IWARA2020 Video Conference - 9th International Workshop on Astronomy and Relativistic Astrophysics

IWARA
From Quarks to Cosmos

Spotlight Plenary Talks

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Title:

Triaxially-deformed Freely-precessing Neutron Stars: Continuous electromagnetic and gravitational radiation

Abstract:

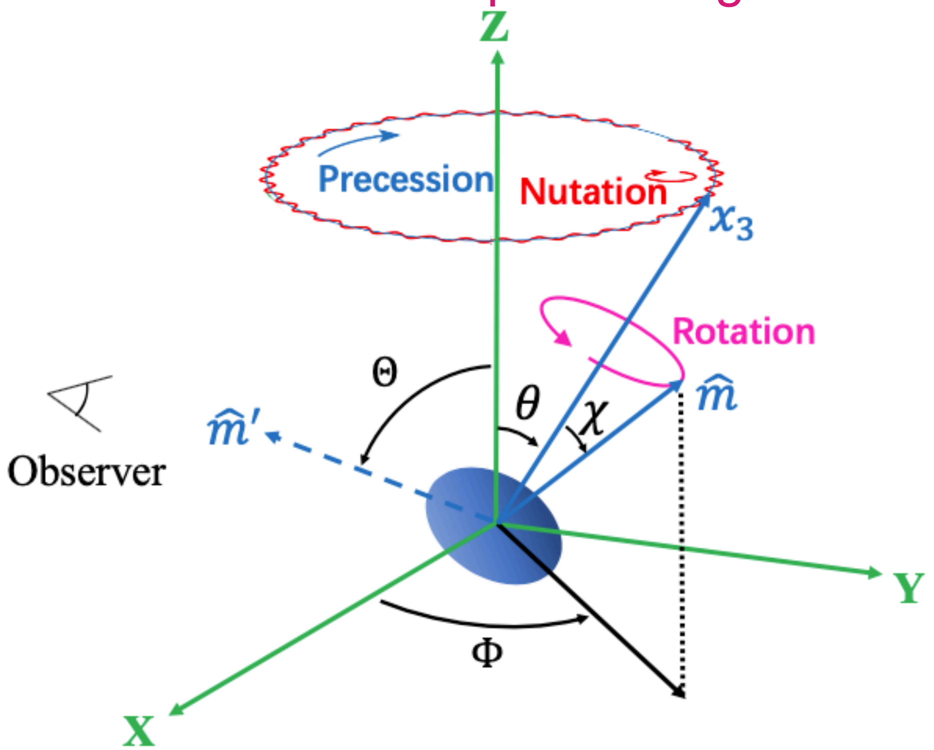
1. The free precession could manifest in (i) the spectra of continuous gravitational waves (GWs) in the kilohertz band, and (ii) the timing behavior and pulse-profile characteristics.

2. We extend previous work and investigate the free precession of a triaxially-deformed NS with analytical and numerical approaches. In particular, its associated continuous GWs and pulse signals are derived.

