Correlations in 1D Bose gases at ranges shorter than "long"

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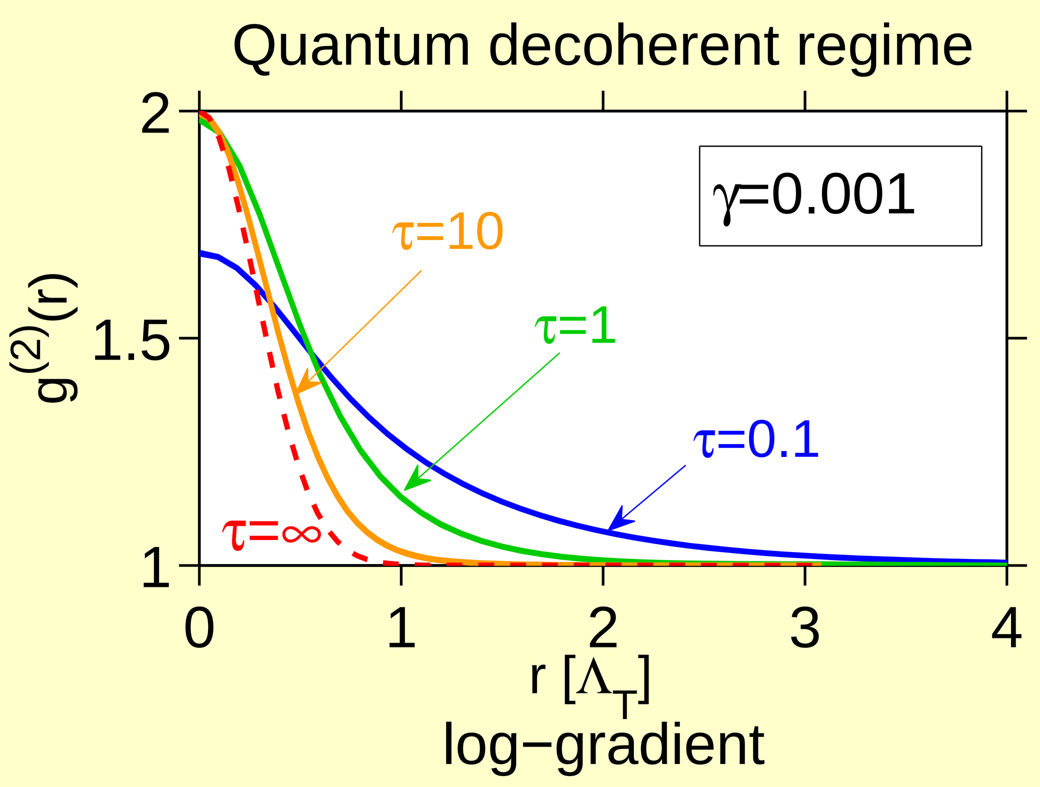
