Supersólidos em Cascas Esféricas

Rafael Aparecido Rodrigues da Paz - 11735185

INTRODUÇÃO

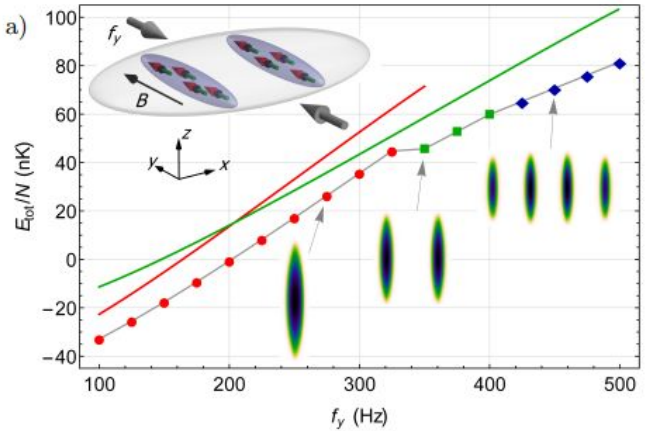
- He superfluido, BECs, London, Landau, Lifshitz, Leggett;

- Efeitos de flutuações quânticas.

Can a Solid Be "Superfluid"?

A. J. Leggett
School of Mathematical and Physical Sciences, University of Sussex, Falmer, Brighton, Sussex, England
(Received 15 September 1970)

It is suggested that the property of nonclassical rotational inertia possessed by superfluid liquid helium may be shared by some solids. In particular, nonclassical rotational inertia very probably occurs if the solid is Bose-condensed as recently proposed by



Wenzel et al. **Phys. Rev. A 96, 053630** (2017)

ORGANIZAÇÃO

1) BEC: propriedades relevantes e descrição via (e)GPE;

2) Fases exóticas: *droplets* quânticos e supersólidos dipolares;

3) O potencial bolha;

4) Supersolidez em cascas esféricas.

MENSAGENS

1) O que é um *droplet* quântico e sua autoligação?

2) O que são supersólidos dipolares?

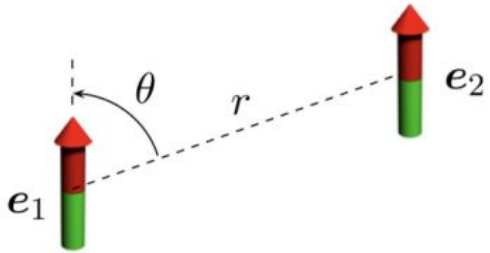
3) O intervalo de ocorrência de supersólidos é muito estreito.

4) Nosso trabalho no IFSC.

DESCRIÇÃO DOS CONDENSADOS

$$ih\frac{\partial\Psi}{\partial t} = \left[-\frac{h^2}{2m}\nabla^2 + V_{tr}(\vec{r}) + g|\Psi|^2 + \frac{1}{2}\int d\tau' \frac{C_{dd}}{4\pi}\frac{1-3cos^2(\theta)}{|\vec{r}-\vec{r'}|^3}|\Psi(\vec{r'},t)|^2 + \gamma_{QF}|\Psi|^3\right]\Psi(\vec{r},t)$$

- Equação de Gross-Pitaevskii (**estendida**);

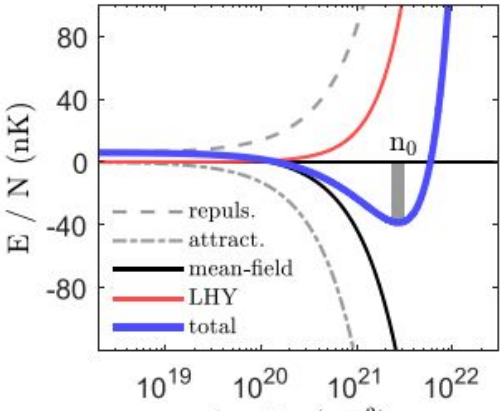


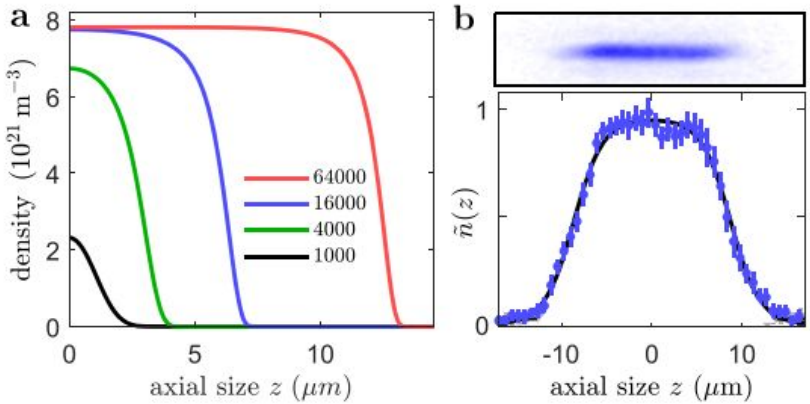
- Coerência e ordem de longo alcance fora da diagonal.

