

# Spin Drag in the Disordered Hubbard Model and Many-Body Localization

William McGehee, Will Morong, Wenchao Xu, Brian DeMarco

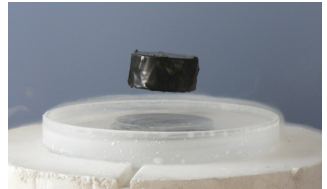
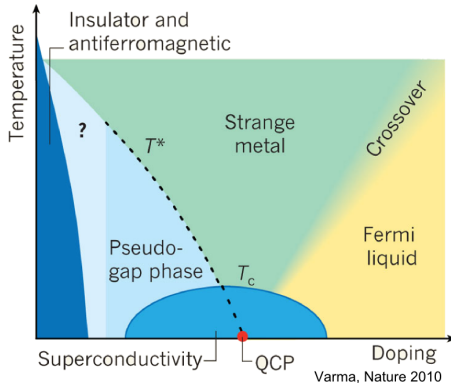
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University of Illinois at Urbana-Champaign

DAMOP 2014

# Disordered Hubbard Model

Strange Metal

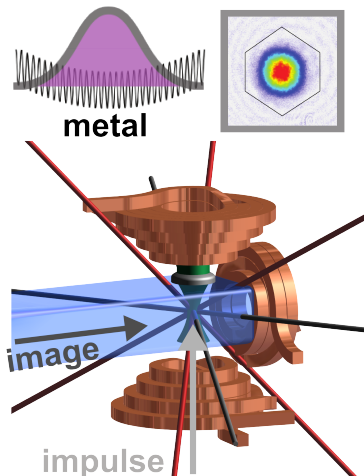
$$T > T_{\text{AFM}}$$



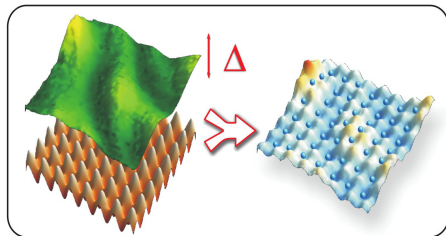
$$H = \sum_i U_i \hat{n}_{i\uparrow} \hat{n}_{i\downarrow} - \sum_{\langle ij \rangle, \sigma} t_{ij} \left( \hat{c}_{j\sigma}^\dagger \hat{c}_{i\sigma} + h.c. \right) + \sum_i \left( \epsilon_i + m\omega^2 r_i^2 / 2 \right) \hat{n}_i$$

Pasienski, Nat. Phys (2010)  
Kondov, arXiv:1305.6072

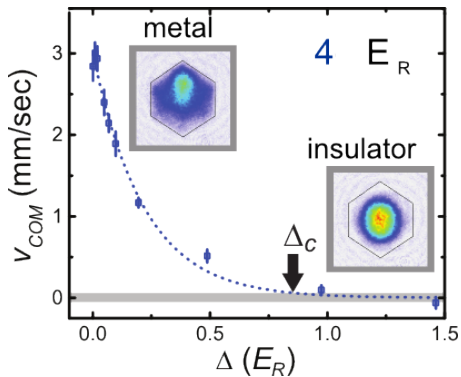
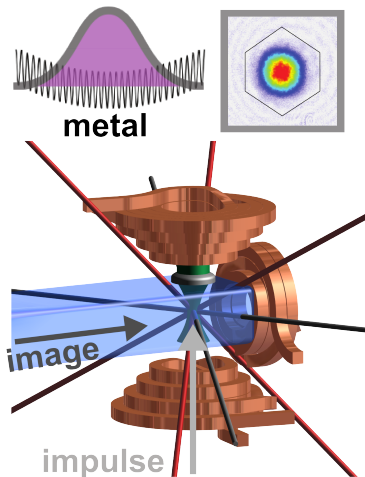
# Transport in Dirty Metal