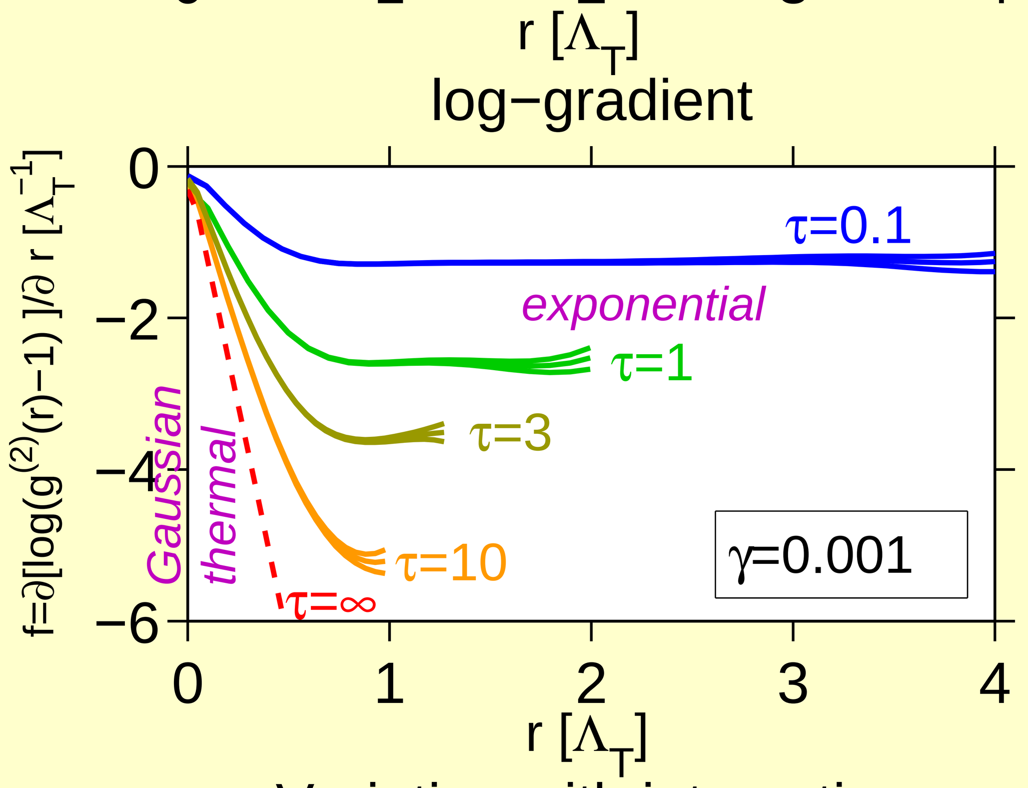
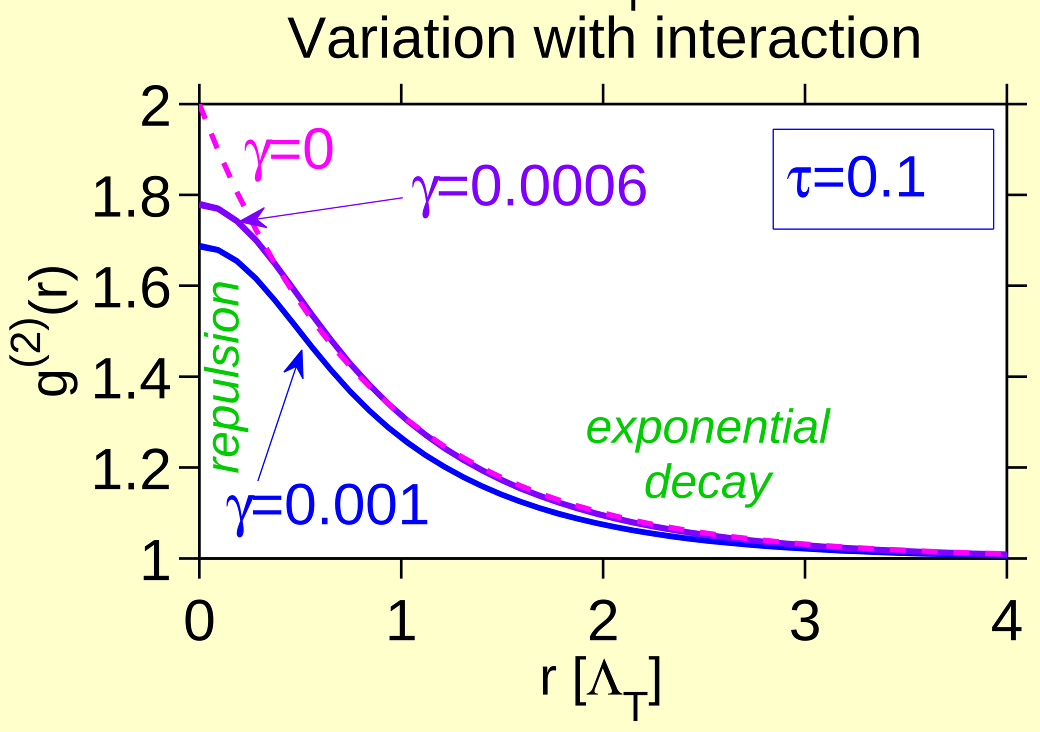
See also neighbouring poster A. G. Sykes *et al.*

