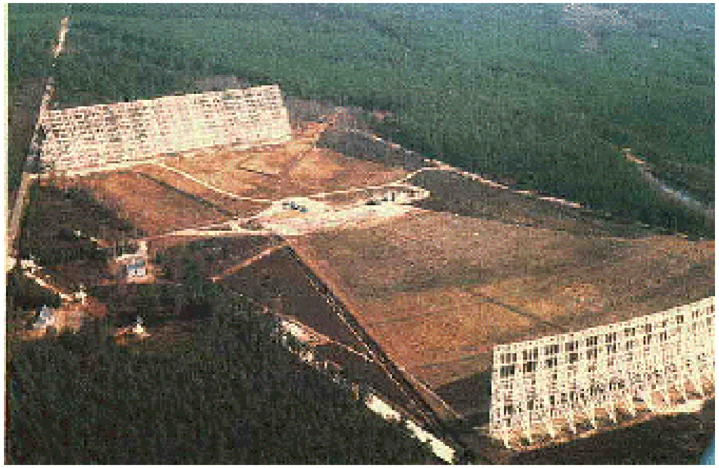
Searches for Young Pulsars



Tania Regimbau

OCA/Nice

Triaxial Emission

Gravitational Wave polarization amplitudes from a triaxial rotating NS:

$$\begin{cases} h_+(t) = h_0 \dfrac{1+\cos^2 i}{2} \cos\phi(t) \\ h_\times(t) = h_0 \cos i \sin\phi(t) \end{cases} \quad \text{with } h_0 = \frac{16\pi^2 G I_{ZZ}}{c^4} \frac{\varepsilon}{P_{orb}^2 d} \simeq 3\times 10^{-24} \frac{\varepsilon f_{rot}^2}{d(kpc)}$$

The **ideal pulsar** is **fast**, **close**, with **large equatorial deformation**!

- **milliseconds** are **fast** but have **small ellipticities** ($\varepsilon < 10^{-9} - 10^{-8}$)
- **magnetars** have **large ellipticities** but are **slowed down very quickly**
- **young normal pulsars**

Population Synthesis

Recover the statistical properties of the total population hidden from radio observation by selection effects.

- initial period: gaussian distribution with

mean <Po>~250-300 ms

and dispertion σ~80-100 ms

(Regimbau & de Freitas Pacheco, A&A, 2000, 359, 242 and confirmed by Faucher-Giguere & Kaspi, 2006, 643, 332)

- 60-90 pulsars with P<80 ms

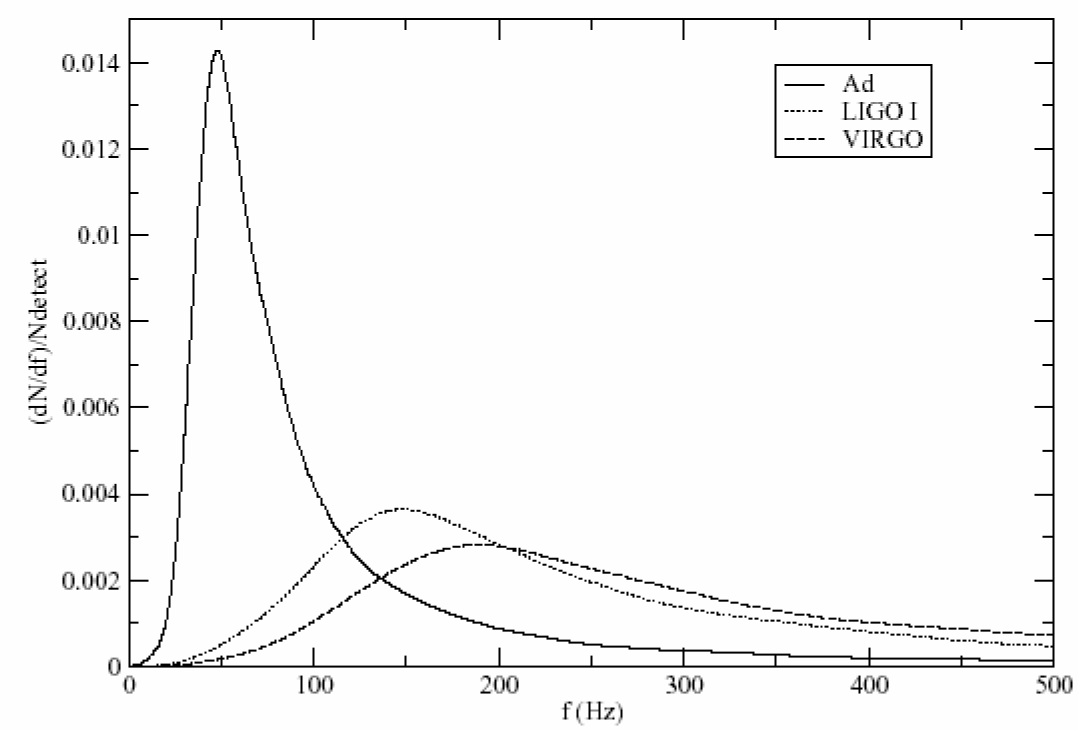
Table 1. Number of detections as a function of the ellipticity for interferometers of the first generation (LIGO and VIRGO) and for an advanced interferometer