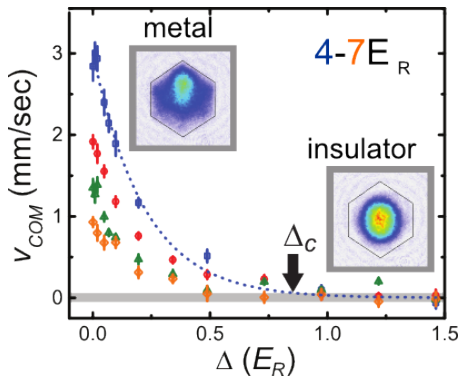
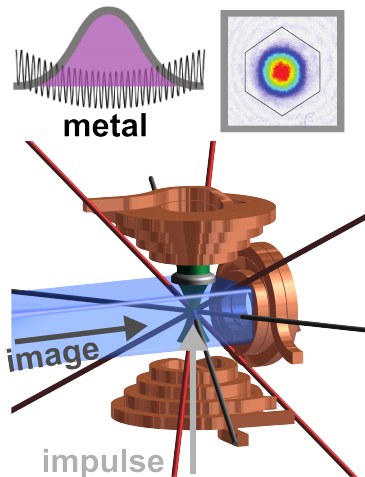
- Ultracold  $^{40}\text{K}$
- 3D lattice + speckle
- Response to impulse



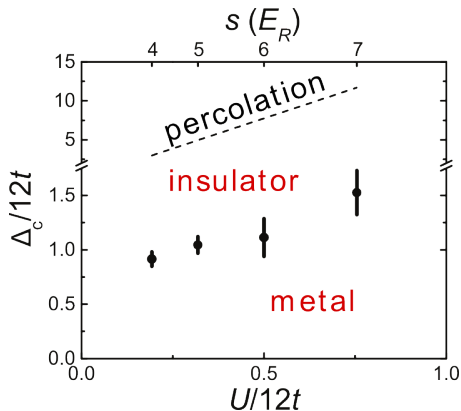
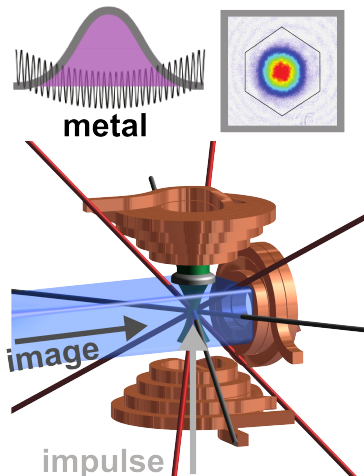
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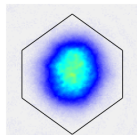
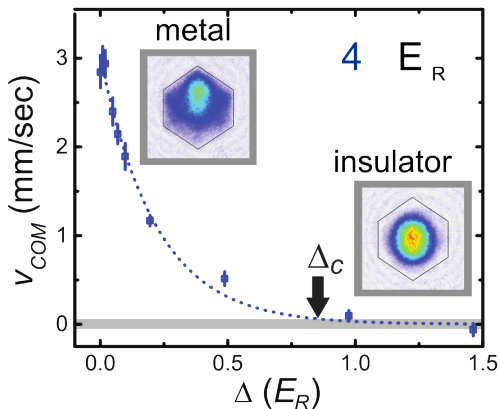
# Transport in Dirty Metal



- Interaction driven MIT!

