Abstract Submitted
for the MAR09 Meeting of
The American Physical Society

Many-flavor electron gas approach to electron-hole drops[1]
GARETH CONDUIT, University of Cambridge, PETER HAYNES, Imperial College — A many-flavor electron gas (MFEG) is analyzed, such as could be found in a multivalley semiconductor or semimetal. Using the rederived polarizability for the MFEG, an exact expression for the total energy of a uniform MFEG in the many-flavor approximation is found; the interacting energy per particle is shown to be $-0.574447(E_h a_0^{3/4} m*^{3/4}) n^{1/4}$, with E_h being the Hartree energy, a_0 being the Bohr radius, and $m*$ being the particle effective mass. The short characteristic length scale of the MFEG motivates a local-density approximation, allowing a gradient expansion in the energy density and the expansion scheme is applied to electron-hole drops, finding a new form for the density profile and its surface scaling properties. The formalism is verified using both Quantum Monte Carlo and density-functional theory calculations.

[1]GJC acknowledges the financial support of the EPSRC, PDH is supported by the Royal Society.

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Date submitted: 17 Nov 2008 Electronic form version 1.4