ON THE LONG TERM STABILITY OF NEUTRON STAR MAGNETIC FIELDS

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It is known that fluid object that it magnetized with a purely poloidal field is unstable to perturbations that overturn the field lines in one hemisphere relative to those in the other. We have shown that this instability occurs even when the entire object is encased by a solid crust, as conjectured by Flowers and Ruderman (FR) nearly a decade ago. We have derived the exact dispersion relation that displays this instability for an infinite, cylindrical geometry, which will be published elsewhere. The timescale for the instability is roughly the ohmic dissipation timescale of the crust.

We suggest that accreting neutron stars in the galactic bulge, which mostly display no periodicity, are distinguished from those in the disk, which mostly do, in that they are old enough for the instability to have occurred in them. Because the instability is likely to destroy almost all of the magnetic dipole moment of the neutron star, the older population of accreting neutron stars is not expected to funnel the accretion flow onto polar caps, and the periodic component of emission sources. Similarly, the death of pulsars after $\sim 10^7$ yr., which is implied by pulsar demographics, could also be accounted for by this instability, as originally suggested by FR.

Invoking field line overturning, rather than decay of a purely crustal field, allows old neutron stars to have magnetospheres, which have been invoked to explain rapid bursting and quasi-periodic oscillations, and which are implied by cyclotron features in gamma ray bursts. The recent dating of the millisecond pulsar via its white dwarf companion establishes that old neutron stars can have surface fields of order 10^9 gauss, which is enough to funnel Eddington accretion into polar caps if it is in purely dipolar form.

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