Short Intro to the Magnetar Model

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The general expression of axis gravitational wave in Astrophysical Models

$$\Omega_{gw}(\nu_o) = \frac{1}{c^2\rho_c}\nu_o \int \frac{\dot{\rho}}{H}\frac{dE_{gw}}{d\nu}(\nu)dz. \quad (1)$$

where c is the light speed, H is the hubble constant, $\nu = \nu_o(1+z)$ and ρ_c the critical temperature. For gravitional wave background progenitor that start emission shortly after birth, we can directly get even rate, $\dot{\rho}$, from the cosmic star formation rate in $M_{\Theta}M_{pc}^{-3}yr^{-1}$, $\rho_f(z)$:

$$\dot{\rho}(z) = \lambda\frac{\rho_f(z)}{1+z}. \quad (2)$$

λ is the mass fraction that converted into the progenitors and calculated locally by

$$\lambda = \frac{\dot{\rho}(0)}{\rho_f(0)} \quad (3)$$

in unite of M_{Θ}^{-1}.

Rotating neutron stars (NSs) with a triaxial shape may have a time varying quadrupole moment and hence radiate GWs at twice the rotational frequency. The total spectral gravitational energy emitted by a NS born with a rotational period P_0 between 1e-3s and 3e-3s, which decelerates through magnetic dipole torques and GW emission, is given by:

$$\frac{dE_{gw}}{d\nu} = K\nu^3\left(1+\frac{K}{\pi^2 I_z}\nu^2\right)^{-1} \quad with \;\; \nu_z \in [0-2/P_0], \quad (4)$$

where

$$K = \frac{192\pi^4 G I_z^3}{5c^2R^6}\frac{\varepsilon^2}{B^2}. \quad (5)$$

We take the average neutron star radius $R = 10$ km. I_z is the moment inertia in unit gcm^2. B is the super-strong crustal magnetic field formed by dynamo action between around 1e14G and 1e16G. And $G = 6.67259 \times 10^{-8}$ cm^{3}g^{-1}s^{-2} is the gravitional constant.