1. How does a triaxially-deformed freely-precessing NS moves?

2. What can be extracted from GWs and timing signals?

A triaxial and precessing NS



- Time evolution of configuration

1. Analytical solution with elliptic functions

2.Numerical solution using quaternions

- Parameterized description of NS

$\epsilon \equiv \frac{I_3 - I_1}{I_3}$ → **Oblateness**

$\delta \equiv \frac{I_2 - I_1}{I_3 - I_2}$ → **Nonaxisymmetry**

$\gamma \equiv \tan\theta_{\min}$ → **Wobble**

➢ **Modulated timing signals of pulsar:**

$$\Delta\Phi = F(\psi, \theta, \phi)$$

Phase residual = Function of NS configuration

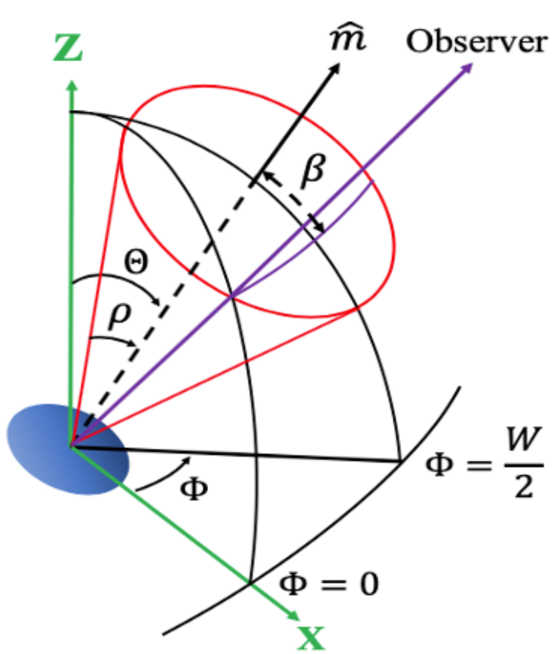
➢ **Modulated pulse profile:**

$$W = G(\Theta), \qquad \Theta = H(\psi, \theta, \phi, \chi, \iota)$$

Pulse width = Function of configuration, emission cone, line of sight

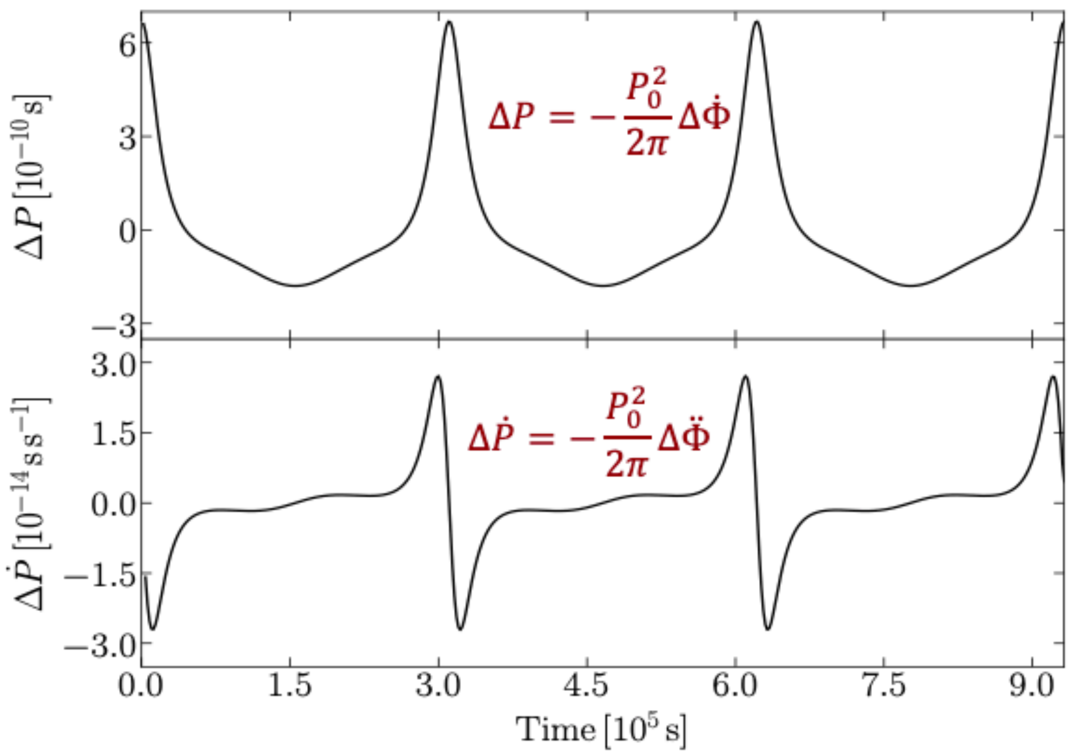
➢ **Quadrupole radiation of GW:**

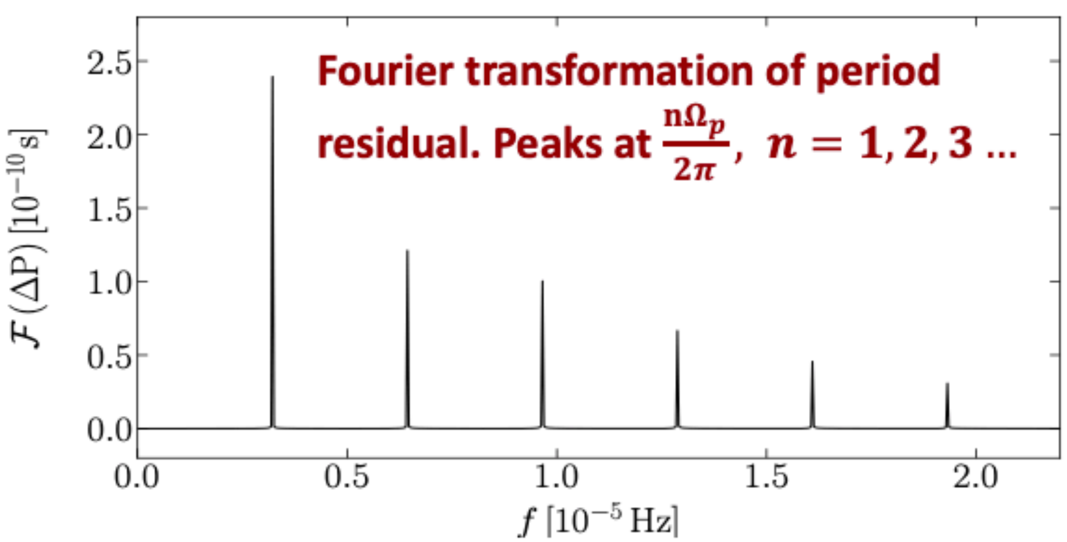
$$h_{ij}^{\mathrm{TT}} = \frac{2G}{c^4 r}\frac{\mathrm{d}^2 I_{ij}}{\mathrm{d}t^2} = -\frac{2G}{rc^4}\mathcal{R}_{ik}\mathcal{R}_{jl}A_{kl}$$

