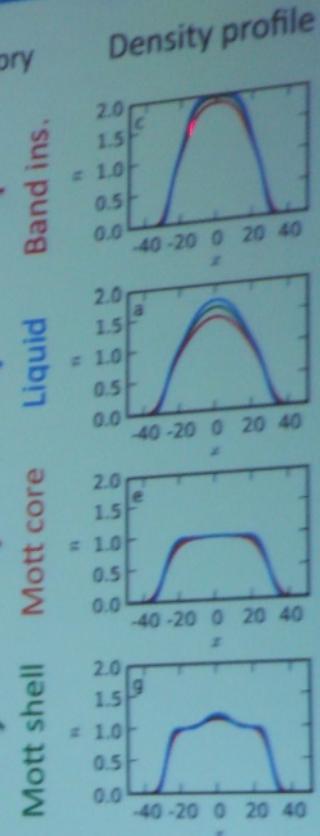
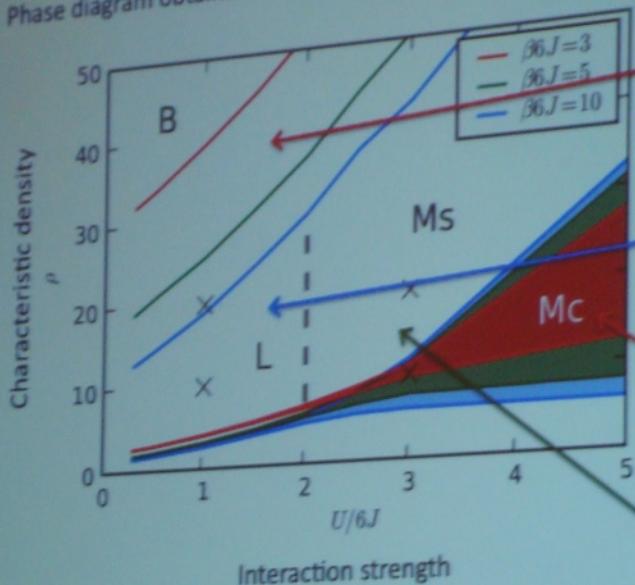


## Phases coexisting within the trap

Phase diagram obtained from single-site Dynamical Mean-Field Theory



[1] L. De Leo et al., PRA 83, 023606 (2011)

[2] L. De Leo et al., PRL 101, 210403 (2008)

## Estimating the entropy: fitting the measured double occupancy

Experimental procedure [1]:

1. fix  $U, J, \rho$
2. measure  $D$

Experimental bounds on  $s$ :

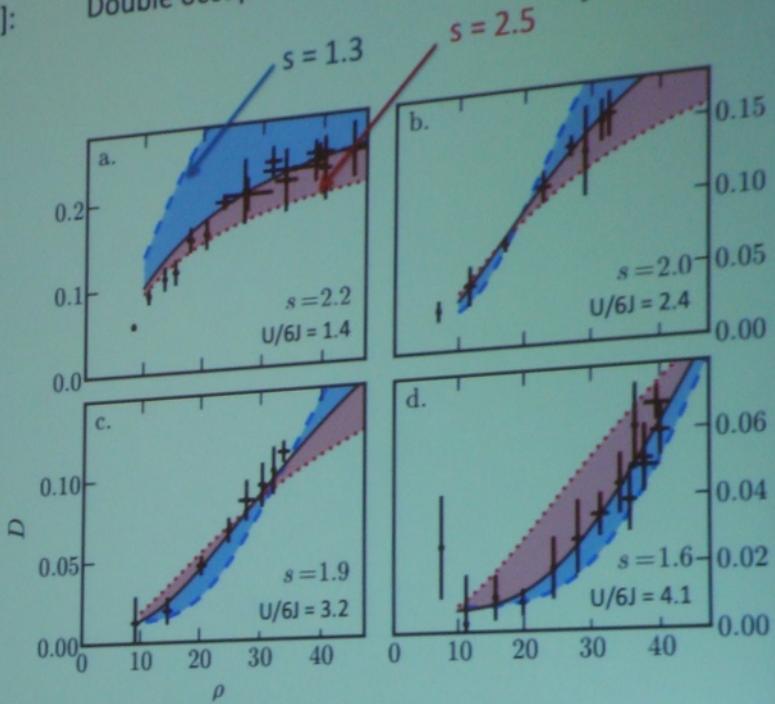
$$s_{\min} = 1.3$$

$$s_{\max} < 2.5$$

$D(s, \rho)$  computed at fixed entropy per atom ( $s$ ). Best fit to experimental  $D$  determines  $s$ .

$D(s, \rho)$  computed using DMFT+LDA and high-temperature series expansion.

