Likely continuous sources for detection by ITF

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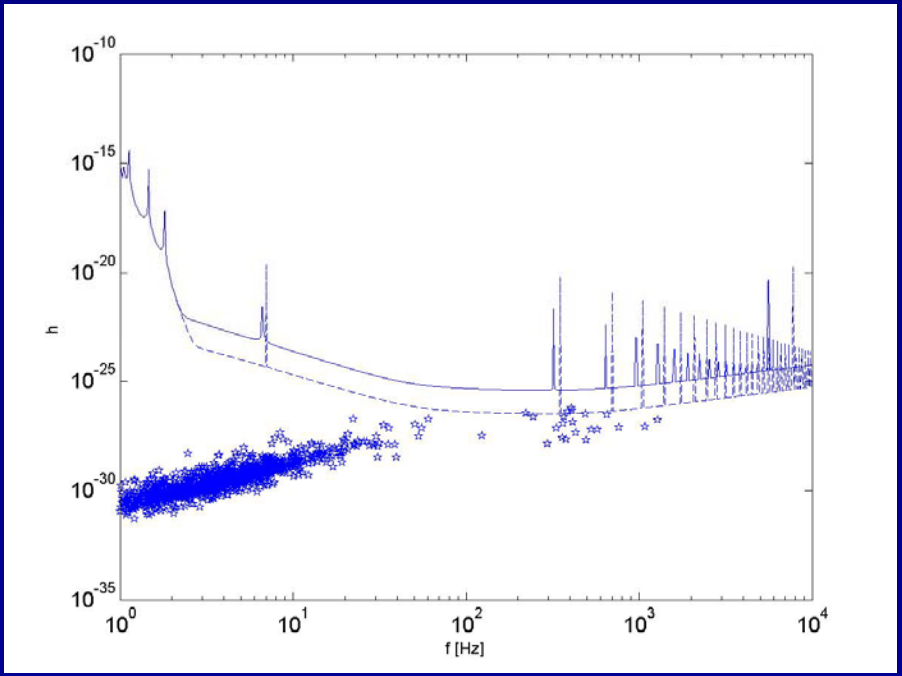
- Slides based on a paper appeared in MNRAS, 2005
- Isolated neutron stars
- "Standard" EOS (no quark matter etc.)
- Parameters distribution taken from the literature (initial period, position, kick velocity)



$$\varepsilon = \min\left(10^{-6}, \varepsilon_{GW} = 1.8 \cdot 10^{5} \sqrt{P_s \dot{P}}\right)$$

Virgo and an "advanced" Virgo

Optimal analysis method over 4 months

- Detection from the known pulsar population can be unlikely (but we cannot exclude surprises…)
- Let us consider a speculative population of NS evolving mainly through the emission of gravitational waves (GWDNS)
- It cannot be excluded both on observational and theoretical ground

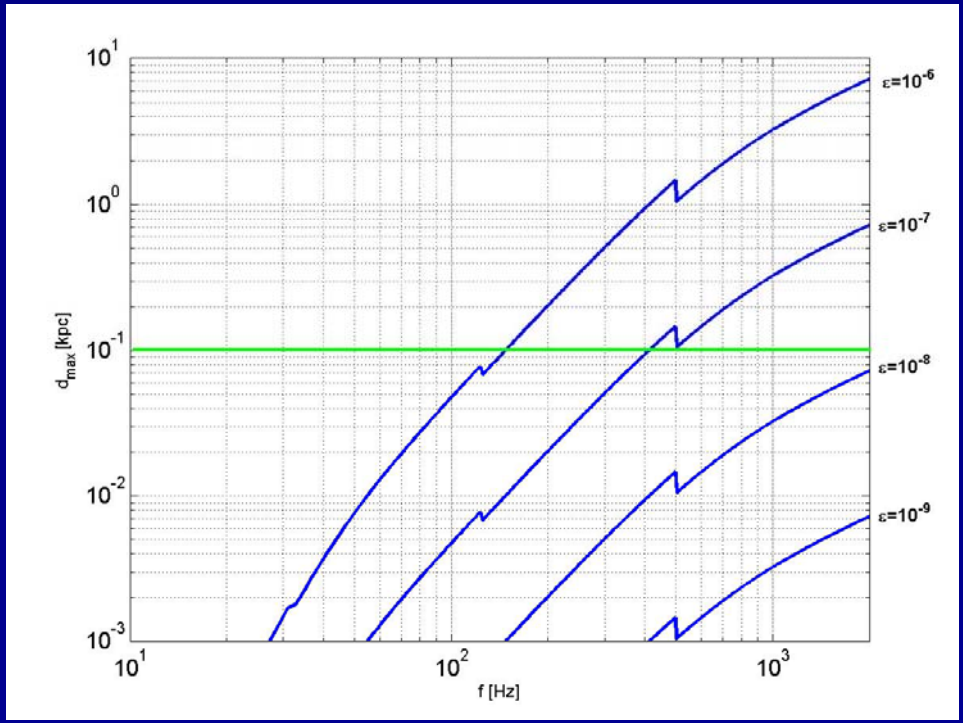
- This can happen if the EM spin-down is low enough

$$B < 4.7 \cdot 10^{8} \left(\frac{\varepsilon}{10^{-6}} \right) \left(\frac{f}{100 Hz} \right) \sin^{-1} \alpha \ \ \mathrm{G}$$ (1.4 Mo, R=10km neutron star)

