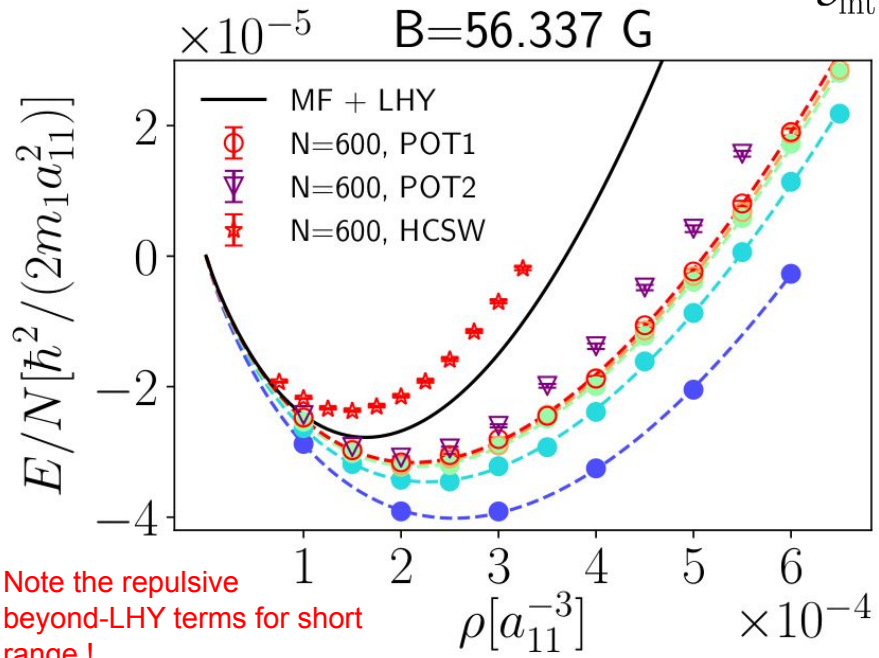
Finite-range effects in ultradilute quantum drops [1] ^{39}K droplets : $a_{22} \neq a_{11}, m_2 = m_2$

$$k \cot \delta(k) = -\frac{1}{a} + \frac{1}{2} r_{\text{eff}} k^2 + \mathcal{O}(k^4).$$

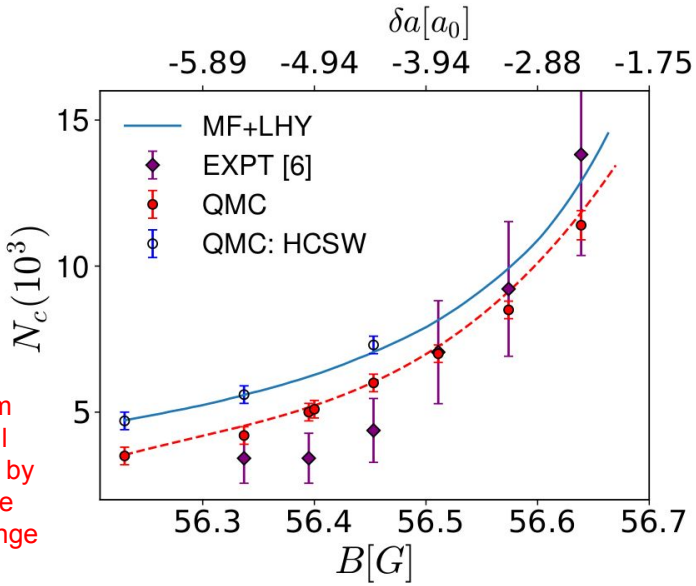
Recipe to use QMC-built functional:

$$\mathcal{E}_{\text{int}} = \alpha\rho^2 + \beta\rho^{\gamma+1} \rightarrow i\hbar\frac{\partial\psi}{\partial t} = \left(-\frac{\hbar^2}{2m}\nabla^2 + V_{\text{ext}}(\vec{r}) + \frac{\partial\mathcal{E}_{\text{int}}}{\partial\rho}\right)\psi$$

$$\mathcal{E}_{\text{int}} = \frac{E}{N}\rho$$



Note the repulsive beyond-LHY terms for short range !



