

## Velocity-Magnetic Field Correlation of Pulsars

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### 1. Introduction and Summary

Monte Carlo simulations of the evolution of pulsars are carried out in order to compare with the recent measurement of the pulsar transverse velocity by Lyne & Lorimer (1994). The new electron density distribution model of Taylor & Cordes (1993) is adopted in the simulation. Accurate pulsar orbits in the Galactic gravitational field are calculated. It is found that the constant magnetic field model of pulsars can account for the new measurement of the pulsar transverse velocity and the apparent correlation between the strength of the magnetic field and the transverse velocity of the pulsars. The present finding confirms the validity of the constant magnetic field model of pulsars and consolidates the idea that the apparent correlation between the strength of the magnetic field and the transverse velocity of the pulsars is caused by observational selection effects.

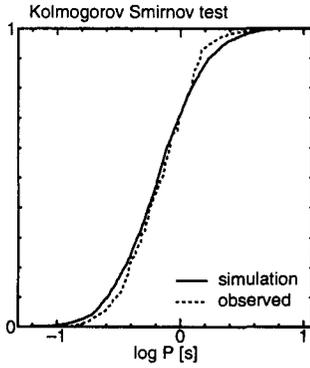
### 2. Simulation Results

We show an example of the simulation. We adopt the following parameters:  $\bar{P}_0 = 10^{-1}$  s,  $\sigma_u = 0.18$ ,  $\bar{Q}_0 = 10^{-6.85}$  s $^{\frac{1}{2}}$ ,  $\sigma_w = 0.45$ ,  $\alpha_i = -2.28$ ,  $\beta_i = \frac{2.28}{3}$ ,  $\gamma_i = 11.64$ ,  $\sigma_\lambda = 0.8$ ,  $\bar{s} = 10^{2.60}$  km s $^{-1}$ ,  $\sigma_s = 0.45$   $r_b = 7.92 \times 10^{-3}$  yr $^{-1}$ . The value of  $\bar{Q}_0$  corresponds to  $B = 3.2 \times 10^{12}$  G. The Kolmogorov diagrams for  $\log P$ ,  $\log \dot{P}$ ,  $\log L_r$ , and  $\log V_t$  are shown.

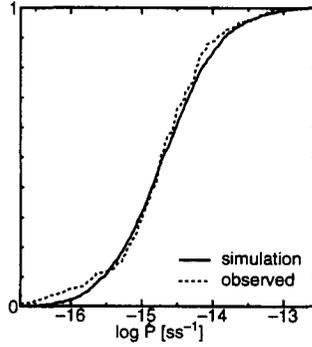
The correlation diagrams for the transverse velocity and the strength of the magnetic field are shown. The simulation automatically reproduces the observed correlation. The apparent correlation is caused by the lack of old high-velocity pulsars which are generally distant from us and difficult to observe.

### References

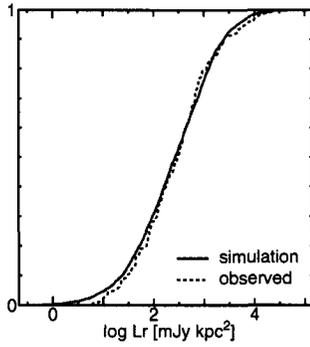
- Itoh, N., & Hiraki, K. 1994, *ApJ*, 435, 784  
Itoh, N., Kotouda, T., & Hiraki, K. 1995, *ApJ*  
Lyne, A. G., & Lorimer, D. R. 1994, *Nature*, 369, 127  
Taylor, J. H., & Cordes, J. M. 1993, *ApJ*, 411, 674  
Wakatsuki, S., Hikita, A., Sato, N., & Itoh, N. 1992, *ApJ*, 392, 628



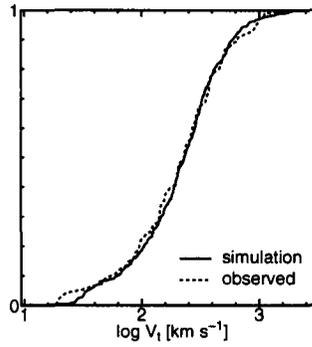
probability = 39.6 ! s



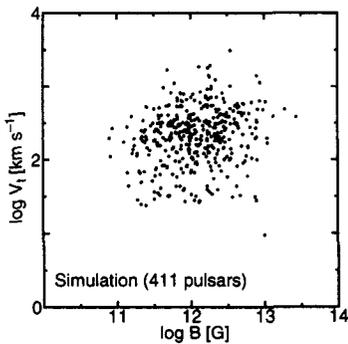
probability = 66.6 ! s



probability = 69.2 ! s

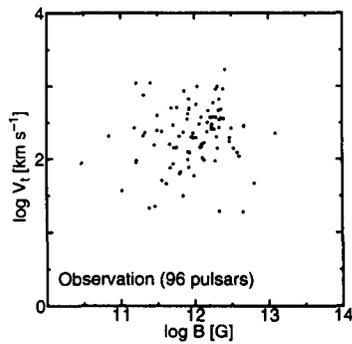


probability = 93.6 ! s



Simulation (411 pulsars)

Spearman's rank-order correlation coefficient  $r_s = 0.181$



Observation (96 pulsars)

Spearman's rank-order correlation coefficient  $r_s = 0.171$