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Nuclear pairing from microscopic forces: singlet channels and higher-partial waves

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Background: An accurate description of nuclear pairing gaps is extremely important for understanding static and dynamic properties of the inner crusts of neutron stars and to explain their cooling process.

Purpose: We plan to study the behaviour of the pairing gaps as a function of the Fermi momentum for neutron and nuclear matter in all relevant angular momentum channels where superfluidity is believed to naturally emerge. The calculations will employ realistic chiral nucleon-nucleon potentials with the inclusion of three-body forces and self-energy effects.

Method: The superfluid states of neutron and nuclear matter are studied by solving the BCS gap equation for chiral nuclear potentials using the method suggested by Khodel, where the original gap equation is replaced by a coupled set of equations for the dimensionless gap function and a non-linear algebraic equation for the gap magnitude at the Fermi surface.

Results: We have successfully applied Khodel's method to singlet (S) and coupled channel (SD and PF) cases in neutron and nuclear matter. Our calculations nicely agree with other ab-initio approaches, where available, and provide crucial inputs for applications in superfluid systems, i.e. the cooling process of Cassiopeia A.

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