ε	10^{-5}	10^{-6}	10^{-7}
VIRGO	15	3	0
LIGO I	12	2	0
Advanced	90	12	2

(Regimbau & de Freitas Pacheco, A&A, 401, 385, 2002)

Detectable pulsars: frequency

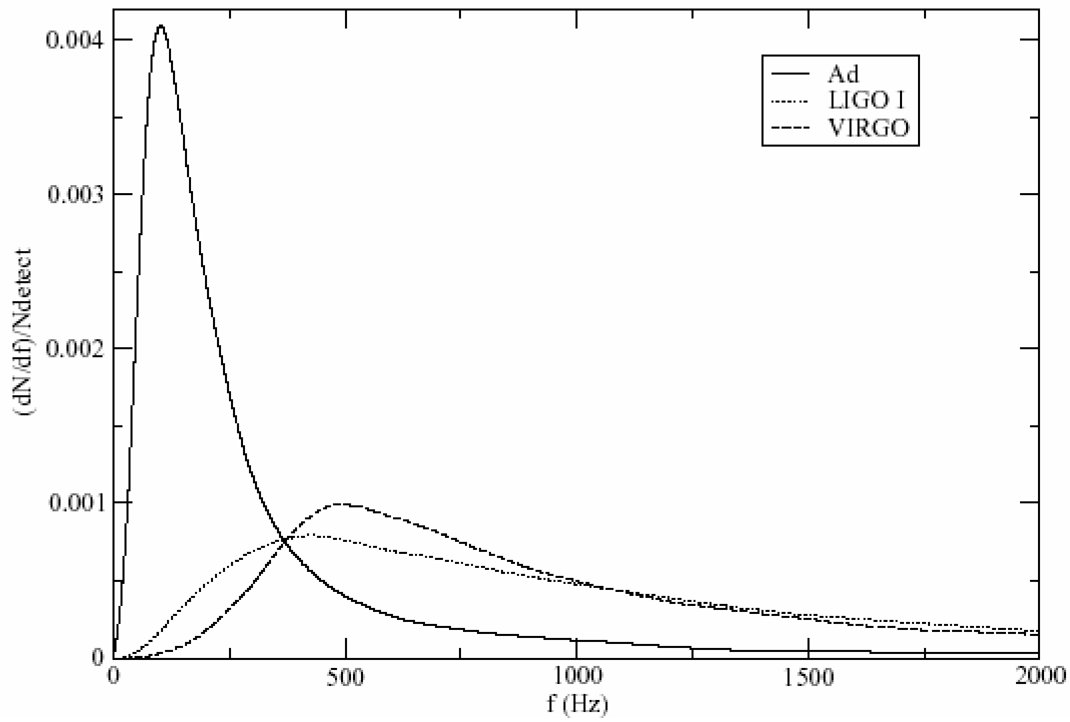
$$\varepsilon = 10^{-5}$$



(Regimbau & de Freitas Pacheco, A&A, 447, 1, 2006)

Detectable pulsars: frequency

$\varepsilon = 10^{-6}$



(Regimbau & de Freitas Pacheco, A&A, 447, 1, 2006)

Observatoire de la Côte d'Azur

Population Synthesis

Recover the statistical properties of the total population hidden from radio observation by selection effects.

