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A hybrid model for pulsar evolution

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The combined effects of both the standard magnetic dipole model and the composite neutron superfluid vortex model on the energy loss rate of neutron stars and pulsar spin down are simultaneously taken into account to study the evolution of neutron stars on the P-Pdot diagram. The evolution path of each neutron star is dictated by a particular mechanism in our hybrid model in different parameter spaces and the valley of each curve is the most possible place for a neutron star to be observed since this is the place which corresponds to the minimum value of the evolution speed (i.e. the time derivative Pdot). In other words, pulsars would distribute around these valleys on the P-Pdot diagram. The combined model can be fitted very well with observation to yield the interesting results:(1) the suppressed region in the lower-right part of the diagram can be explained by neutrino cyclotron emission from the 1S0 neutron superfluid vortexes in neutron stars. (2) All radio pulsars that were identified with super strong magnetic fields with field strength beyond the critical quantum magnetic field before are now all lying inside the critical magnetic field line in our model. (3) The peak of neutron star magnetic fields (logB) distribution revels a gaussian distribution in our model whereas the statistics of the simple magnetic dipole model results in a distribution with non-symmetrical peak.

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