# Superfluid properties of dilute neutron matter

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Dilute neutron matter is one of the simplest many-body nuclear systems. At sufficiently small densities, corresponding to $k_F \lesssim 0.6$ fm$^{-1}$, its properties originate from the two-body $s$-wave interaction only. It is known that dilute neutron matter becomes superfluid at low temperatures. The superfluid properties have been a subject of many studies over the years, with quite different results. In particular, the value of the $^1S_0$ superfluid energy gap at zero temperature is at present not well established and strongly depends on the solution method [1]. Except predictions of BCS theory evolution of the energy gap as a function of temperature as well as the critical temperature of phase transition are almost unknown.

From the theoretical point of view, pure and dilute neutron matter is a fascinating system since at a certain density range it becomes a nearly-universal Fermi gas. Such systems are presently of great interest as a result of an extraordinary progress in the field of cold atoms which have taken place over the last few years [2]. Taking advantage of the Feshbach resonances experimentalists can mimic the properties of dilute neutron matter, giving nearly direct constraints on its properties. It gives opportunity to gain reliable insight into physics of superfluid state, which can be tested directly by ultra cold atoms experiments [3].

I will present results of fully non-perturbative, Path Integral Monte Carlo calculations for dilute neutron matter. In particular evolution of the energy gap as a function of temperature and the critical temperature of phase transition will be presented. I will show also that our results do not indicate the presence of qualitative changes in comparison to the case of strongly interacting atomic gases [4].

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[3] J.T. Stewart, J.P. Gaebler, and D.S. Jin, Nature **454**, 744 (2008); J.P. Gaebler *et al.*, arXiv:1003.1147v1.

[4] G. Wlazłowski, P. Magierski, arXiv:0912.0373v1.