- Possible mechanisms:
  - post-core-collapse hypercritical accretion (Geppert et al. 1999)
  - magnetic axis alignment (Zhang et al. 1998)
  - different evolutionary path respect to pulsars…

- Given an initial population of GWDNS we may want to see which is the parameter distribution at present and how many detections we could expect

- The search for GWDNS is 'by definition' blind
- However, we can try to see if the source parameter space can be reduced in some way
- Obviously, uncertainty in the initial parameters and no electromagnetic counter-part may affect results
- Some of the results could be interesting also for other NS populations (e.g. pulsars)



Maximum distance vs. signal frequency assuming:

-Hierarchical all-sky search

- Observation time $T_{obs} = 4$ months

- Minimum spin-down decay time $\tau = 10^4$ years

- 10^9 candidates selected after first incoherent step

• Initial period distribution: various choices investigated

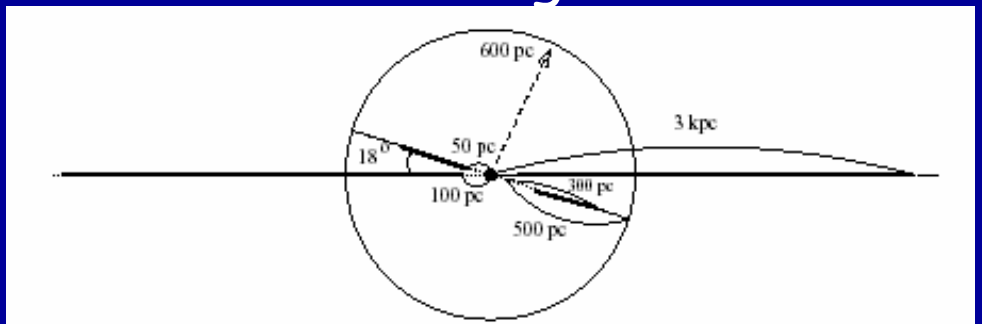
-"standard" log-normal $\left(\overline{\log P_0} = -2.3;\ \sigma_{\log P_0} = 0.3;\ P_{0;\min} = 0.5ms\right)$

- "standard" with $P_{0;\min} = 10ms$

- uniform in $[2,15]ms$

• Kick velocity distribution: double gaussian (Arzoumanian et al. 2002)

• Initial position distribution: exponential in R $\left(R_0 = 3.2kpc\right)$ and z $\left(z_0 = 75pc\right)$ + Gould Belt (where the expected NS formation rate 2-3 times larger than the contribution of the disc in the solar neighbourhood



A schematic picture of the Gould belt from Popov et al. 2004

- Ellipticity distribution: exponential with mean value between 10^{-6} and 10^{-8}
- Age distribution: uniform up to 100Myr

- We evolve the initial population in the gravitational potential of the Galaxy and compute the expected number of detections assuming to perform a hierarchical blind search with:

- Observation time $T_{obs} = 4\,\text{months}$
- signal frequency up to $f = 2\,\text{kHz}$
- minimum spin-down decay time $\tau = 10^4\ \text{years}$
- 10^9 candidates selected after the first incoherent step

- **General results**
- ~45% of the NS escape from the galaxy (in agreement with, e.g. Arzoumanian et al. 2002)
- ~140 NS are found within 1kpc from the Sun and with age less than 4Myr (in agreement with Popov 2003)
- ~1/2 of these were born in the Gould Belt

- **Results more specific for GW detection (initial Virgo)**

Model	$\lambda = 0.5$	$\lambda = 0.2$	$\lambda = 0.1$	$\lambda_{\min}$
standard 1	$1.4 \cdot 10^{-7}$	$2.5 \cdot 10^{-7}$	$4.8 \cdot 10^{-7}$	0.076
standard 2	$6.4 \cdot 10^{-7}$			0.27
uniform	$2.4 \cdot 10^{-7}$	$6.0 \cdot 10^{-7}$		0.12

50th and 90th percentiles for frequency, distance, declination, age

$f_{50}, f_{90}[Hz]$	$d_{50}, d_{90}[kpc]$	$\|\vartheta\|_{50}, \|\vartheta\|_{90}(\mathrm{deg})$	$t_{50}, t_{90}[Myr]$
300,700	.16,.35	19,54	0.4,1.8

- Most detectable sources have age less than 2Myr
- Nearly all detectable sources have spin-down age >10000yr
- Most detectable sources have distance less than 400 pc
- Few detectable sources have low spin frequencies
- Most detectable sources are well above the galactic plane
- Is it meaningful to restrict the parameter space to be explored or not?

- For an advanced ITF we expect a rate about two order of magnitude larger
- A GWDNS fraction as small as 0.0008 may allow for detections

Conclusions

- Detection with initial ITF is not 'impossible'
- Local matter distribution is important (Gould belt)
- Blind search for detection, but less wide searches for GW astronomy?