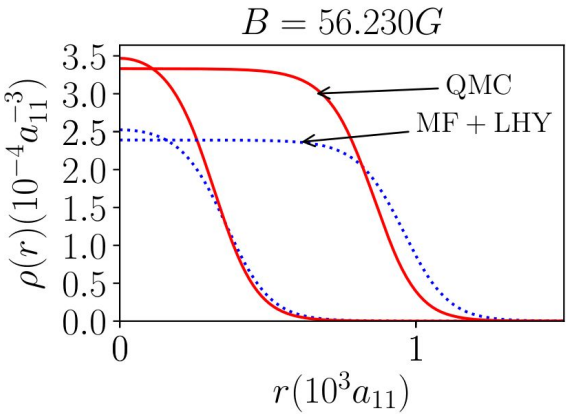
Critical atom number well reproduced by including the effective range

[1] V. Cikojević, L. V. Markić, and J. Boronat, *Finite-range effects in ultradilute quantum drops,* New Journal of Physics 22, 053045 (2020) ,

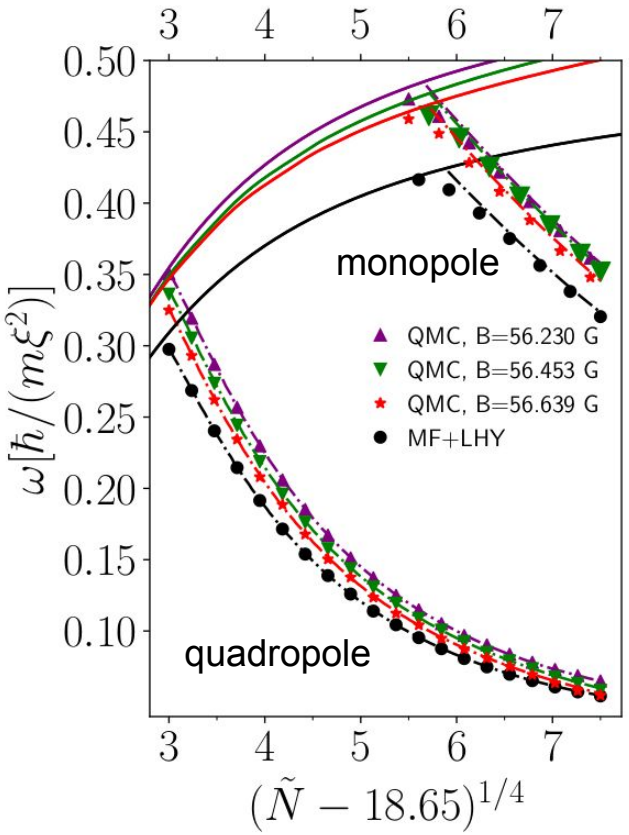
e-mail me for a discussion 🙂 cikojevic.viktor@gmail.com

[2] C. Cabrera, L. Tanzi, J. Sanz, B. Naylor, P. Thomas, P. Cheiney, and L. Tarruell, Science 359, 301 (2018).

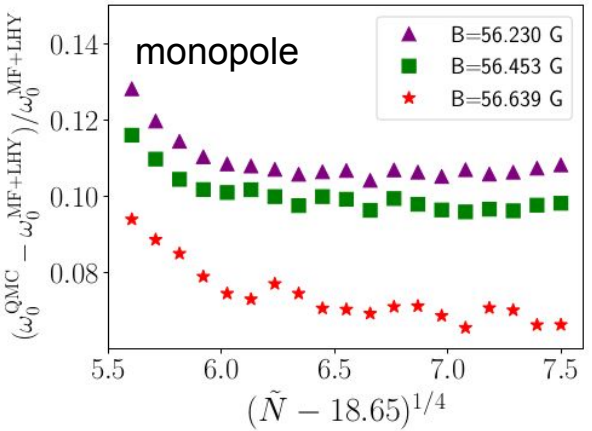
Finite range effects on statics and excitation modes of a ^{39}K droplet

