Search for GW from Vela pulsar in VSR2 data

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The F-statistic

(Maximum likelihood detection)

In general parameters of targeted pulsars h_o, ϕ_o, ψ, ι are unknown

$$s(t) = A_1 h_1(t) + A_2 h_2(t) + A_3 h_3(t) + A_4 h_4(t)$$

$$\mathcal{F} \cong \frac{2T_o}{S_0} \frac{B(\langle xh_1 \rangle^2 + \langle xh_3 \rangle^2) + A(\langle xh_2 \rangle^2 + \langle xh_4 \rangle^2) - 2C(\langle xh_1 \rangle \langle xh_2 \rangle + \langle xh_3 \rangle \langle xh_4 \rangle)}{D}$$

$$\langle g \rangle := \frac{1}{T_o} \int_0^{T_o} g(t)\, \mathrm{d}t$$

$$\mathcal{F} \geq \mathcal{F}_o$$

The G-statistic

For Vela parameters ψ, ι are estimated to a very high accuracy and only h_o and ϕ_o are unknown

VELA:

$$\psi = 130.63 \pm 0.05,$$

$$\iota = 63.6 \pm 0.6.$$

Maximize the likelihood function with respect to h_o and ϕ_o

$$s(t) = h_o \cos \phi_o h_c(t) + h_o \sin \phi_o h_s(t)$$

$$\mathcal{G} = \frac{T_o}{N S_o} \left(\langle x(t) h_c(t) \rangle^2 + \langle x(t) h_s(t) \rangle^2 \right)$$

$$\mathcal{G} \geq \mathcal{G}_o$$

UPPER LIMITS FOR THE GRAVITATIONAL WAVE SIGNAL FROM THE VELA PULSAR

We search for gravitational wave signal from the Vela pulsar in the VSR2 data with the most recent v3 callibration . We assume that the gravitational wave and electromagnetic phase track each other precisely thus we use the Vela pulsar ephemeris obtained from radio observations.   We perform two searches one using the **F-statistic** assuming that the parameters h_o (amplitude) , ϕ_o (phase), ψ (polarization angle) , ι (inclination) are unknown and the other using the **G-statistic** assuming that only h_o and ϕ_o are unknown (values of ψ and ι are taken from X-ray observations of Vela nebula). In data analysis we take into account non-stationarity of the data.

No significant sginal was discovered

Preliminary upper limits

TABLE I: Upper limits on GW signal from Vela pulsar from the VSR2 data. FA($\mathcal{F}$) and FA($\mathcal{G}$) are false alarm probability for the $\mathcal{F}$-statistic and the $\mathcal{G}$-statistic search, respectively, $\rho_{ul}^{\mathcal{F}95\%}$ and $\rho_{ul}^{\mathcal{G}95\%}$ are 95% confidence upper limits for signal-to-noise ratio in the two cases respectively, $h_{gul}^{\mathcal{F}95\%}$ and $h_{gul}^{g\mathcal{G}95\%}$ are upper limits for dimensionless amplitude h_0 assuming Gaussian distribution of the data for search with the two statistics, $h_{ul}^{\mathcal{F}95\%}$ and $h_{ul}^{\mathcal{G}95\%}$ are upper limits obtained from injections of simulated signals in the data. The factors $r_{sd}^{\mathcal{F}}$ and $r_{sd}^{\mathcal{G}}$ are ratios of the spin down limit for the Vela pulsar to upper limits on amplitudes for the $\mathcal{F}$-statistic and the $\mathcal{G}$-statistic search, respectively.

FA($\mathcal{F}$)	FA($\mathcal{G}$)	$\rho_{ul}^{\mathcal{F}95\%}$	$\rho_{ul}^{\mathcal{G}95\%}$	$h_{gul}^{\mathcal{F}95\%}$	$h_{gul}^{\mathcal{G}95\%}$	$h_{ul}^{\mathcal{F}95\%}$	$h_{ul}^{\mathcal{G}95\%}$	$r_{sd}^{\mathcal{F}}$	$r_{sd}^{\mathcal{G}}$
61%	38%	2.6	2.8	2.62×10^{-24}	1.91×10^{-24}	–	–	0.80	0.58