

An all-sky search algorithm for
continuous gravitational waves from
spinning neutron stars in binary
systems

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Motivation

- Non-axisymmetric neutron stars are predicted to emit gravitational waves according to GR
- Structure of neutron stars is an active area of theoretical research
 - Observation of gravitational waves might assist other EM observations to constrain the equation of state
- In the most sensitive region of the LIGO band, between 50 and 1000 Hz, 111 out of 182 pulsars are in binary systems

Binary parameter space

- Five non-relativistic parameters describe a binary orbit (3 for a circular orbit)
- Most of the observed pulsars in binary systems have:
 - Eccentricity < 0.1 (nearly circular)
 - Very small spindown [$\text{abs}(\dot{f}) < 1\text{e-}16$ Hz/s]

Binary parameter space

- Signal frequency modulation:

$$\Delta f_{max} \simeq 1.82 \left(\frac{f}{1 \text{ kHz}} \right) \left(\frac{M_{NS}}{1.4 M_{\odot}} \right)^{1/3} \left(\frac{P}{2 \text{ hrs}} \right)^{-1/3} \left[\frac{q}{(1+q)^{2/3}} \right] \text{ Hz}$$

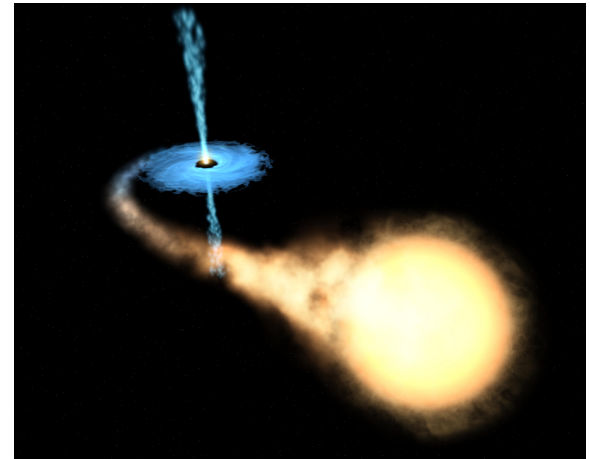
Δf_{max} = Modulation depth maximum (edge-on system)

f = GW frequency

M_{NS} = NS mass

P = orbital period

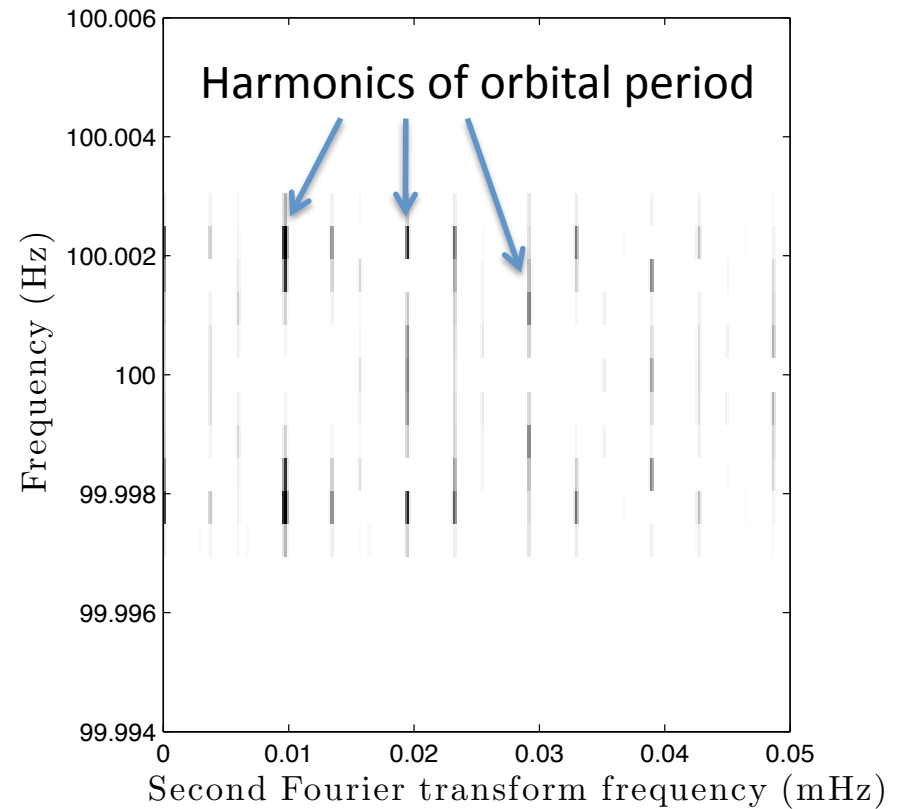
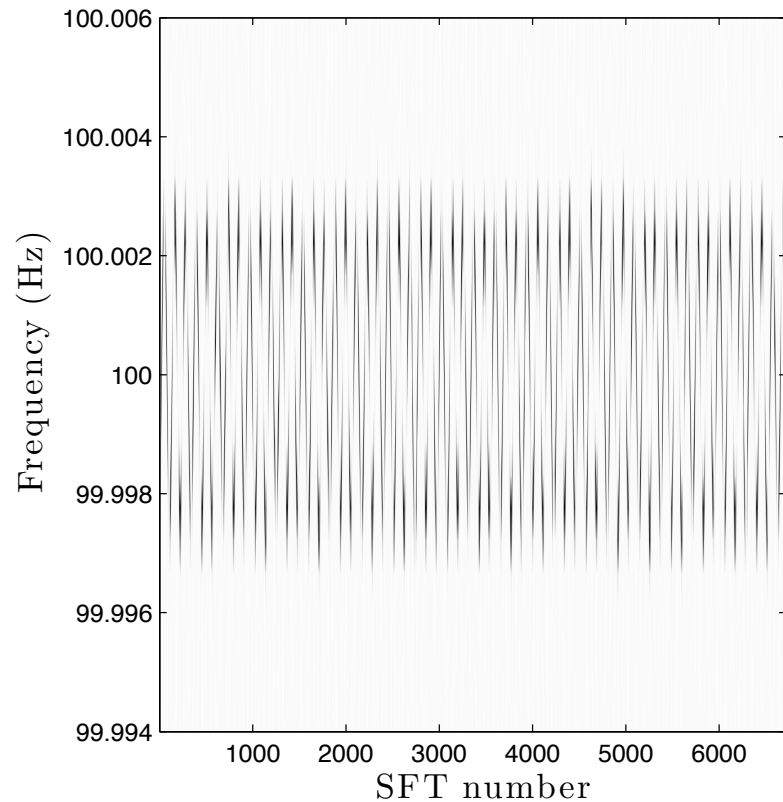
q = Companion mass/NS mass



Current continuous gravitational wave search strategies

- Targeted searches (Isolated or binary systems, mature)
- Directed searches:
 - Cas A (Isolated, mature)
 - Sco X-1 (Binary, S2 search and other methods approaching maturity)
- All-sky searches:
 - Einstein@home, PowerFlux (Isolated, mature)
 - TwoSpect (Binary, approaching maturity) and Polynomial (Binary, active development)

TwoSpect analysis method



Darkest pixels are pixels with power ≥ 0.5 * maximum power

Simulated signal results

