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**Paired Phases of a Trapped Fermi Gas with Unequal Spin Populations**<sup>1</sup> G.B. PARTRIDGE, WENHUI LI, Y.A. LIAO, R.G. HULET, Department of Physics and Astronomy and Rice Quantum Institute, Rice University, Houston TX, 77251 — A strongly interacting ultra-cold gas of fermionic  $^6\text{Li}$  with unequal numbers of two spin components exhibits two distinct low temperature states.<sup>2</sup> Phase separation is observed at the lowest temperatures, where a uniformly paired core is maintained in the center of the trap, up to large number imbalance, by the expulsion of excess unpaired atoms. Sharp boundaries between the core and the unpaired atoms are consistent with a first-order phase transition. In addition, the spatial distribution of the superfluid core deforms, in violation of the local density approximation. At higher temperature, the core remains unpolarized up to a critical polarization before going normal, but does not deform. The boundaries are not sharp in this case, indicating a partially polarized shell between the core and the unpaired atoms. The temperature dependence is consistent with a tri-critical point in the phase diagram.

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<sup>2</sup>G. B. Partridge, Wenhui Li, Y. A. Liao, R. G. Hulet, M. Haque, and H. T. C. Stoof. *Phys. Rev. Lett.* **97**, 190407 (2006)

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