- initial magnetic field: log-gaussian distribution with

mean <log B>~13 G

and dispertion σ~0.8 G

(Regimbau & de Freitas Pacheco, A&A, 2000, 359, 242 and confirmed by Faucher-Giguere & Kaspi, 2006, 643, 332)

- ~10% with B >10^{14} G (magnetars)

$$\varepsilon_B = g\frac{B^2R^4}{GM^2}\sin^2\alpha = 2\times10^{-8}\,gB_{14}^2\sin^2\alpha$$

incompressible fluid (Ferraro, 1954): $g = 12.5 \quad \varepsilon_B = 2.5\times10^{-7}B_{14}^2\sin^2\alpha$

superconductiong interior of type I (Bonazzola & Gourgoulhon 1996): $g = 520 \quad \varepsilon_B = 5.5\times10^{-3}B_{14}^2\sin^2\alpha$

Magnetars

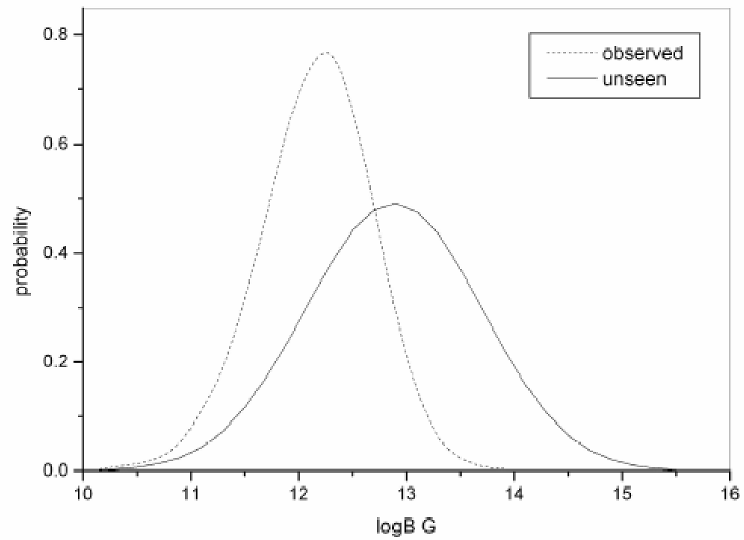


Fig. 2. Magnetic field distributions of the observed (dashed line) and the unseen population (full line) of pulsars