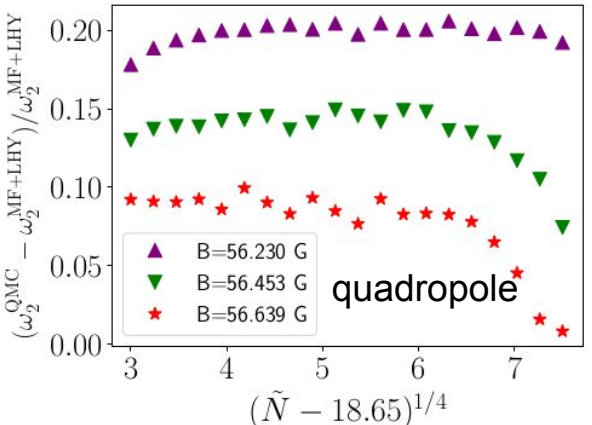


Density profile for small and large droplets. Quadropole and breathing mode frequency of an isolated droplet
(preliminary, soon available on arxiv)

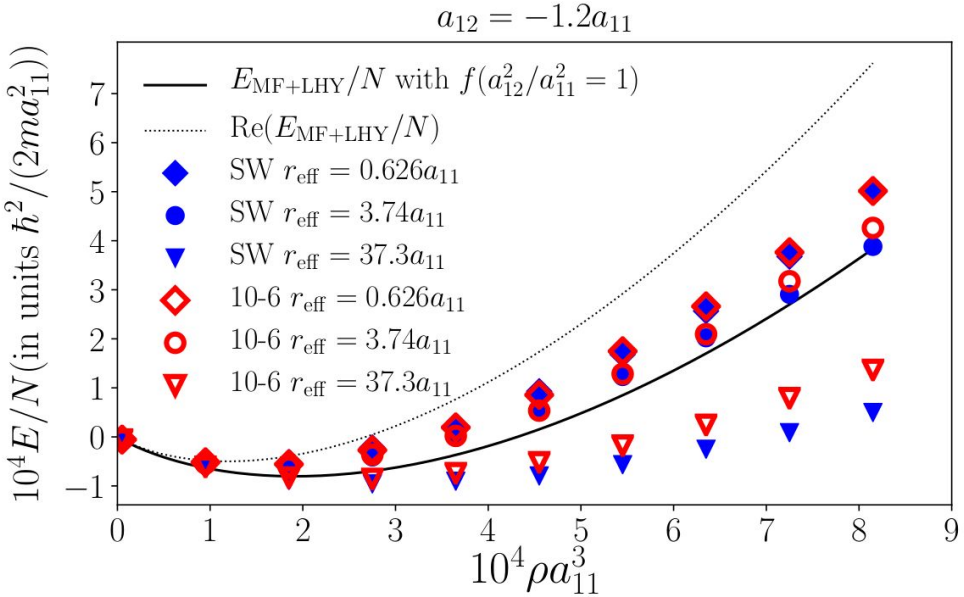


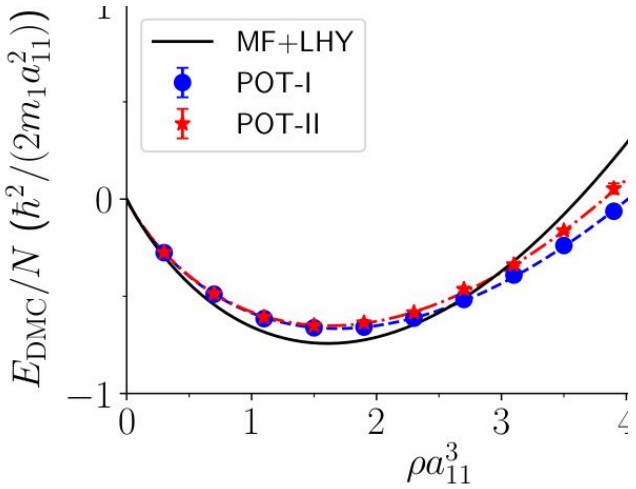
Relative difference to MF+LHY





Universality in two parameters: a and $r_{\rm eff}$. General feature?





