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Have we seen all glitches?

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Abstract. Neutron star glitches are observed via artificially scheduled pulsar pulse arrival-time observations. The detection probability density of glitch events for a given data set is an essentially required knowledge for realizing glitch detectability with a specified observing system and schedule. In Yu & Liu (2017), the detection probability density was derived for the Yu et al. (2013) data set. In this proceeding, further discussions are presented.

Key words: pulsars: general – stars: neutron

Hundreds of pulsars have been observed at the Parkes Observatory over decades by a number of timing programmes. A search for pulse frequency glitches in a data set that contains 1911 yr of observations in total for 165 pulsars was done by Yu et al. (2013). The result is that 107 glitches were identified in 36 pulsars. For the Yu et al. (2013) data set, glitch identification depends on the observing cadences and the observed timing noise. Yu & Liu (2017) thus defined the complete probability formula of identifying glitch events (see Eq. 1 therein). They found that the derived detection probability densities for both the group and individual cases are not uniform; as the glitch becomes larger the density increases (see Figs. 5, 7 and 8 therein). The high-cadence observations of the Crab pulsar showed that the $\Delta\nu$ values of glitches are significantly larger than those of the timing noise (Espinoza et al., 2014). This implies that the cadences with which the Yu et al. (2013) pulsars were observed were not adequate to observe all occurred glitches.

In Fig. 1, the average pulse time-of-arrival (ToA) interval for each of the 165 pulsars is plotted on the $P-\dot{P}$ diagram. For the non-glitching pulsars, the averages range between 10.4 d for PSR J1359−6038 and 798.7 d for PSR J1047−6709; most averages are a few tens of days. For the glitching pulsars, the averages range between 8.3 d for the Vela pulsar and 240.6 d for PSR J1740−3015. For PSR J1740−3015, the low observing cadences result in the unidentification of thirteen glitches in the Yu et al. (2013) data. PSR J1341−6220 which shows seventeen glitches was on average observed every 23.5 d. Figure 2 shows the ToA interval modulation index of the average over the intervals' standard deviation for each pulsar. For the non-glitching pulsars, the indices range between 0.08 for PSR J1456−6843 and 1.20 for PSR J1721−3532. For the glitching pulsars, the indices range between 0.06 for PSR J1105−6107 and 1.12 for PSR J1531−5610, while PSR J1341−6220 has 0.73. In Fig. 3, the amplitude of the power spectral density of the observed timing noise is shown. PSR J1341−6220 has the maximum amplitude in the sample. In general, young pulsars show large timing noise while timing noise does not seem to correlate with the magnetic field.

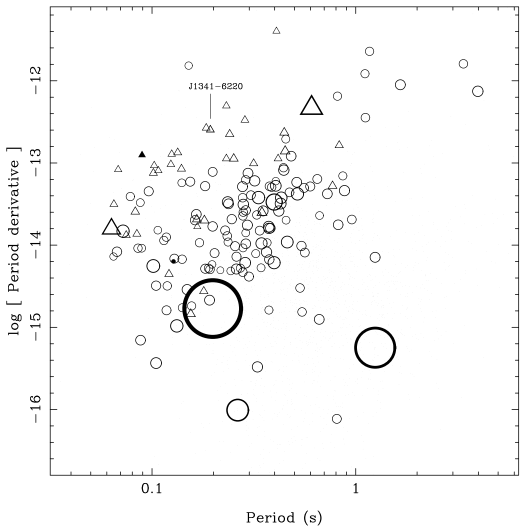

Figure 1. Average ToA intervals on the $P-\dot{P}$ diagram. Circles indicate the non-glitching pulsars, triangles indicate the glitching pulsars. Minima are shown by solid symbols. The symbol size is a linear function of the value with positive slope.

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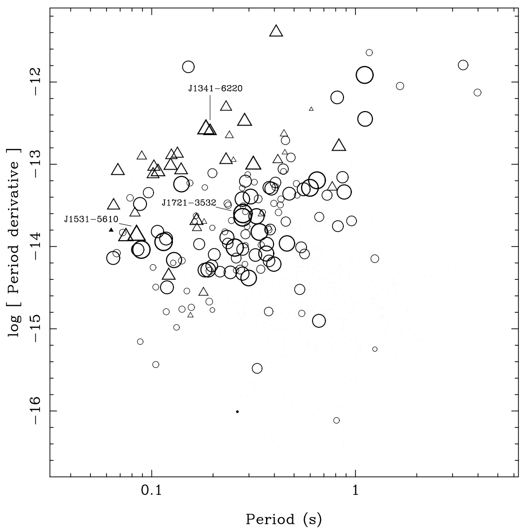

Figure 2. ToA interval modulation index on the $P-\dot{P}$ diagram. Circles indicate the non-glitching pulsars, triangles indicate the glitching pulsars. Minima are shown by solid symbols. The symbol size is a linear function of the value with positive slope.

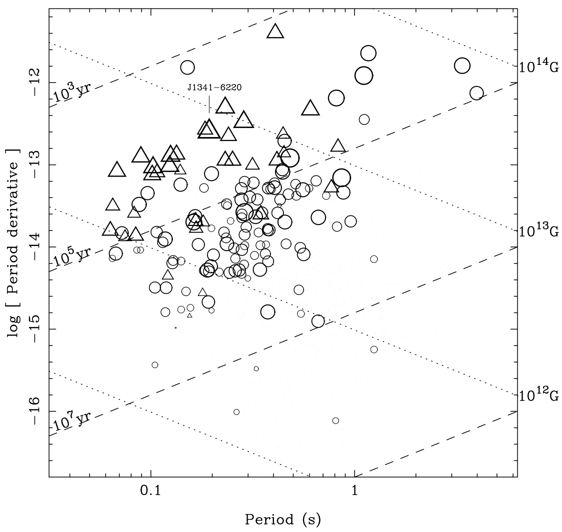

Figure 3. Amplitude of power spectral density of the observed timing noise on the $P-\dot{P}$ diagram. Circles indicate the non-glitching pulsars, triangles indicate the glitching pulsars. The symbol size is a linear function of the value with positive slope.