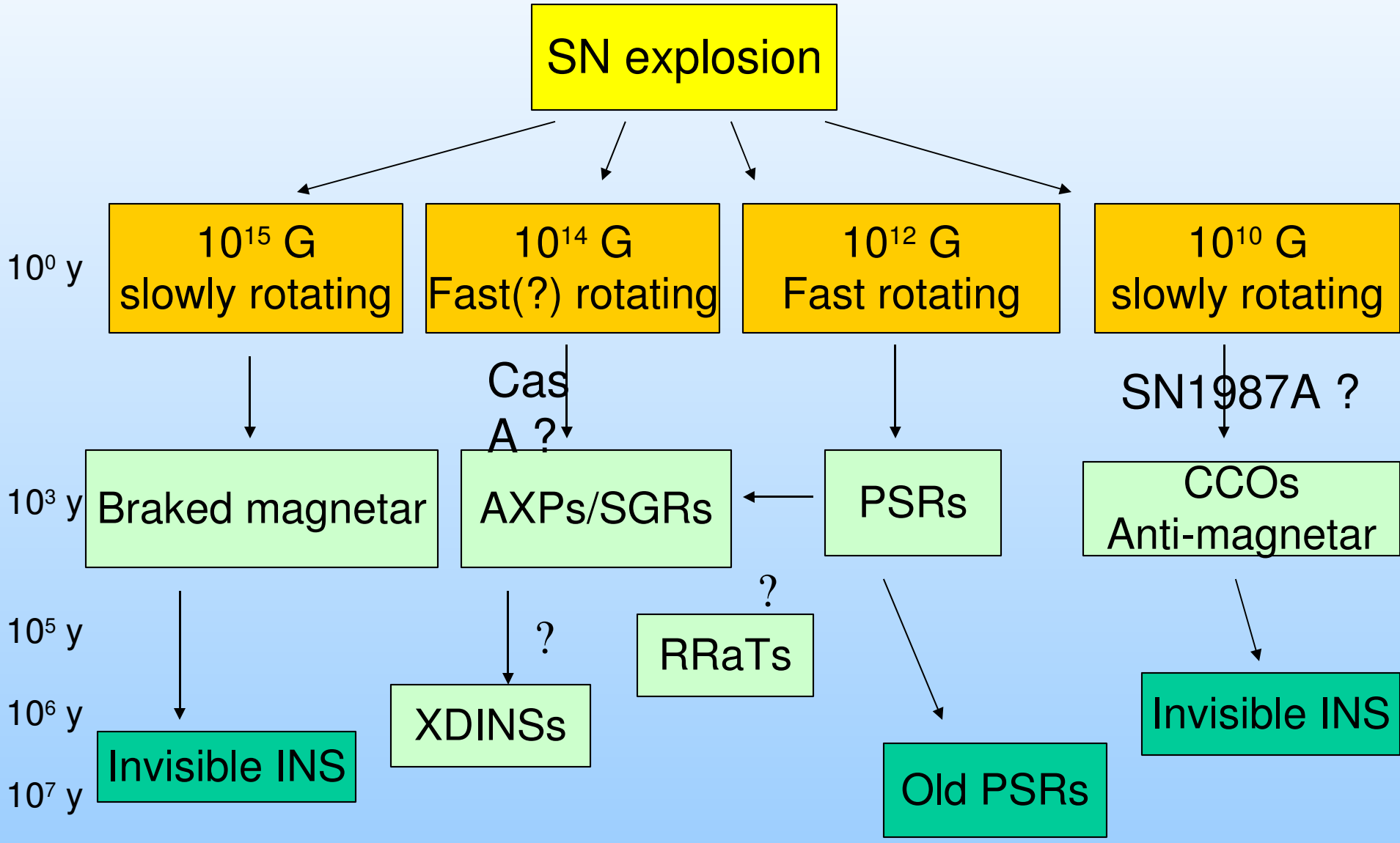


De Luca et al.2006

1) magnetar B-field origin ?

2) Spin history dominated by SN fallback

Other “braked” INSs ?


SN explosion
10^{15} G
slowly rotating
10^{14} G
Fast(?) rotating
10^{12} G
Fast rotating
10^{10} G
slowly rotating
10^0 y
Cas A ?
SN1987A ?
10^3 y
Braked magnetar
AXPs/SGRs
PSRs
CCOs
Anti-magnetar
?
10^5 y
?
RRaTs
10^6 y
XDINSs
Invisible INS
Invisible INS
10^7 y
Old PSRs