

# Exotic supersolid states in Rydberg-dressed systems via Quantum Monte Carlo

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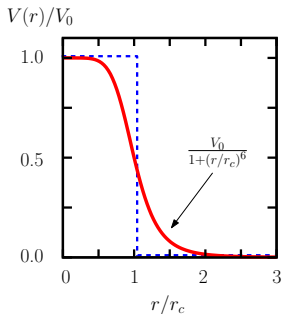
VaQuM2020: Variational methods for Quantum Many-body systems  
Lyon, July 6, 2019

# Introduction

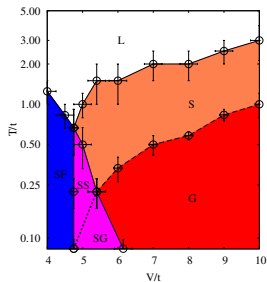
Hardcore bosons on a square lattice described by the Hamiltonian

$$H = -t \sum_{\langle i,j \rangle} (b_i^\dagger b_j + \text{h.c.}) + V \sum_{i < j: r_{ij} \leq r_c} n_i n_j$$

Interaction relevant for experiments  
with **Rydberg-dressed atoms**  
[Jau 2015, Zeiher 2016]

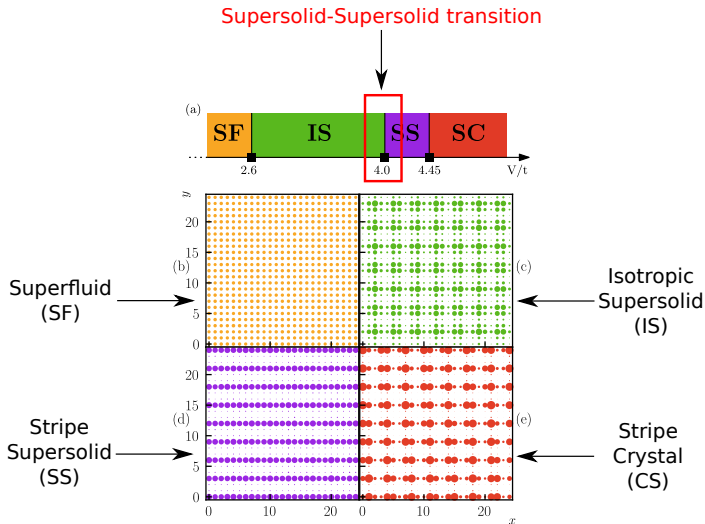


**Supersolids and superglasses**  
on triangular lattice  
[Angelone 2016]



# Ground-state (GS) results

We use **Path Integral Monte Carlo (PIMC)** simulations  
Density  $\rho = 5/36$ ,  $r_c = 2$  [Masella et al., PRL 2019]

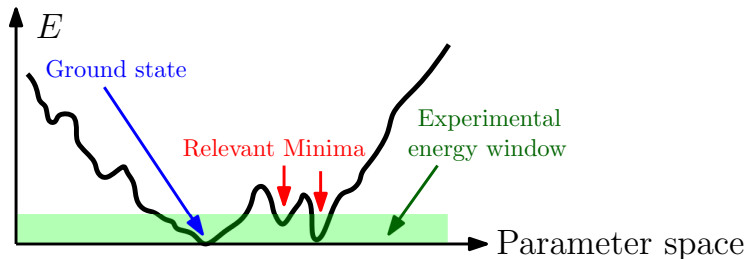


# Out-of-equilibrium with PIMC ?

## Can PIMC give insight about out-of-equilibrium results ?

For cold atom experiments, yes:

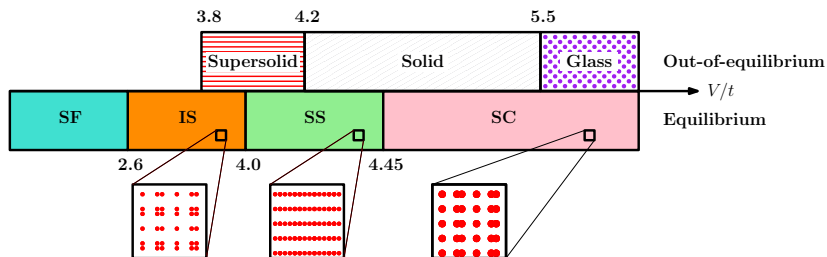
- **Tailor simulation protocol to reach out-of-equilibrium states** (e.g., simulated temperature quenches)
- States **within experimental energy deviance from GS** are **physically relevant for experiments**



# Out-of-equilibrium results

We find **glasses and out-of-equilibrium (super)solids**  
[Angelone et al., PRA 2020]

**Different properties from ground-state counterparts:**  
e.g., **essentially isotropic vs anisotropic ground-state**



All states within common experimental energy windows above GS ( $\sim$  %)

# Conclusions & Acknowledgements

Rich physics in **finite-range interactions model**  
of interest for **cold Rydberg-dressed atoms**

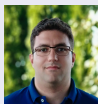
**Novel supersolid-supersolid transition** in the ground state  
[Masella et al., PRL 2019]

**Out-of-equilibrium (super)solids and glasses**  
in energy region **relevant for experiments**  
[Angelone et al., PRA 2020]

**Joint work with:**



Fabio  
Mezzacapo



Guido  
Masella



Guido  
Pupillo



Nikolay  
Prokof'ev



Marcello  
Dalmonte

**Thanks for the attention!**