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Why do the braking indices of pulsars span a range of more than 100 millions?

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Here we report that the observed braking indices of the 366 pulsars in the sample of Hobbs et al. range from about -10ˆ8 to about +10ˆ8 and are significantly correlated with their characteristic ages. Using the model of magnetic field evolution we developed previously based on the same data, we derived an analytical expression for the braking index, which agrees with all the observed statistical properties of the braking indices of the pulsars in the sample of Hobbs et al. Our model is, however, incompatible with the previous interpretation that magnetic field growth is responsible for the small values of braking indices (<3) observed for "baby" pulsars with characteristic ages of less than 2x10ˆ3 yr. We find that the "instantaneous" braking index of a pulsar may be different from the "averaged" braking index obtained from fitting the data over a certain time span. The close match between our model-predicted "instantaneous" braking indices and the observed "averaged" braking indices suggests that the time spans used previously are usually smaller than or comparable to their magnetic field oscillation periods. Our model can be tested with the existing data, by calculating the braking index as a function of the time span for each pulsar. In doing so, one can obtain for each pulsar all the parameters in our magnetic field evolution model, and may be able to improve the sensitivity of using pulsars to detect gravitational waves.

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