A

Transition to degeneracy at weak interactions







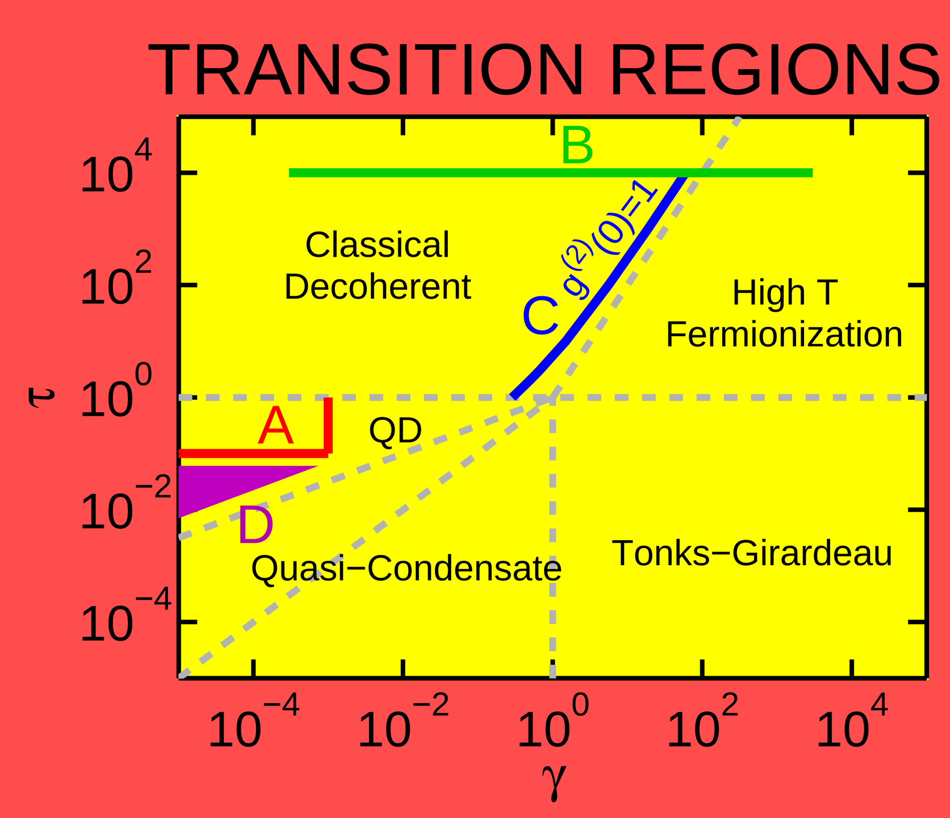
Due to interplay of

- Thermal fluctuations on ranges $\sim \Lambda_T$
- Phase fluct. on range $l_\phi \sim \Lambda_T/\sqrt{\pi\tau}$ (exponential decay of $g^{(2)}$)
- Antibunching at shortest range ($\gamma > 0$)