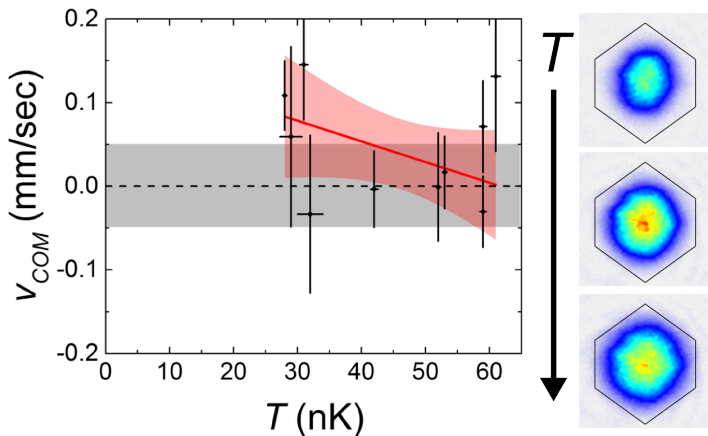
# Vary Temperature in Lattice

- Increase Temp for marginally localized gas



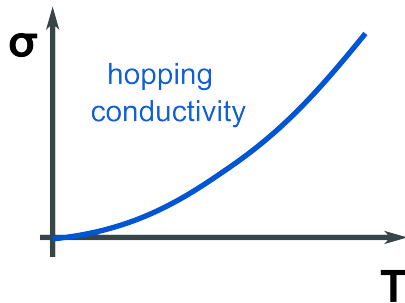
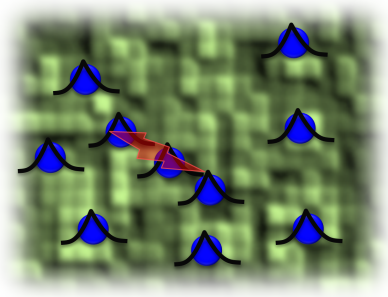
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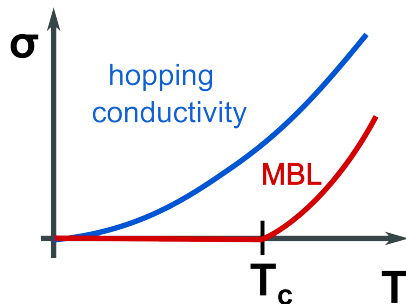
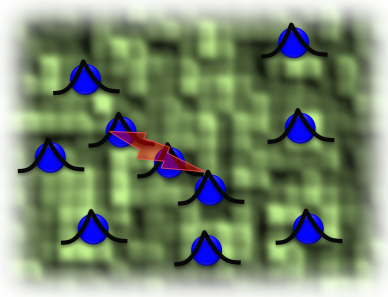




# Consistent with Many Body Localization



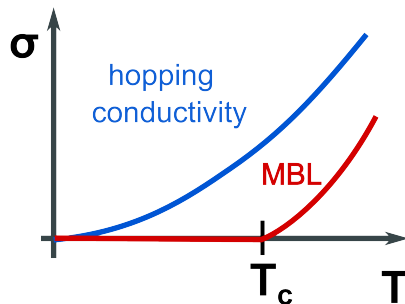
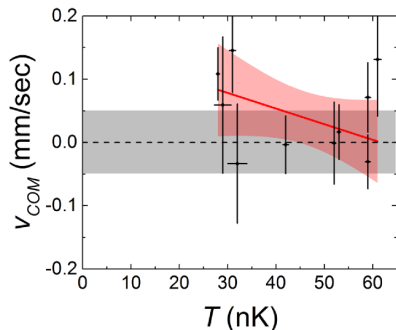
# Consistent with Many Body Localization



MBL: Anderson localized states  $\rightarrow$  interactions as perturbation

- Basko, Aleiner, Altshuler (2006)  $\sigma = 0$  for  $T \neq 0$

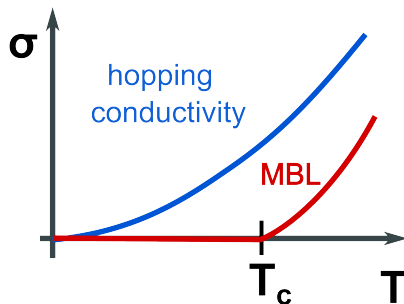
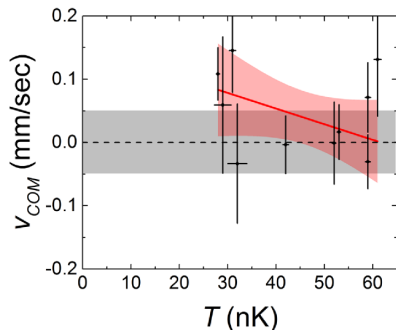
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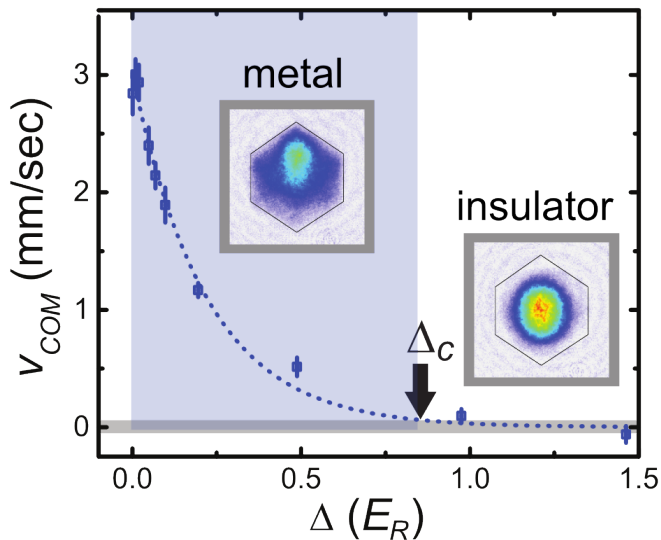
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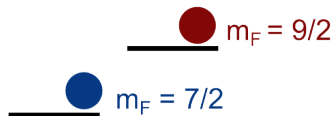
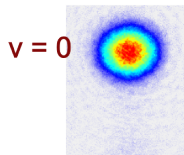
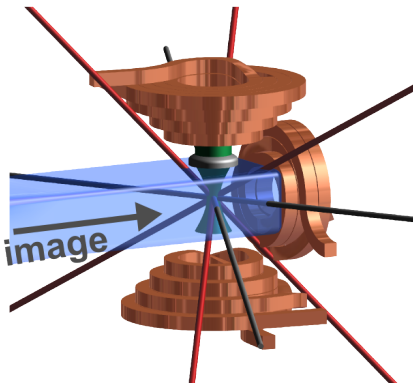
- Basko, Aleiner, Altshuler (2006)  $\sigma = 0$  for  $T \neq 0$
- Oganesyan and Huse (2007)  $\sigma = 0$  for  $T \rightarrow \infty$