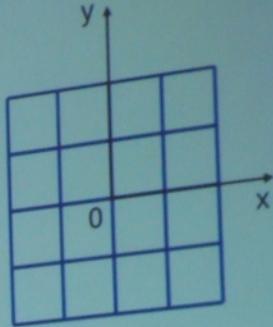
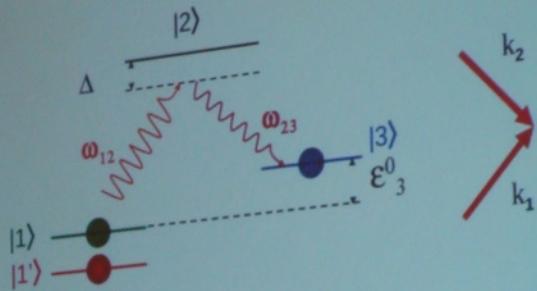
$$\text{Double occupancy: } D(s, \rho) = \frac{2}{N} \sum_i \langle n_{i\uparrow} n_{i\downarrow} \rangle$$



[1] R. Jördens et al., PRL 104, 18041 (2010).

## Raman spectroscopy in the lattice

Transfer of a portion of the atoms stored into the optical lattice to a third hyperfine state

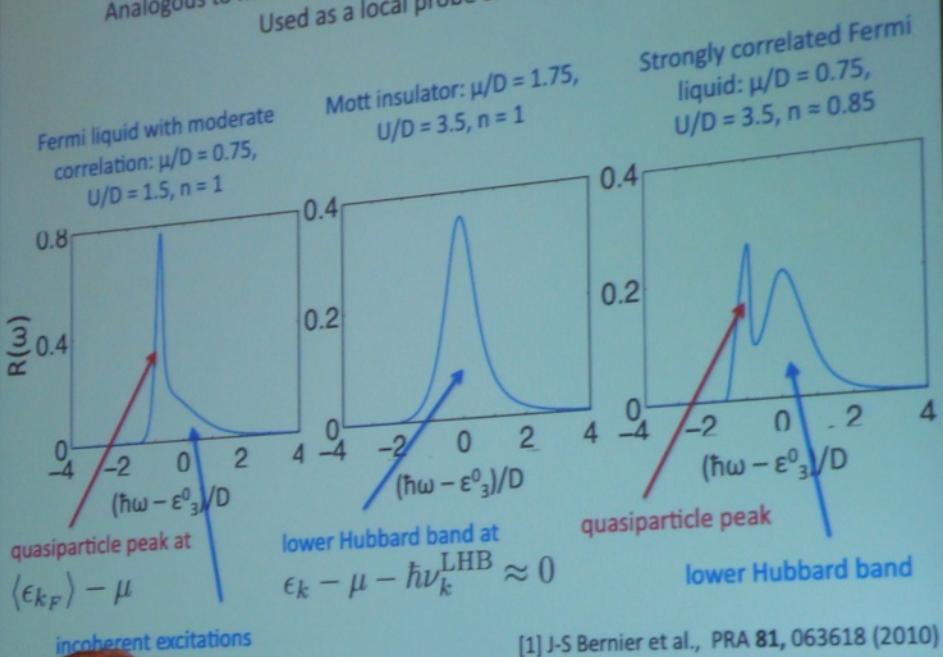


- Atoms in hyperfine states 1 and 1' form the many-body state
- $\Delta$ : detuning from state 2
- Transferred energy:  $\hbar\omega/2\pi = \hbar(\omega_{12} - \omega_{23})/2\pi$
- Transferred momentum:  $q = k_1 - k_2$

[1] J-S Bernier et al., PRA 81, 063618 (2010)

## Signatures of correlations from momentum-integrated RF spectroscopy

Analogous to momentum-integrated photoemission spectroscopy  
Used as a local probe and at  $\mathbf{q} = 0$



[1] J-S Bernier et al., PRA 81, 063618 (2010)

## Conclusions

1. Evaluation of the entropy from double occupation measurements: Mott state realized at  $s = 1.4$
2. Single-site DMFT can accurately describe cold fermionic atoms in 3D optical lattices in the currently accessible temperature range
3. Upper bound on critical entropy per atom to reach the Néel state at intermediate coupling:  $s \approx 0.67$
4. Cooling by trapped reshaping could reduce the entropy per atom by a factor of 10:  $s_i = 2 \rightarrow s_f = 0.2$
5. Momentum-integrated Raman spectroscopy can be used as a probe:
  - At  $\mathbf{q} = \pi/a$ : thermometer in the lattice
  - At  $\mathbf{q} = 0$ : detection of strong correlation effects