Prospects for detecting GWs from accreting neutron stars

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The expected GW amplitude

- Observationally accreting NSs seem to spin slower than expected. Is this because of GW emission?
- If torques are balanced + simplifying assumptions

$$h_0^2 \propto \sqrt{\frac{R^3}{M}} \times \frac{\text{Flux}(\mathcal{F})}{\text{spin freq.}(\nu_s)}$$

$\Longrightarrow$ observation of $(\mathcal{F}, \nu_s)$ yields h_0

- Three sets of sources for which we might hope to have some idea of spin frequencies
  - Millisecond pulsars (10 sources)
  - Sources showing burst oscillations (MSPs with burst oscillations are consistent) (12 + 7 sources)
  - kHz QPO systems (probably weak link with spin frequency)

Deriving the expression for h_0

- GW torque

$$\mathcal{T}_{gw} = \frac{\dot{E}_{gw}}{\Omega_s} = -\frac{32 G Q^2 \Omega_s^5}{5c^5}$$

- Acretion torque

$$\mathcal{T}_a = \dot{M} R^2 \Omega = \dot{M} R^2 \sqrt{\frac{GM}{R^3}} = \dot{M}\sqrt{GMR}$$

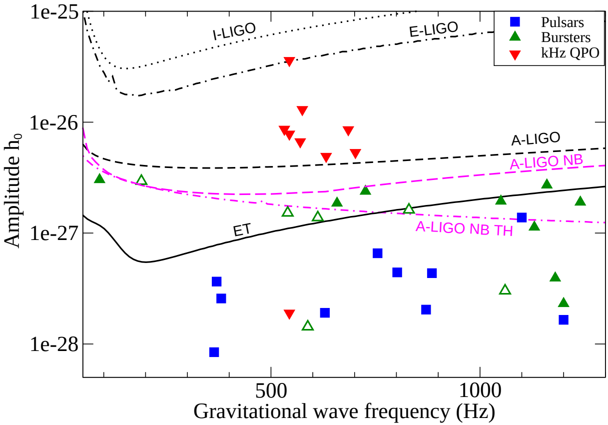
- Observed flux and luminosity

$$\mathcal{F} = \frac{L}{4\pi d^2} \quad L = \frac{GM\dot{M}}{R} \implies \dot{M} = \frac{4\pi R d^2 \mathcal{F}}{GM}$$

- GW amplitude

$$h_0^2 = \frac{5G}{2\pi^2 c^3 d^2 \nu^2} \dot{E}_{gw} = \frac{5G}{2\pi^2 c^3 d^2 \nu^2} \mathcal{T}_a \Omega_s \propto \frac{\mathcal{F}}{\nu_s}$$

The best case scenario - mountains

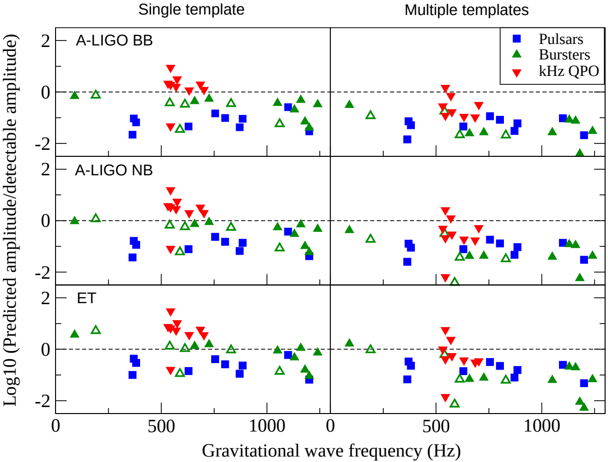


- Single template search: $h_0 = 11.4\sqrt{S_h/DT_{obs}}$ with $T_{obs} = 2y$, and long term avg. flux, mountain scenario
- This is degraded because of statistics and computational cost limitations: $h_0^{sens} = F_{stat}\sqrt{S_h/N^{1/2}DT_{coh}}$

More realistic scenarios

- Parameters: $(\nu_s, \dot{\nu}_s, a\sin\iota, e, P_{orb}, \dot{P}_{orb}, T_{asc}, w)$
- For a circular orbit of constant radius and constant spin: $(\nu_s, a\sin\iota, P_{orb}, T_{asc})$
- For each source we are given best fit parameters + errors
- Coherent metric worked out by Dhurandhar & Vecchio
- $N_t \propto T^{10}$ for $T \ll P_{orb}$ and $\propto T^2$ for $T \gg P_{orb}$
- First calculate which parameters don't need to be searched over
- Calculate number of templates in remaining parameter space
- F_{stat} calculated for a false alarm rate $0.01/N_{trials}$
- Consider coherent and semi-coherent methods
  - Use semi-coherent if full coherent is impossible

More realistic scenarios



- Detectability with statistical factor and computational cost taken into account
- Mountain scenario, 2y observation, ×50 and ×100 times increase in computational resources for A-LIGO and ET resp.