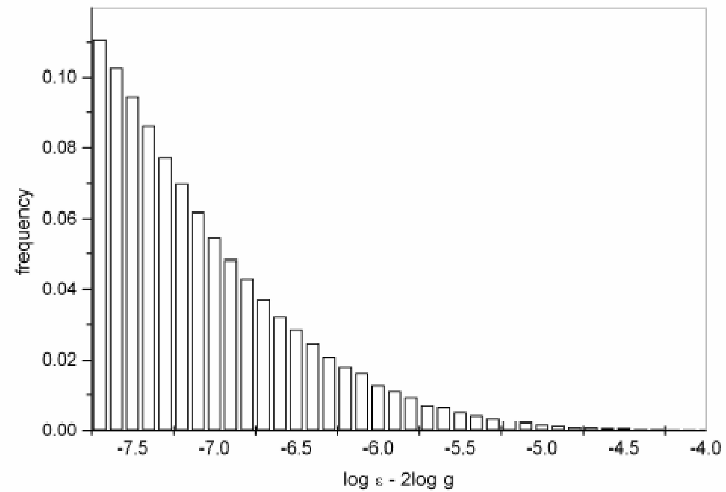
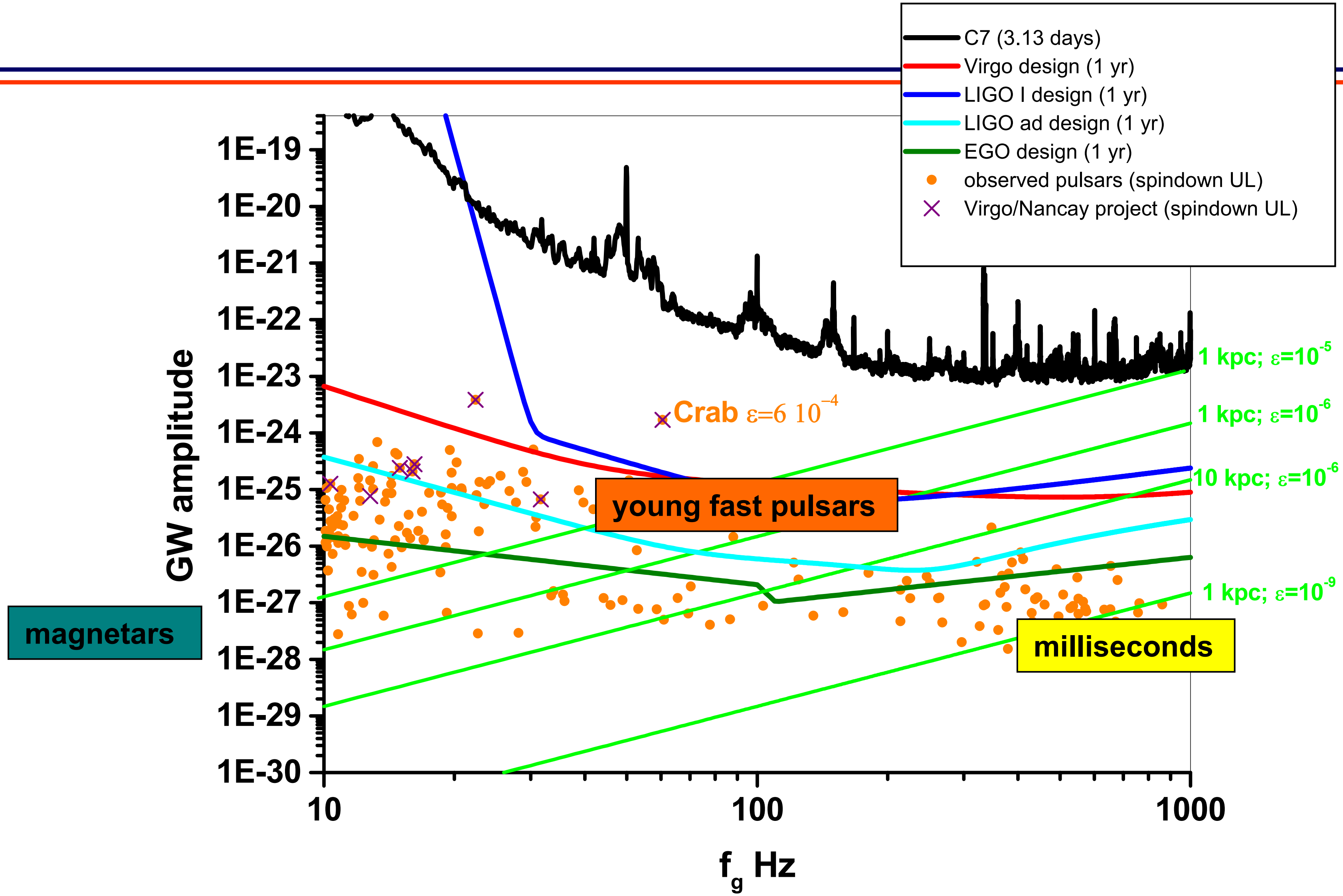


Fig. 3. Simulated distribution probability for the expected magnetic ellipticity of magnetars

(Regimbau & de Freitas Pacheco, A&A, 447, 1, 2006)


C7 (3.13 days)
Virgo design (1 yr)
LIGO I design (1 yr)
LIGO ad design (1 yr)
EGO design (1 yr)
observed pulsars (spindown UL)
Virgo/Nancay project (spindown UL)
GW amplitude
1E-19
1E-20
1E-21
1E-22
1E-23
1E-24
1E-25
1E-26
1E-27
1E-28
1E-29
1E-30
10
100
1000
f_g Hz
Crab ε=6 10^-4
1 kpc; ε=10^-5
1 kpc; ε=10^-6
10 kpc; ε=10^-6
1 kpc; ε=10^-9
young fast pulsars
magnetars
milliseconds

Observatoire de la Côte d'Azur

Collaboration with Nancay

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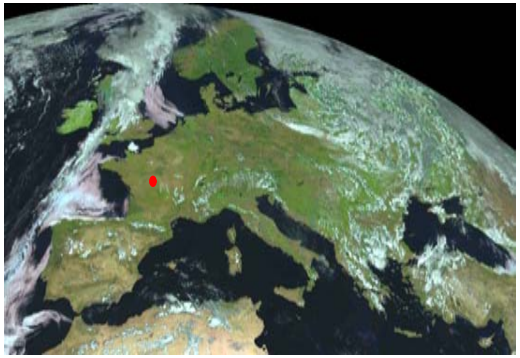


