

# The gravitational wave signal from isolated objects

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**Abstract.** According to the theoretical study, a deformation object (e.g., a spinning non-axisymmetric pulsar star) will radiate a gravitational wave (GW) signal during an acceleration motion process by LIGO science project. These types of disturbance sources with a large bump or dimple on the equator would survive and be identifiable as GW sources. In this work, we aim to provide a method for exploring GW radiation from isolated neutron stars (NSs) with deformation state using some observational results, which can be confirmed by the next LIGO project. Combination with the properties in observation results (e.g., PSR J1748-2446, PSR 1828-11 and Cygnus X-1), based on a binary population synthesis (BPS) approach we give a numerical GW radiation under the assumption that NS should have non-axisymmetric and give the results of energy spectrum. We find that the GW luminosity of  $L_{GW}$  can be changed from about  $10^{40}$  erg/s–  $10^{55}$  erg/s.

**Keywords.** Gravitational waves, neutron star, evolution.

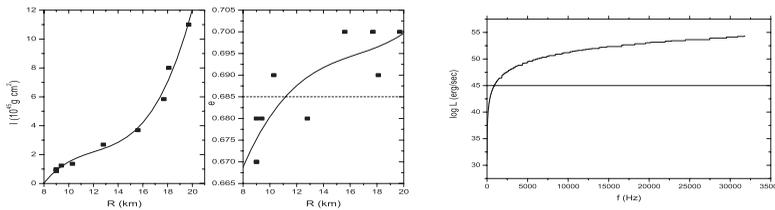
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## 1. Introduction

In Einsteins theory of general relativity, gravitational wave (GW) is considered as a phenomenon resulting from a space perturbation of the metric traveling at the speed of light, and the observation of the binary pulsar PSR 1913+16 has given an indirect evidence of GW radiation (e.g. Hulse & Taylor 1975). Nowadays, these ripples in space-time due to GW have still not been directly observed on the ground detectors. The various frequency ranges of the GW detectors can respectively fix different GW sources (Jaffe & Backer 2003; Belczynski, Kalogera & Bulik 2002; Liu 2009; Liu *et al.* 2010A; Liu *et al.* 2010B; Liu *et al.* 2012). Here, we focus on the other, much less studied groups of isolated neutron stars due to asymmetric mechanism, which can be divided into two groups according to the difference of GW radiation: I) the intrinsic asymmetry of NSs, II) the relative motion of the asymmetric part of NSs (e.g., Papaloizou & Pringle 1978). In this work, we aim to explore the GW radiation from group I. The three formation mechanisms in group I can be summarized as follows: i) a rotating NS with asymmetrical ellipsoid. (e.g., Hessels *et al.* 2006); ii) a oblique-dipole-rotator model (e.g., PRS1828-11); iii) the mass deformations due to an eccentricity in the equatorial plane of NS (the typical example is the low-mass X ray binaries: Cygnus X-1). The purpose of this poster is to study the GW radiation from an isolated object with asymmetric structure.

## 2. Computations

The GW luminosity  $L_{GW}$  and dimensionless strain  $h$  of a rigidity object with rotating process are predicted by Press & Thore (1972). The description of our physics parameters and assumptions are as follows: (I) In the single-star evolution code, we trace back to



**Figure 1.** Left: The fitting physical property curves of NS; Right: The spectral energy distribution of rapid rotating NS.

the formation of a NS from the zero-age main sequence to remnant stages. (II) We give the fitting curves of physical properties according to the NS dynamic structure model and equation of state in left panel of Fig. 1. (III) For the eccentricity  $e$ , we obtain it from uniform distribution in the range  $10^{-3}$  to  $10^{-11}$ . (IV) We present a Gaussian distribution of  $D$  from the GW sources to the earth in the Galaxy. In order to compare with observation, we download 109 NSs with rotation period less than 0.05s from the website (<http://www.atnf.csiro.au/research/pulsar/psrcat/>).

### 3. Results and Discussion

In general, the total energy ( $Mc^2$ ) of NS is about  $10^{54}$  erg, the rotation energy is  $10^{53}$  erg. Therefore, for the  $e > 10^{-5}$ , the most energy of NS can be radiation as GW signal during several years. All these calculations of isolated objects can examine that these sources are expected to be a type of GW sources. In our model, the influence parameter  $\xi$  of eccentricity can be changed to the influence of mass, which is  $2.8 \times 10^{-4} < \xi < 8.9 \times 10^{-9}$ , corresponding to the value of strain amplitude  $0.8 \times 10^{-24} < h < 10^{-32}$ . Our prediction agrees with that of Crab nebula and Virgo cluster ( $10^{-24} - 10^{-25}$ ). Meanwhile, the right panel of Fig. 1 gives the spectral energy distribution of rapid rotating NS and implies that the GW luminosity of  $L_{GW}$  can be changed from about  $10^{40}$  erg/s –  $10^{55}$  erg/s.

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