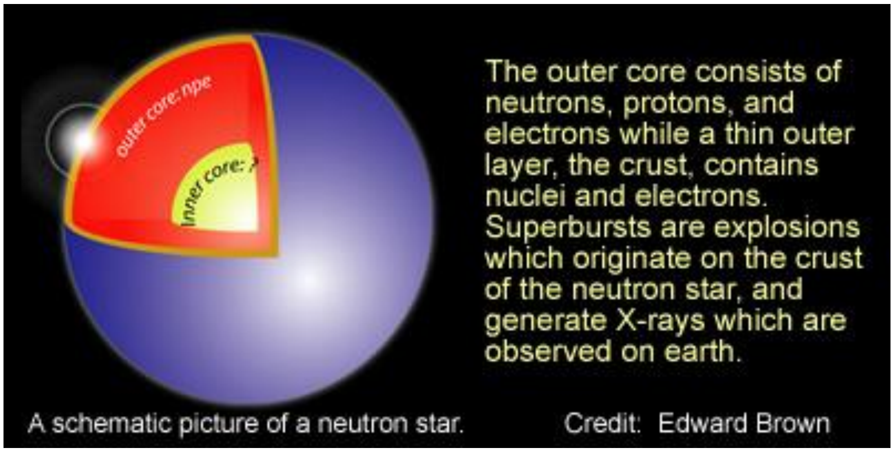
Possible Resonances in the ^{12}C + ^{12}C Fusion Rate and Superburst Ignition



Superbursts are powerful thermonuclear explosions on the surface of an accreting neutron star. Superbursts emit thousands of times more energy than normal Type-I X-ray bursts, and last hours instead of minutes. While normal X-ray bursts are fueled by the fusion of Hydrogen and Helium, superbursts are thought to be fueled by the fusion of Carbon. Carbon is more difficult to fuse, because of the larger number of protons, and thus superbursts likely originate at a deeper point in the crust, where the higher density facilitates the fusion reaction.

Current theoretical models of the neutron star crust imply that the crust is too cold to fuse carbon and create the observed superburst explosion. Randy Cooper (UCSB), Andrew Steiner (MSU) and Edward Brown (MSU) have proposed a solution to this difficulty. They examined other possible mechanisms to ignite superbursts such as unstable electron captures and other light-element fusion reactions and found that none of them were sufficient to generate superbursts. They then proceeded to show that a resonance, a strong enhancement in the fusion rate at a particular value of the collision energy, could allow carbon ignition at lower temperatures and potentially answer the question of how colder neutron star crusts are still able to generate the observed superbursts. Experimental data on the fusion rate of carbon at the energies which are relevant for superburst ignition cannot yet rule out a strong resonance. Future measurements of the carbon fusion cross section may demonstrate that Cooper, Steiner, and Brown's model is correct, and that an unobserved resonance in the Carbon fusion cross section helps ignite superbursts.

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