The apparent decay of pulsars magnetic fields

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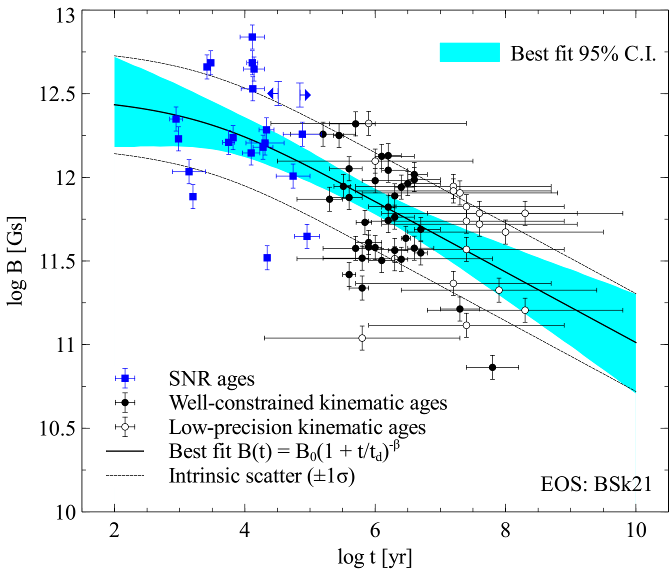

Figure 1: Apparent evolution of magnetic fields of 76 isolated radiopulsars.

The semi-numerical spindown law of a normal radiopulsar with realistic plasma-filled magnetosphere has been derived recently (starting from [1]). According to it, the spin-down luminosity depends on the magnetic obliquity relatively weakly, and thus it allows to observationally constrain the surface field strength B of a neutron star within a quite narrow interval using its timing properties only.

We accurately reviewed all sources of uncertainty related to directly unmeasurable parameters arising in this spindown law, such as neutron star mass (radius, moment of inertia), obliquity etc, and derived the modified timing-based estimator of the pulsar magnetic field strength, which is quite accurate and allows to explicitly estimate its uncertainty.

Using the representative subset of modern theoretical equations of state for dense matter, we demonstrate that the magnetic field strength may be estimated with accuracy up to 10-20%, and discuss how the possible timing irregularities may influence it (see [2] for details).

We applied this estimator to probe in a statistically and physically correct way the evolution of magnetic field during pulsar's lifetime. To do it, we used the ages of supernova remnants (SNRs) associated with young pulsars, along with kinematic ages of older pulsars, for 76 objects in total (see the Figure 1). We found a significant trend $B(t) \propto t^{-\beta}$ with $\beta = 0.21 \pm 0.04$. We discuss the astrophysical implications of this result taking into account the effects of observational selection.

References

[1] A. Spitkovsky, *ApJ* 648, L51 (2006)

[2] A. Biryukov, A. Astashenok & G. Beskin, *MNRAS* 466, 4320 (2017)

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