Symmetric Bose-Bose mixture [1]:

$$a_{11} = a_{22}, m_2 = m_1$$

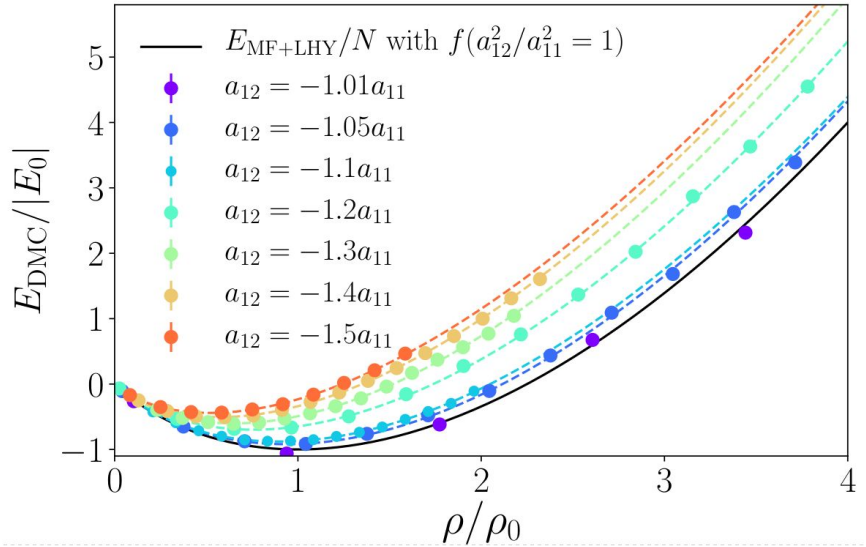
(preliminary!) Heterogenous mixture [2]

$$a_{11} \neq a_{22}, m_2 \neq m_1$$

[1] V. Cikojević, L. V. Markić, G. E. Astrakharchik, and J. Boronat, Phys. Rev. A 99, 023618 (2019).
[2] C. D'Errico, A. Burchianti, M. Prevedelli, L. Salasnich, F. Ancilotto, M. Modugno, F. Minardi, and C. Fort, Phys. Rev. Research 1, 033155 (2019).

Small effective range: beyond-LHY energy is repulsive

For a small effective range, one observes positive energy coming from beyond-LHY terms [1-3]



Symmetric Bose-Bose mixture [1]:

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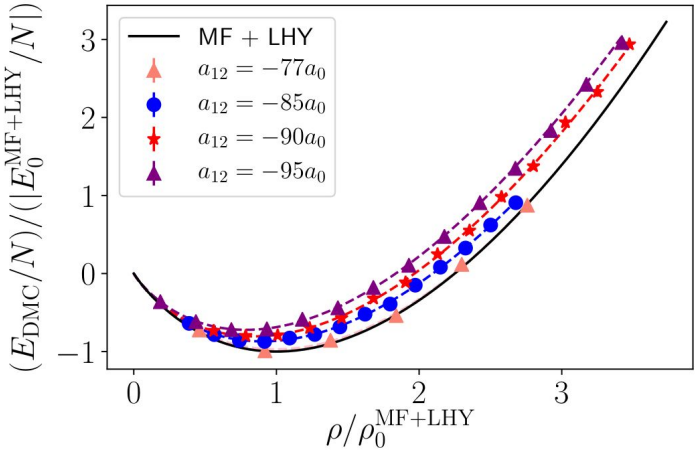

Heterogenous mixture [2] **(preliminary!)**

$$a_{11} \neq a_{22}, m_2 \neq m_1$$

[1] V. Cikojević, L. V. Markić, G. E. Astrakharchik, and J. Boronat, Phys. Rev. A 99, 023618 (2019).
[2] H. Hu and X.-J. Liu, arXiv preprint arXiv:2005.08581 (2020)
[3] M. Ota and G. E. Astrakharchik, arXiv preprint arXiv:2005.10047 (2020)