Abstract for an Invited Paper
for the MAR10 Meeting of
The American Physical Society

What do we know about the unitary Fermi gas?

AUREL BULGAC, University of Washington

A little more than ten years ago George Bertsch realized that the system of spin-1/2 fermions interacting with a zero range and infinite scattering is a nontrivial problem, in spite and also because of the absence of any dimensional scales, apart from the separation among particles. While it was clear at that time that this rather abstract problem has some relevance to the physics of neutron stars, soon it became evident that this is problem of much larger interest, in particular for cold fermionic atoms in traps. While there were many attempts over the years to elucidate the properties of this system using analytical methods, various approximate many-body techniques but so far solutions with a controlled accuracy failed to be produced. Quantum Monte Carlo (QMC) methods however have been particularly successful and they serve as the reference for experimentalists and theorists alike. With QMC methods applied either at zero or finite temperature a large number of properties of the Fermi gas in the unitary regime have been elucidated. This system proved to be a somewhat unique quantum superfluid: it has the largest critical temperature and pairing gap (in appropriate units) known; it has the largest critical velocity. It has been also possible to use QMC techniques in conjunction with Density Functional Theory to show that many other exotic phases are extremely likely to be realized in these systems: the Fulde-Ferrell-Larkin-Ovchinnikov and induced p-wave pairing. In the latest turn of events it was shown that this system demonstrates the existence of the pseudogap phenomenon as well, a property shared with high temperature superconductors.