$g^{(2)}$ Density correlations

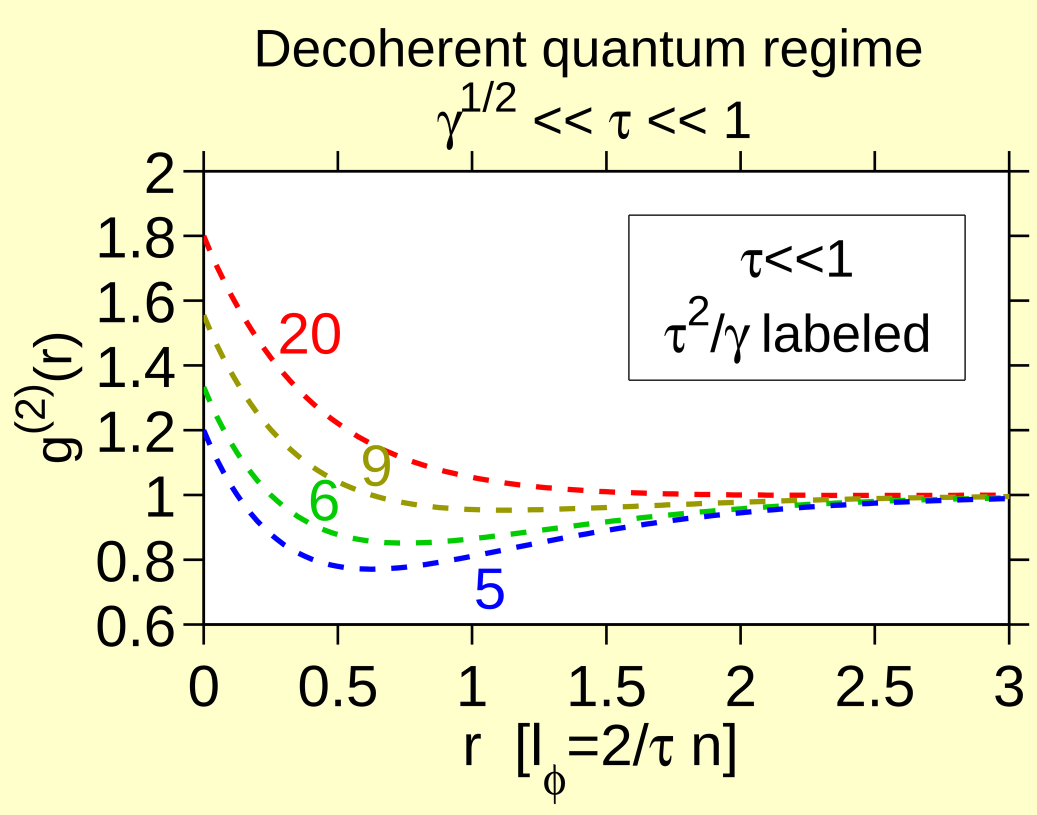
$$g^{(2)}(\mathbf{r}) = \frac{\widehat{\Psi}^\dagger(0)\widehat{\Psi}^\dagger(\mathbf{r})\widehat{\Psi}(\mathbf{r})\widehat{\Psi}(0)}{\mathbf{n}^2}$$

Gives the shape of local density structures



D

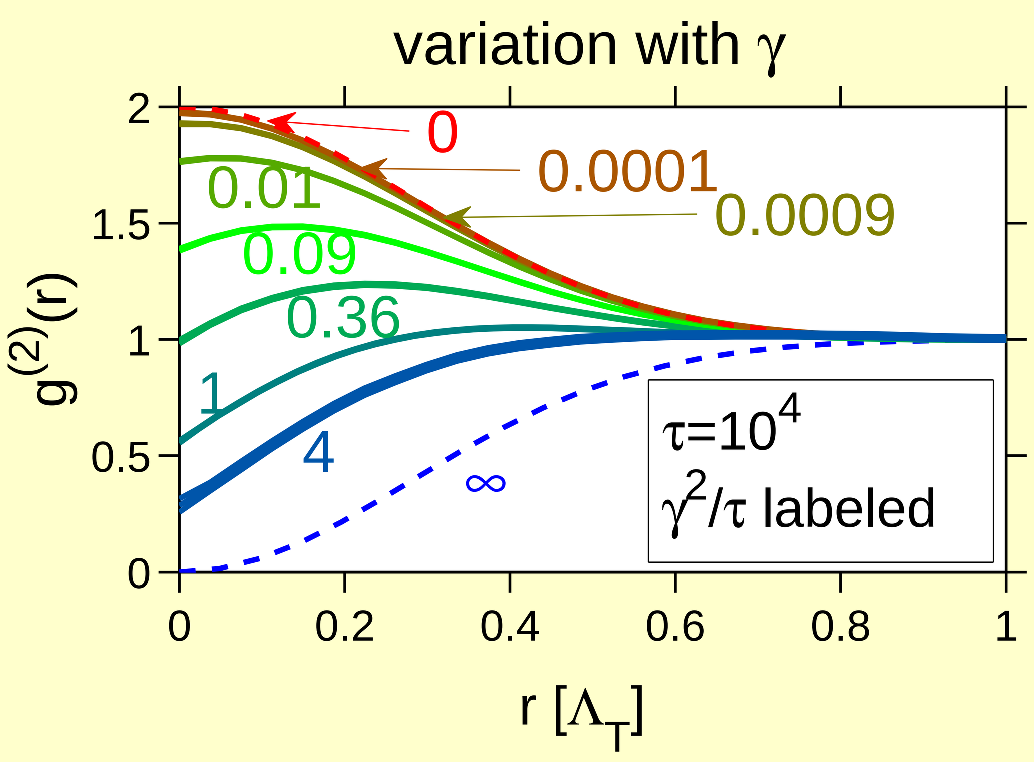
Antibunching at-a-range



Long-range antibunching is due to healing length $\xi \sim l_\phi\sqrt{\tau^2/\gamma}$ being $\gg l_\phi$