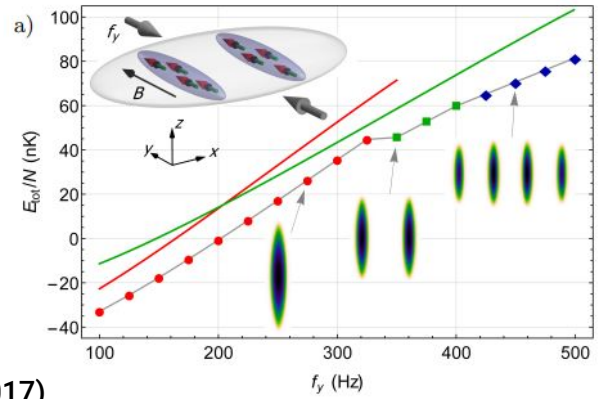
Lahaye et al. **Rep. Prog. Phys. 72, 126401** (2009)

DROPLETS QUÂNTICOS

- Repulsão de FQ vs atração de campo médio;
- Autoligação;
- Propriedades;
- Muitos droplets.



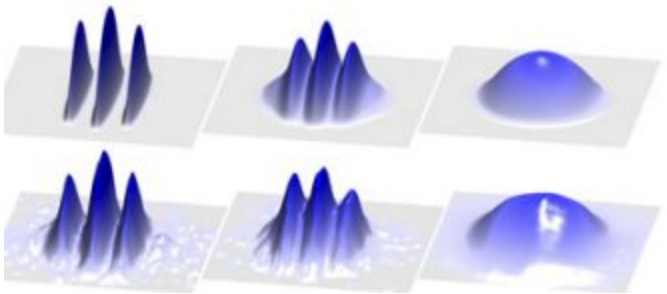




Böttcher, et al. **Rep. Prog. Phys. 84 012403** (2021); Wenzel et al. **Phys. Rev. A 96, 053630** (2017)

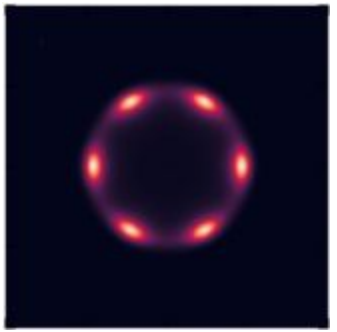
SUPERSÓLIDOS

- Estrutura periódica e superfluidez;



- Ordens de longo alcance na diagonal e fora;

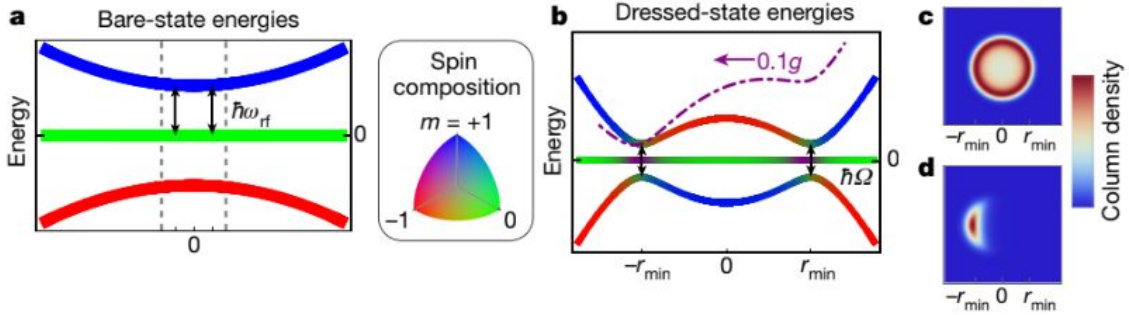
- Coerência;

