The neutron matter Equation of State at low density

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Neutron matter at low density is studied within the hole-line expansion. Calculations are performed in the range of Fermi momentum k_F between 0.4 and 0.8 fm^{-1}. The following features are found:

1. The Equation of State is determined only by the $^1S_0$ channel;
2. The contribution of three-body forces is quite small;
3. The effect of the single particle potential is negligible;
4. The three hole-line contribution is below 5 per cent of the total energy and is, indeed, vanishingly small at the lowest densities.

Despite the unitary limit is actually never reached, the total energy stays very close to one half of the free gas value throughout the considered density range. To clarify the origin of this behavior a rank one separable representation of the bare NN interaction, which reproduces the physical scattering length and effective range and is actually determined only by these two physical quantities, gives results almost indistinguishable from the full Brueckner G-matrix calculations with a realistic force. The extension of the calculations below $k_F = 0.4$ fm^{-1} does not indicate any pathological behavior of the neutron Equation of State. The main correlation in the low density range appears to be the Pauli principle, whose effect is still strong even for these low values of the Fermi momentum. Comparisons with other calculations are discussed. The neutron matter Equation of State in the low density region seems to be well established.