EXCITATIONS IN STRONGLY INTERACTING FERMI GASES

Chris Vale[1,*], Carlos Kuhn[1], Sascha Hoinka[1], Paul Dyke[1], Ivan Herrera[1]

[1]*Centre for Quantum and Optical Sciences, ARC Centre of Excellence in Future Low-Energy Electronics Technologies, Swinburne University of Technology, Hawthorn VIC 3122, Australia*
**e-mail: cvale@swin.edu.au*

Dynamical processes in strongly-correlated quantum systems are central to understanding transport and dissipation. Here, we experimentally measure the excitation spectra of strongly interacting Fermi gases as a function of both the temperature and interactions. At temperatures below the superfluid transition, long wavelength excitations are dominated by the Bogoliubov-Anderson phonon mode whose frequency and width provide the sound speed and damping rate, respectively [1]. At higher energies, single particle excitations become accessible allowing a direct measurement of the pairing gap. Bragg spectra of gases at unitarity show a strong dependence on the temperature, particularly across the superfluid transition where the evolution of the phonon mode displays striking similarities to what is found in liquid helium [2]. In the high-momentum limit, studied of the excitation spectra reveal universal features, such as Tan's contact parameter which we have mapped across the superfluid transition [3]. These measurements establish quantitative benchmarks for many-body theories of fermionic matter.

References

[1] S. Hoinka, P. Dyke, M. G. Lingham, J. J. Kinnunen, G. M. Bruun, and C. J. Vale, *Nature Phys.* **13**, 943 (2017).

[2] C. C. N. Kuhn, S. Hoinka, I. Herrera, P. Dyke, J. J. Kinnunen, G. M. Bruun, and C. J. Vale, arXiv:1912.03830 (2019).

[3] C. Carcy, S. Hoinka, M. G. Lingham, P. Dyke, C. C. N. Kuhn, H. Hu, and C. J. Vale, *Phys. Rev. Lett.* **122**, 203401 (2019).