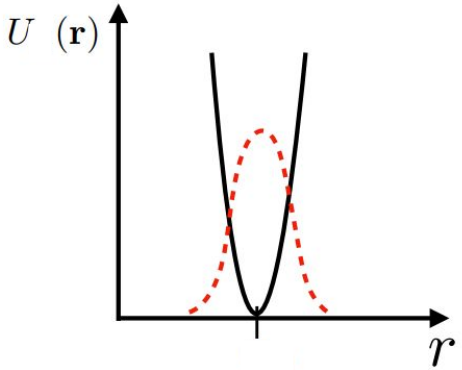


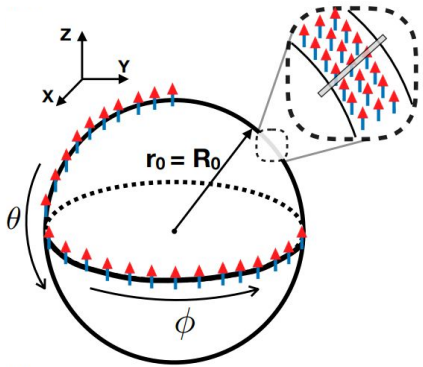
- Espectros de excitação de sólido e superfluido simultâneos.

Böttcher, et al. **Rep. Prog. Phys. 84 012403** (2021); Sánchez Baena, et al.. **Phys. Rev. Res 6, 3** (2024)

CASCA ESFÉRICA

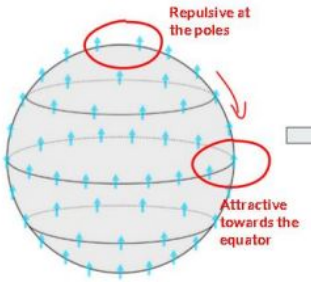




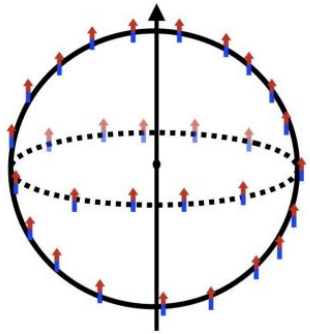


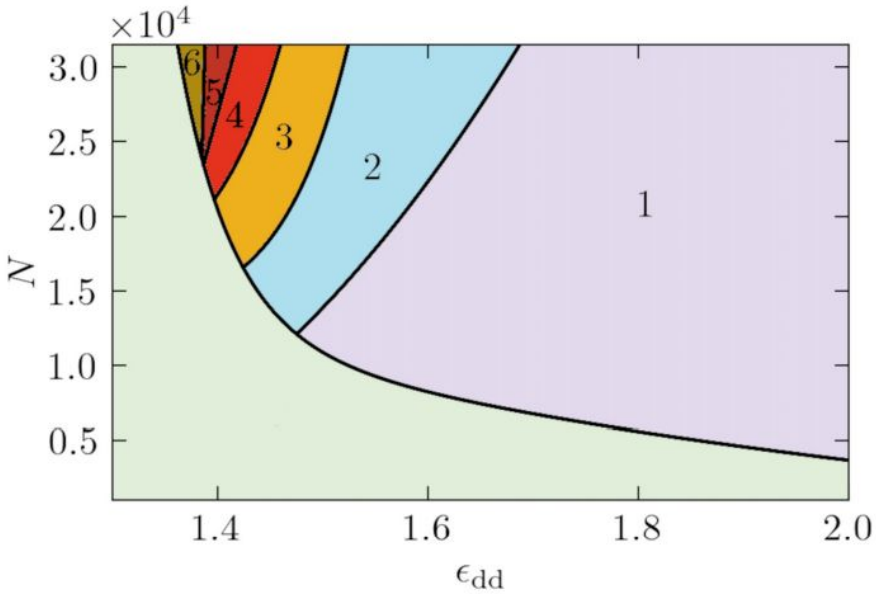
$$V_{tr}(r) = m\omega_0^2 r_0^2 \sqrt{\frac{\left[(r/r_0)^2 - \Delta/\varepsilon\right]^2}{4} + (\Omega/\varepsilon)^2} \approx \frac{1}{2} m\omega_0^2 \left(r - R\right)^2$$

