OLE - 1

DARPA "OLE" PROGRAM $20,000,000 over 6 years 2009-2014

↗ optical lattice emulation

Goal is to use ultracold trapped atoms to emulate condensed matter phenomenon.

Eg 2001 Superfluidity / Bose Einstein condensation
Nobel PRIZE

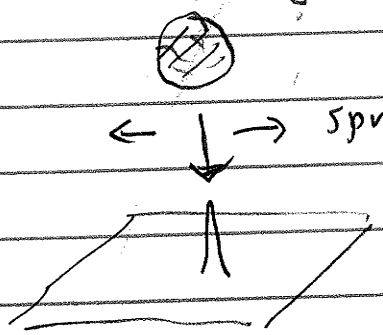
Q: what do you know about BEC?

A: $n(k=0)$ is huge.

How did they detect BEC?

Literally drop atoms and look for big peak in atoms dropping straight down

trapped gas



OLE-2

Monroe group - Maryland

Trying to emulate quantum spin models like

Heisenberg. Actual focus is "Ising in transverse field"

$$\hat{H} = \sum_{ij}' J_{ij} \hat{\sigma}_i^x \hat{\sigma}_j^x + B \sum_i \hat{\sigma}_i^z$$

not necessarily ~~near neighbor~~

standing wave of laser light gives lattice

$^{171}Yb^+$ ions two spin states

2009 3 spins

2014 18 spins

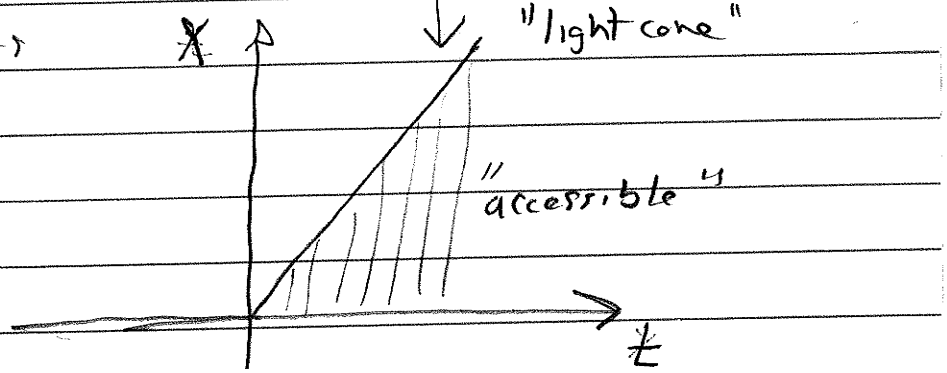
compare to HW problem

"Lieb Robinson bound"

If you twist spin at one end,

with what speed does signal propagate

down chain of spins



Apparently Lieb Robinson bound is understood

for J_{ij} = nn only but <u>not</u> otherwise.

Spins are <u>individually</u> addressible.

Ising transverse → XY transverse

$$\hat{H} = \sum J_{ij}\left(\hat{\sigma}_i^x \hat{\sigma}_j^x + \hat{\sigma}_i^y \hat{\sigma}_j^y\right) + B\sum \hat{\sigma}_i^z$$

Claim is

$$\hat{\sigma}_i^x \hat{\sigma}_j^x + \underbrace{B_y}_{\text{huge}}\left(\hat{\sigma}_i^y + \hat{\sigma}_j^y\right)$$

$$\rightarrow \hat{\sigma}_i^x \hat{\sigma}_j^x + \hat{\sigma}_i^y \hat{\sigma}_j^y$$