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Liquid gas transition of nuclear matter in QCD

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We illustrate that the nuclear liquid gas transition of nucleon can be described in quantum chromodynamics through combining the quark gap equation and Faddeev equation of nucleon. We investigate the liquid gas transition at zero temperature and
finite chemical potential, and analyze that there exists a finite difference of gas and liquid solution of quark propagator due to the shift of the nucleon pole mass in medium that is generated in the nucelon channel in quark gap equation. Such a difference leads to a first order phase transition and determines the binding energy of nucleon and the saturation density. We apply a model independent analysis after approximating such a difference as a contour that involves the contribution from the difference of two poles and then derive an analytical relation of binding energy and the sigma term of nucleon which then gives the binding energy being $E/A = 15.9$ MeV. Moreover, by similarly relating the vector charge of nucleon to the nuclear saturation density together with the binding energy, one also finds the saturation density $n_{\mathrm{B}}^{0} = 0.15\ \mathrm{fm}^{-3}$.

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