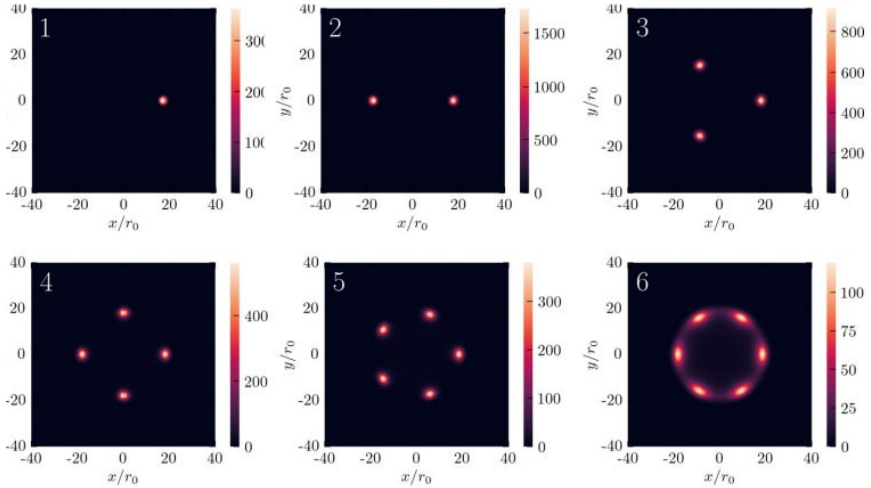
Carollo, et al. **Nature. 606 281** (2022); Diniz, et al.. **Sci. Rep 10, 4831-1** (2020)



SUPERSÓLIDOS DIPOLARES







Diniz, et al.. **Sci. Rep 10, 4831-1** (2020); Sánchez Baena, et al.. **Phys. Rev. Res 6, 3** (2024)

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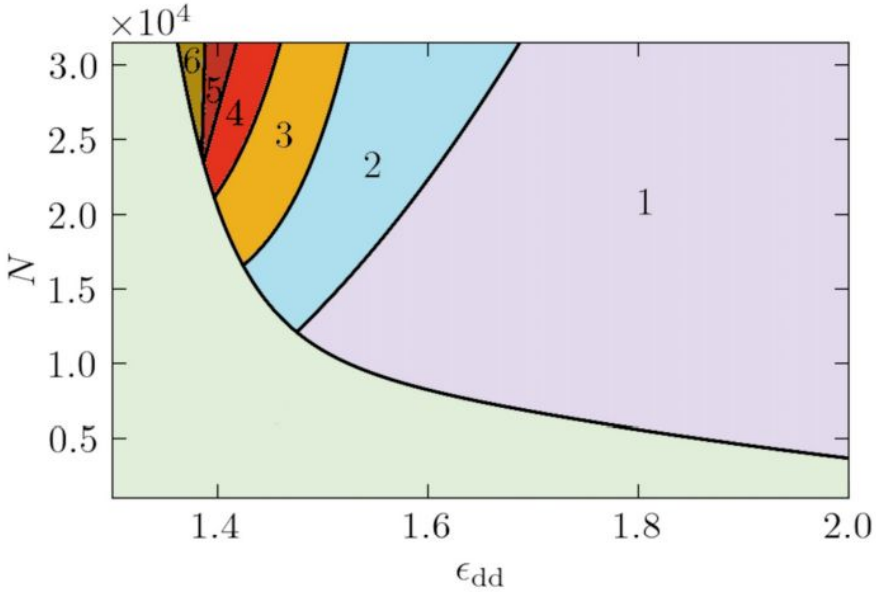

Sánchez Baena, et al.. **Phys. Rev. Res 6, 3** (2024)

$$\psi(\vec{r}) = \sqrt{n_q}\, exp\left[-\frac{1}{2}\left(\frac{r-R}{\sigma}\right)^2\right] exp\left(-\frac{1}{2}\frac{cos^2(\theta)}{\beta^2}\right) \sum_{p=0}^{q-1} exp\left[-\frac{(\phi - 2\pi p/q)^2}{\alpha^2}\right]$$

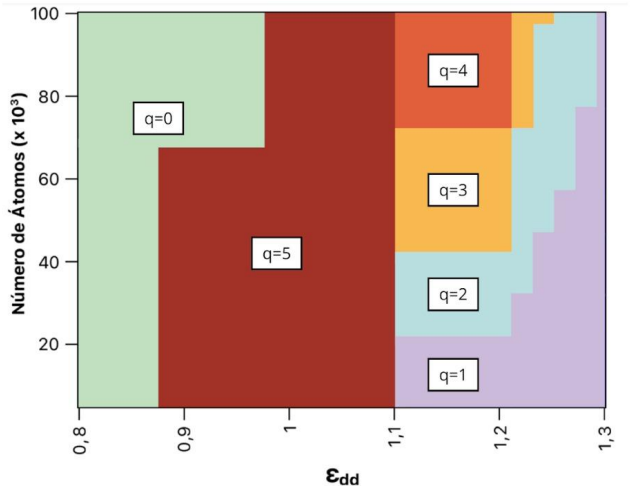

Figura cedida por Karla Yelisetty.

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