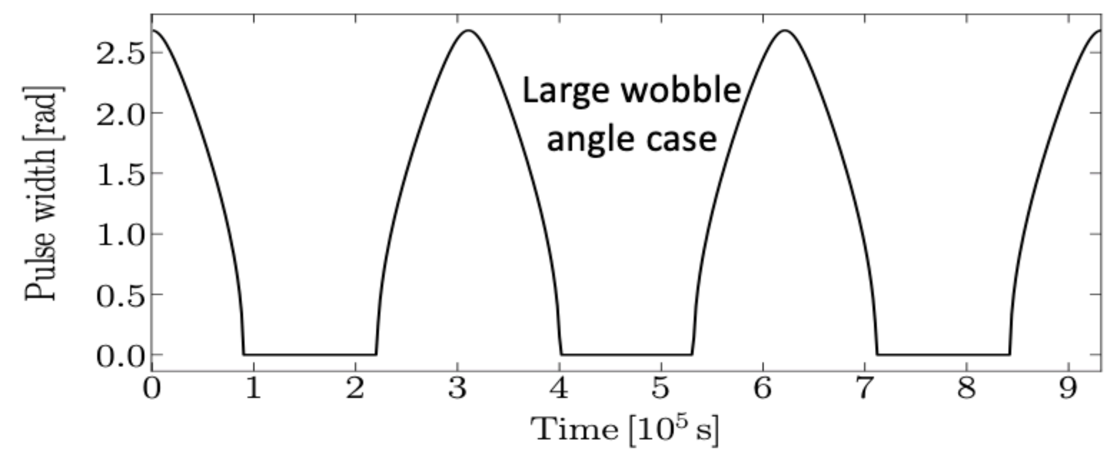


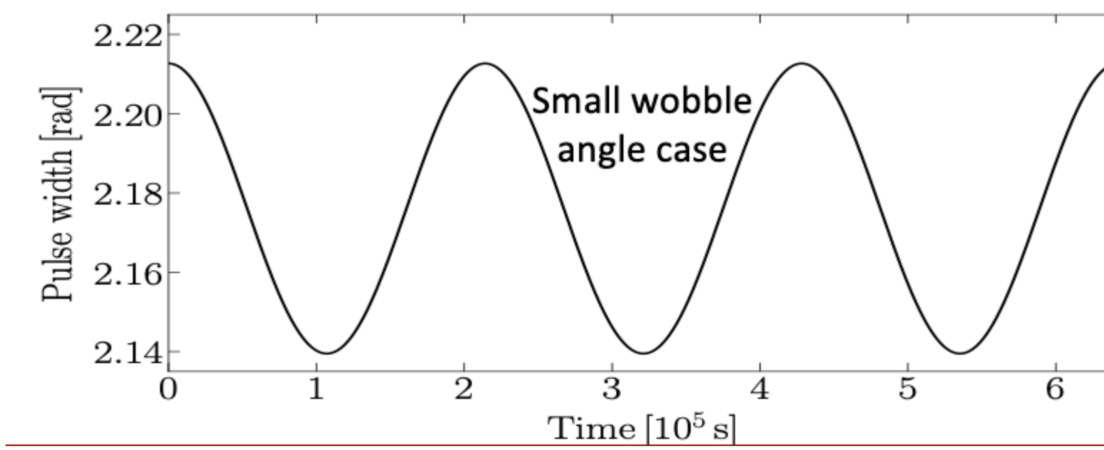
Electromagnetic radiation is confined in a emission cone with angular radius ρ

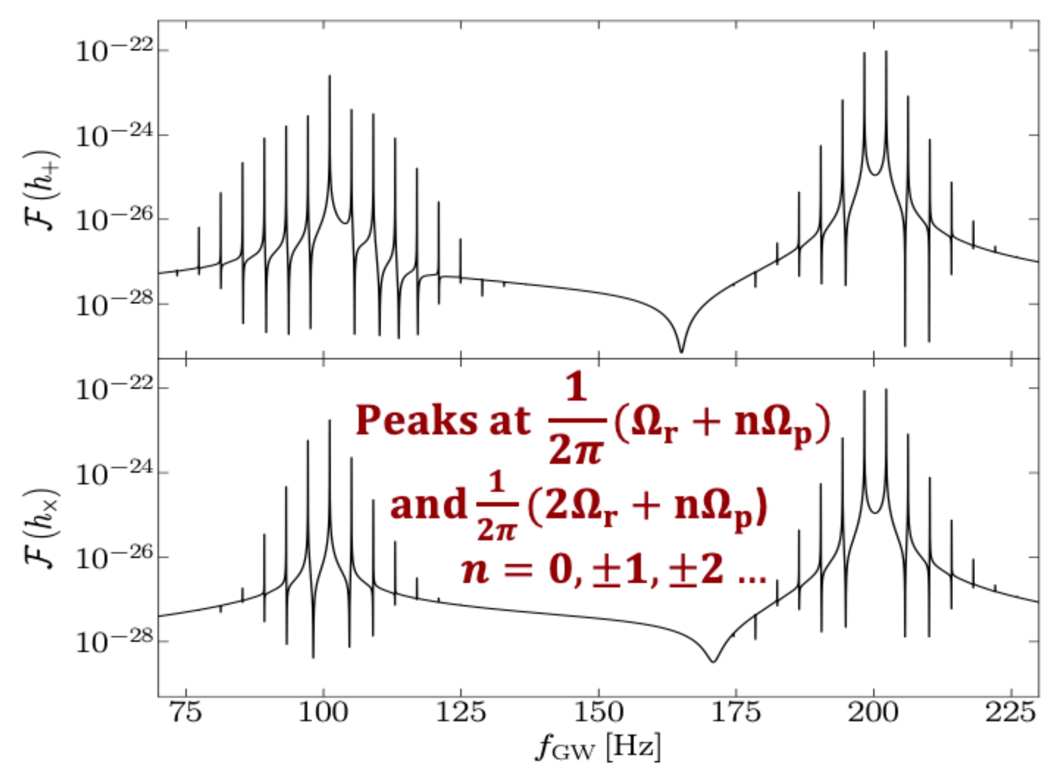
Conclusion: Radio/X-ray signals and continuous GWs from precession will provide valuable information on the structure of NS











Small wobble

$$\Delta P \approx \frac{P_0^2}{2\pi}\Omega_p\gamma(\delta+1)\cot\chi\cos\left(\Omega_p t\right) + \frac{P_0^2}{4\pi}\Omega_p\gamma^2\left(1+2\cot^2\chi\right)\cos\left(2\Omega_p t\right)$$