# Quantitative behavior of metallic phase



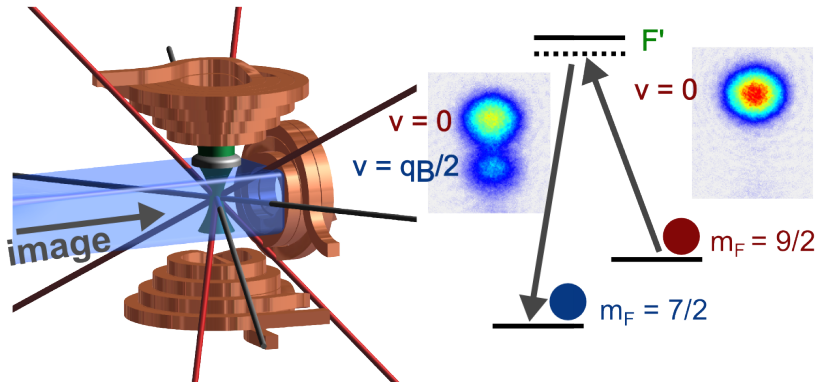
# Spin Drag in Hubbard Gas

- Spin friction as analog of resistance



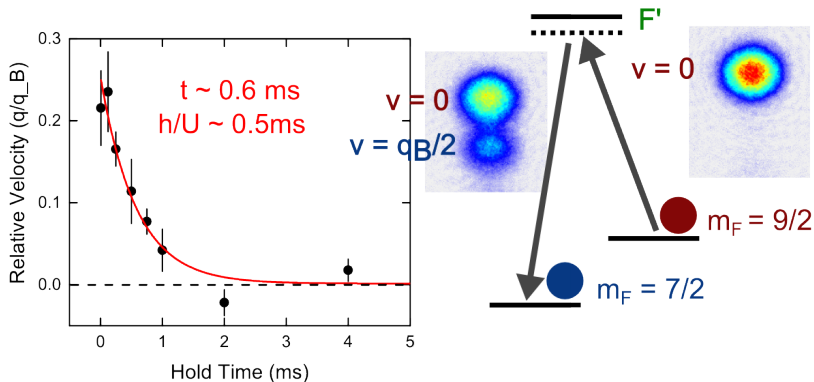
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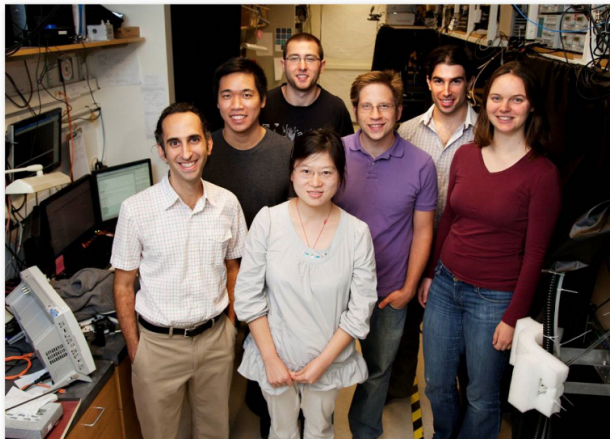
- Spin friction as analog of resistance



Currently looking for non-Fermi liquid behavior...



# Thanks!



Phil Russ

Stan Kondov

David Chen

Will McGehee

Carrie Meldgin

Brian DeMarco

Wenchao Xu



Will Morong