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ON THE PERIOD CHANGES OF PULSARS

For the pulsar NP 0527 it has been suggested that it was ejected from the Crab nebula in the supernova explosion in A.D. 1054, since its 1°2 angular separation from the Crab pulsar NP 0532 is small in comparison with the average density of pulsars, and the dispersion measures of these two pulsars differ by only 10 % (E.C. Reifenstein, III, W.D. Brundage, D.H. Staelin, Phys. Rev. Let. 22, 311, 1969). This hypothesis implies that the tangential velocity of NP 0527 is about 0.15c = 45000 km/sec, corresponding to an annual proper motion of 4"8. In a blink search for a high velocity star around the position of NP 0527 A.J. Perry (IBVS 347) found no such object down to about 18.5 magn.

But the high velocity of NP 0527 can be tested in another way. Even, when an object has a constant space velocity, its radial velocity is changing at a yearly rate of v^2t/r, where v denotes the tangential velocity of the object in km/sec, t the number of seconds in a year, and r the distance of the object in km. This change in radial velocity gives rise to an apparent period change of $\Delta P = v^2tP/rc$ per year. For an object with $v = 0.15c$ at the distance of the Crab nebula (2000 ps) and having the period of NP 0527 (3^{s}745), the period change would be 12700 nsec/year. This is a figure 2-3 orders of magnitude higher than those obtained for the period changes of other pulsars (s. Table below), with the exception of NP 0532 and PSR 0833 - 45 for which the observed period changes amount roughly to the same value. Therefore, if NP 0527 was ejected from the Crab nebula in the supernova explosion in A.D.1054, it should show a comparatively rapid period increase.

The above mentioned effect always works in the same direction: it causes an increase of the period. Therefore, the observation that pulsar periods are (with only one anomalous temporary exception of PSR 0833-45, s. IAU Circ 2140) continuously increasing, does not necessarily indicate in all cases a real physical change, so much the more as there are some indications that pulsars were thrown out at high speeds in supernova explosions (G.Burbidge, F.Hoyle, Nature 221, 847). I have calculated the tangential velocities and the corresponding annual proper motions which are necessary to give the observed period changes for 6 pulsars as consequences of the changes in radial velocity. In the Table P is the observed period, ΔP the observed period change, r the distance in parsecs estimated from the dispersion measure (Nature, 222, June 7, 1969) and v the calculated tangential velocity. The calculated velocities are one order of magnitude lower than the value attributed to NPØ 0527.

Pulsar	P sec	P nsec.y^{-1}	r ps	v km sec^{-1}	Annual proper motion
CP 0328	0,715	60	430	3500	1″5
CP 0834	1,274	124	390	3300	1,8
CP 0950	0,253	37	60	1600	5,6
CP 1133	1,188	109	130	1900	3,0
HP 1506	0,740	167	>600	>6300	-
CP 1919	1,337	26	230	1150	1,0

Though the period changes of NPØ 0532 and PSR 0833-45 might be intrinsic (if not caused by a variation of integrated electron content along the line of sight, particularly in the vicinity of the source), it is premature to draw inferences for the evolution of pulsars from the observed period changes.

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