MONTE CARLO SIMULATIONS OF RADIO PULSARS AND THEIR PROGENITORS

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ABSTRACT. The formation of neutron stars in binary systems is often used to explain the nature of specific radio pulsars and characteristics of the pulsar population as a whole. We have investigated the extent to which such scenarios provide a self-consistent description of the pulsar population. Using a computer simulation, we modeled the evolution of the main sequence stellar population and compared the predicted neutron star population to the observed radio pulsar population, focusing our attention on the pulsar velocity distribution and the incidence of binary pulsars. These characteristics relate very directly to the binary nature of pulsar progenitors, and are not strongly dependent on models of pulsar magentic field and luminosity evolution.

The need to reproduce both the high velocities typical of pulsars and the low incidence of binary pulsars strongly constrains the formation of pulsars in binary systems. Unless one assumes that virtually all pulsars originate in close binary systems, the observed velocity distribution cannot result from the disruption of binary systems by symmetric supernova explosions; some additional acceleration process (e.g. asymmetric supernova mass ejection or asymmetries in pulsar radiation) must act during or soon after a pulsar's formation. It is possible to reproduce the velocity distribution by assuming that all pulsars are born in binary systems with initial orbital periods less than about 30 years. However, the predicted incidence of binaries is then too large by more than an order of magnitude, unless one also assumes that the process of mass transfer from the primary to the secondary is almost always nonconservative, or that the minimum mass necessary for a stripped helium core to explode as a supernova is larger (over $4\,M_{\odot}$) than currently believed. Further analyses of the radio pulsar population, the X-ray binary population and the abundances of elements ejected in supernovae should help determine which of these alternatives is most reasonble. Additional studies of the main sequence stellar population, accounting more accurately for evolutionary and observational selection effects, will reduce the uncertainties in modeling the formation of the neutron star population.

It has also been suggested that the observed correlation between pulsar velocities and magnetic moments (see Cordes, these Proceedings) is induced by the differing evolutionary paths by which stars in binary systems form radio pulsars. Our simulation does not reproduce this correlation, and we do not find any paths likely to produce low velocity, low magnetic field neutron stars not in binary systems.

We are submitting a full description of our model and results to *The Astrophysical Journal*.

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