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Séminaire de Physique Nucléaire Théorique

Macroscopic quantum phenomena in the inner crust of neutron stars and their implications for observations.

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In this talk, I describe basic macroscopic quantum phenomena that occur in the inner crust of neutron stars, when the matter has cooled down mostly due to neutrino emission processes. At these conditions, the plasma crystallizes, and baryons form coherent pairs, which then experience Bose-Einstein con- densation. Due to a competition between the nuclear surface forces and the Coulomb forces from the protons, the crystallized plasma is expected to be a lower-dimensional crystal in its ground state in a range of densities around a half of the saturation density of symmetric nuclear matter (”spaghetti” for one-dimensional and ”lasagna” for two-dimensional). This regime of nuclear matter (the ”pasta” phase) is poorly explored, although it is crucial for physics at the crust-core boundary, especially in models of evolution of the magnetic field that link observations with the nuclear physics. Early works have ad- dressed superfluidity of only neutrons, leaving aside the proton pairing inside the nuclear clusters. Here, I focus on the effects of superfluidity of protons in the pasta phase that may have far-reaching consequences for observable properties of neutron stars.

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