- Millisecond pulsars (SKA) : detection of the GW stocha ... ıHz
- Binary systems (Virgo/LIGO)
- Young and glitching pulsars (Virgo/LIGO)

(timing for continuous signal searches, coincidence for o

Observed Pulsars

PSR	fgw (Hz)	dP/dt	D(kpc)	association	glitches	obs. time (hrs/month)
B0244+60	9.21	*	*	*	*	10
B2238+58	14.29	*	*	*	*	5
J1740-3015	3.30	4.6587E-13	3.28	*	14	1
B0531+21	60.44	4.22765E-13	2	SNR:Crab	11	4
J1801-2451	4.81	1.12882E-13	13.49	SNR:W28(?)	6	2
J1803-2137	14.97	1.34105E-13	3.94	SNR:G8.7-0.1(?)	3	2
J1825-0935	2.60	5.22853E-14	1	*	3	2
J2116+1414	4.54	2.89263E-16	4.43	*	3	2
B0355+54	12.79	4.39686E-15	2.07	*	2	4
J1721-3532	7.13	2.51862E-14	6.36	*	2	2
J1755-2521	1.70	9.01928E-14	4.12	*	2	1
J1801-2305	16	1.27906E-13	4.61	*	2	2
J1910-0309	3.96	2.18734E-15	10.25	*	2	2

Observatoire de la Côte d'Azur

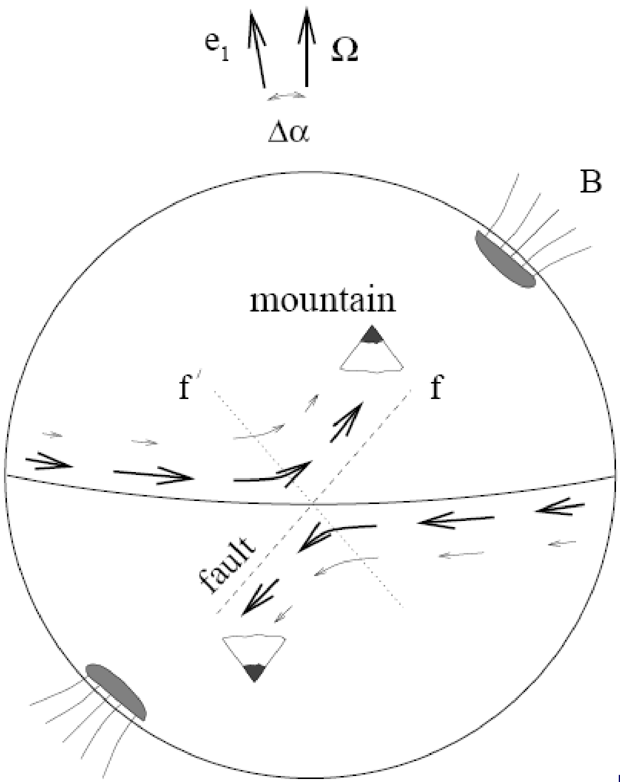
Merci!

Observed Pulsars

PSR	Period (s)	dP/dt	D(kpc)	association	glitches	obs. time (hrs/month)
B0244+60	0.217097	*	*	*	*	10
B2238+58	0.139937	*	*	*	*	5
J1740-3015	0.60667	4.6587E-13	3.28	*	14	1
J0534+2200	0.03309	4.22765E-13	2	SNR:Crab	11	4
J1801-2304	0.4158	1.12882E-13	13.49	SNR:W28(?)	6	2
J1803-2137	0.13362	1.34105E-13	3.94	SNR:G8.7-0.1(?)	3	2
J1825-0935	0.76898	5.22853E-14	1	*	3	2
J2116+1414	0.44015	2.89263E-16	4.43	*	3	2
J0358+5413	0.15638	4.39686E-15	2.07	*	2	4
J1721-3532	0.28042	2.51862E-14	6.36	*	2	2
J1755-2521	1.17597	9.01928E-14	4.12	*	2	1
J1801-2451	0.12492	1.27906E-13	4.61	*	2	2
J1910-0309	0.5046	2.18734E-15	10.25	*	2	2

Observatoire de la Côte d'Azur

Starquakes



Link, Franco, Epstein, astro/ph/9805115)