Answer on Question 55066, Physics / Astronomy | Astrophysics

Question:

For a 2ms pulsar where we can measure pulse times-of-arrival (TOAs) to a fractional precision of 10−3 of the pulsar period, estimate the frequency precision we can achieve over a 10-year span of data using pulsar timing.

Solution:

In general, the frequency f of any signal is just the derivative of its phase - with time: f = $d\phi/dt$. TOAs correspond to measurements of the pulse phase. In this case, we can make a fractional phase measurement $\Delta\phi = 10^{-3}$ over a timespan of 10 yrs ($\Delta t = 3.15\times10^{8}$ s). Therefore, the precision is:

$$f_{err} = \frac{\Delta\phi}{\Delta t} = \frac{1\times10^{-3}}{3.15\times10^{8}} \approx 3\times10^{18}\,Hz$$

Answer: $f_{err} = 3 \times 10^{18}$ Hz