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Many-body blow-up of boson stars

We study ground states of a system of N identical bosons in \mathbb{R}^3 , described by the Hamiltonian

$$H_N = \sum_{i=1}^N \left(\sqrt{-\Delta_{x_i} + m^2} + V(x_i) \right) - \frac{a}{N-1} \sum_{1 \leq i < j \leq N} |x_i - x_j|^{-1}.$$

acting on Hilbert space $\bigotimes_{\text{sym}}^N L^2(\mathbb{R}^3)$. Here the parameter $m > 0$ is the mass of particles, $a > 0$ describes the strength of the attractive interaction, and $V \geq 0$ is an external potential. We are interested in the behavior of the ground state energy per particle of H_N and the corresponding ground state when $N \rightarrow \infty$ and $a = a_N$ tends to a^* (*Chandrasekhar limit*) from below.

We first study blow-up behavior of ground state energy as well as of ground states when $a \nearrow a^*$ in the effective model: *Hartree theory*.