Non-equilibrium dynamics of a strongly interacting Fermi gas

P. Dyke[a,b], A. Pennings[a,b], I. Herrera[a,b], S. Hoinka[a,b], M. Davis[b,c], S. Musilino[d], D. J. M. Ahmed-Braun[d], V.E. Colussi[d], S. J. J. M. F. Kokkelmans[d] , H Kurkjian[e] and C.J. Vale[a,b]

[a] *Optical Sciences Centre, Swinburne University of Technology, Melbourne, Victoria 3122, Australia*

[b] *ARC Centre of Excellence in Future Low-Energy Electronics Technologies, Australia.*

[c] *School of Mathematics and Physics, University of Queensland, Queensland 4072, Australia.*

[d] *Eindhoven University of Technology, 5600 MB Eindhoven, The Netherlands.*

[e] *Laboratoire de Physique Théorique, Université de Toulouse, CNRS, UPS, France*

Ultracold Fermi gases with tunable interactions provide a versatile test bed for studying quantum many-body phenomena; unlocking new ways to study condensed matter physics in an environment free of defects. We study the dynamics in a two-component strongly interacting Fermi gas following a quench of the inter-atomic interactions. In a first study, we measure the time dependent formation of pairs and their Bose-Einstein condensate after a quench of the interactions across the normal to the superfluid phase transition. We find that the short range correlations evolve far more rapidly than the long-range correlations needed to form a Bose-Einstein condensate. Finally, we perform a quench of the interactions within the superfluid phase, which excites oscillations of the superfluid order parameter, commonly known as the Higgs mode. Using two-photon Bragg spectroscopy, we directly observe the amplitude oscillations and obtain measurements of the pairing gap and damping rate as a function of temperature. Our data show good agreement with time-dependent BCS theory.