Crystalline Structure Size in Neutron Stars*

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We investigate the size of the objects forming a crystal lattice in the mixed phase of confined and reconfined matter in neutron stars whose presence was predicted in [1]. The objects take various forms according to the pressure and therefore the location in the star. We idealize the geometry of the objects as droplets, rods and slabs. As the spacing between droplets decreases, they merge to form rods, and the rods to form slabs.

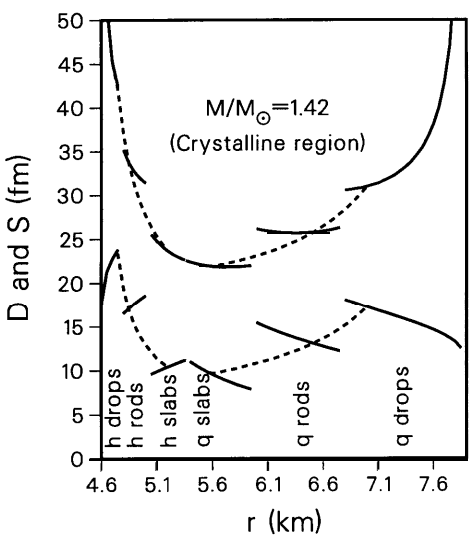

Figure 1: Crystalline mixed region in a neutron star showing the diameter D (lower curves) and spacing S (upper curves) of indicated geometric structures as a function of radial Schwarzschild coordinate. Region internal to 4.6 km is pure quark matter. Notation 'h drops' denotes hadronic drops immersed in quark matter, and so on. Stellar radius is 10.7 km. Dashed line is continuous dimensionality interpolation

In Fig.1 we show the diameter of the geometrical objects as a function of radial location in a star, identify their forms and plot the spacing between centers of the rare phase objects immersed in the other phase. The pressure at the center and extending to 4.6 km is sufficiently high that this region is occupied by pure quark matter. The region between 4.6 and 7.8 km is in the crystalline confined-deconfined phase. Since the phase transition is completed before the center of the star is reached, the geometrical structures span the full range of forms. At the outer edge of the mixed phase region, quark drops of *finite* diameter are spaced, in the limit of no quark matter, at infinite distance. At greater depth and therefore proportion of quark matter the drops are more closely spaced and slightly larger in size. Deeper in the star, drops are no longer the favored configuration and merge to form rods of varying diameter

It is almost certain that solid regions in a pulsar will play a role in the period glitch phenomenon, whether associated with cracking of the solid as in star quakes, or with unpinning of superfluid vortices from solid regions. Glitch behavior is highly individualistic from one pulsar to another. We tentatively suggest that this may be due to the extreme sensitivity on stellar mass of the radial extent of the solid crystal region and the forms that occupy it as well as the moments of inertia associated with different gaseous (quark), liquid and solid regions. The interior solid region of the mixed phase and the crustal solid, separated by a nuclear liquid, offer interesting possibilities for interaction or stimulated response at the time of a glitch originating in one of them and in post-glitch recovery.

* N. K. Glendenning and S. Pei, Phys. Rev. *C* **52** (1995) 2250.

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[1] N. K. Glendenning, Phys. Rev. D, **46** (1992) 1274.