Strongly interacting Fermi gases

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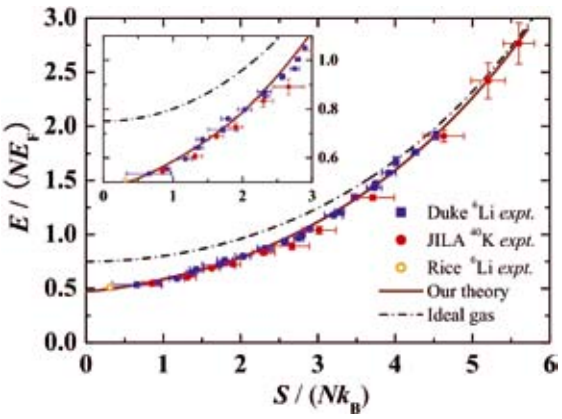
Great progress was achieved in this very exciting field in 2007, including ACQAO's first publication in Nature Physics[1], the highest impact-factor primary research physics journal. Highlights, including three high-impact journal papers, are as follows:

First evidence of fermionic universality

A detailed comparison of theory and experiment on universal fermion thermodynamics in strongly interacting, ultra-cold Fermi gases was published in Nature Physics[1].



Measurements have confirmed a theoretical prediction published in 2006: all strongly interacting Fermi gases were predicted to show identical thermodynamic behaviour. Late in 2006, detailed experimental data became available for the first time, for different fermions under different conditions. All the new data lies on a single universal curve, exactly as we predicted. This is an outstanding discovery, showing the way to a new kind of strong-interaction physics of extreme simplicity and wide applications in other physics disciplines.

Polarized Fermi gases

Three papers in this rapidly moving new field were published, including one in the high impact Phys. Rev. Letts journal. The complete phase diagram[2] and detailed proposal for observing the exotic FFLO[3] states fora polarized 1D Fermi gas, was published, using exact solutions. Polarized Fermi gases are being experimentally studied in several laboratories.Experiments at Rice University are now underway. A mean field study for the three-dimensional phase diagram[4] was also published.

Vortices in Fermi gases

Two studies of vortices in Fermi gases were published. These are an important benchmark of superfluid behaviour, and are readily observable in experiments. One paper calculated the density profile for giant vortices[5] , the other, published in Phys. Rev. Letts., showed the existence of unique bound-states in the cores of vortices produced in polarized, strongly interacting Fermi gases[6].

References

[1] H. Hu, P.D. Drummond, and X.-J. Liu, Nature Physics **3** , 469 (2007).
[2] H. Hu, X.-J. Liu, and P.D. Drummond, Phys. Rev. Lett. **98** , 070403 (2007).
[3] X.-J. Liu, H. Hu, and P.D. Drummond, Phys. Rev. A **76**, 043605 (2007).
[4] X.-J. Liu, H. Hu, and P.D. Drummond, Phys. Rev. A **75**, 023614 (2007).
[5] H. Hu, and X.-J. Liu, Phys. Rev. A **75**, 011603 (2007)
[6] H. Hu, X.-J. Liu, and P.D. Drummond, Phys. Rev. Lett. **98** , 060406 (2007).