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The free energy of a dilute 2d Bose gas

We consider a two-dimensional interacting Bose gas in a homogeneous setting. The two-body interaction potential is assumed to be non-negative and of finite scattering length a. Under these quite general assumptions, we are able to obtain an asymptotic expansion formula of the free energy of the system at non-negative temperature in the dilute limit $a^2\rho \ll 1$, where ρ is the density. In the limit of zero temperature, the formula reduces to the asymptotic ground state energy which is an earlier result by Lieb and Yngvason (2001). Our work extends the corresponding result in three dimensions proved by R. Seiringer (2008) and J. Yin (2010).