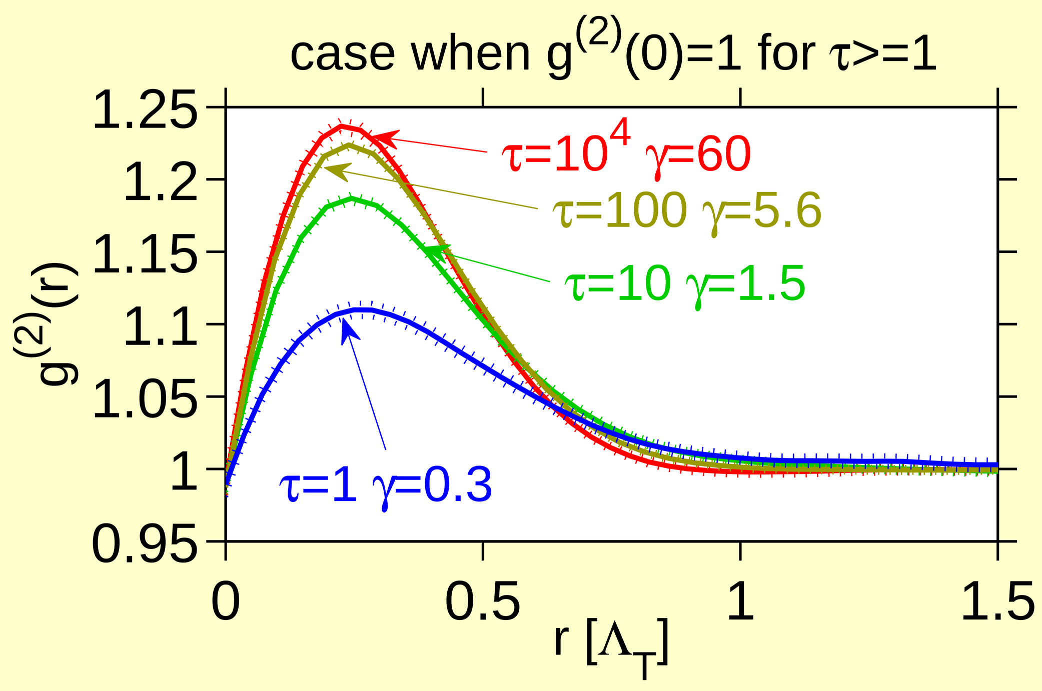
B

Hight T fermionization



C

Bunching at-a-range



Due to interplay of

- Thermal fluctuations on ranges $\sim \Lambda_T$
- Fermi repulsion at shorter but comparable ranges

Imaginary time

When $t = 1/k_BT$, and $\hat{\rho}$ is the density matrix

$$\frac{\partial\hat{\rho}}{\partial t} = \left(\widehat{N}\,\frac{\partial\,[t\mu]}{\partial t} - \widehat{H}\right)\hat{\rho},$$

$\hat{\rho}(t=0)$ is known, so one can integrate to lower temperatures.

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Gauge P calculation

- Expansion in terms of an off-diagonal coherent state $|\alpha\rangle$ operator basis

$$\hat{\rho} = \int G(\vec{\alpha},\vec{\beta},\Omega)\,\Omega\,\frac{|\vec{\alpha}\rangle\langle\vec{\beta}^*|}{\langle\vec{\beta}^*|\vec{\alpha}\rangle}\mathcal{D}\vec{\alpha}\mathcal{D}\vec{\beta}\,d^2\Omega$$

- Sample initial distribution G.
- Appropriate random walk of samples corresponds to full quantum mechanics.