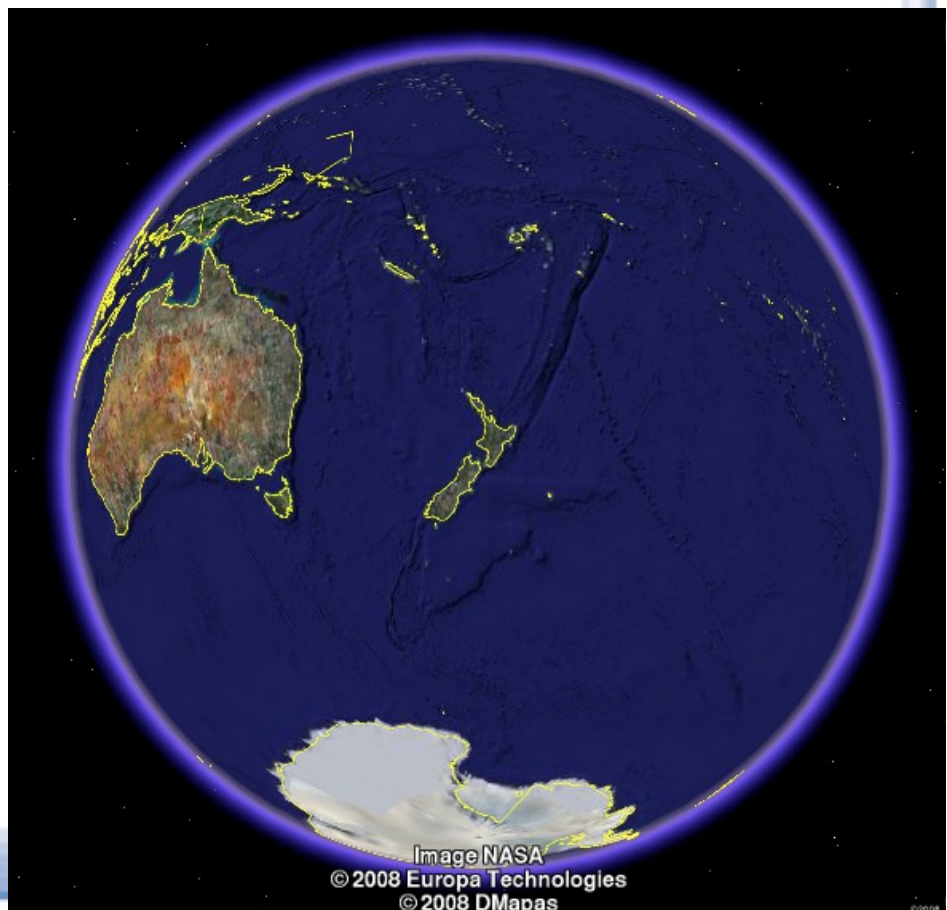
Dynamic systems

Maarten Hoogerland

University of Auckland



Today

- Anderson localisation
- Optical lattices

Anderson localisation

PHYSICAL REVIEW VOLUME 109, NUMBER 5 MARCH 1, 1958

Absence of Diffusion in Certain Random Lattices

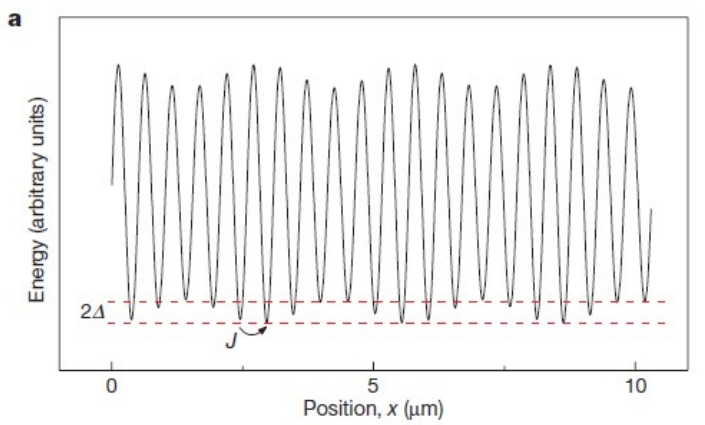
P. W. ANDERSON
Bell Telephone Laboratories, Murray Hill, New Jersey
(Received October 10, 1957)

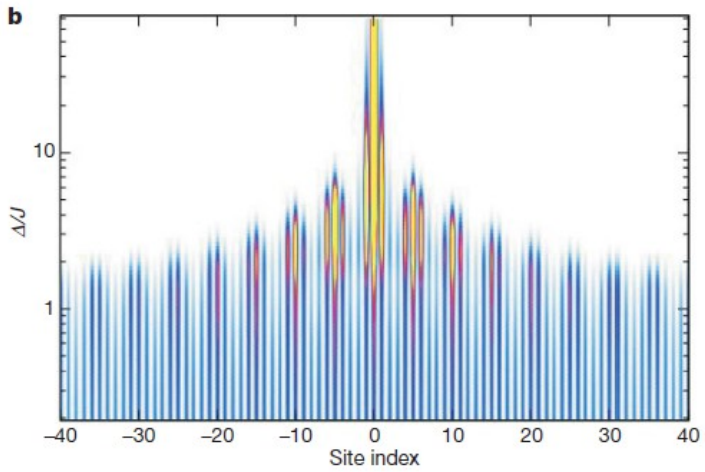
This paper presents a simple model for such processes as spin diffusion or conduction in the "impurity band." These processes involve transport in a lattice which is in some sense random, and in them diffusion is expected to take place via quantum jumps between localized sites. In this simple model the essential randomness is introduced by requiring the energy to vary randomly from site to site. It is shown that at low enough densities no diffusion at all can take place, and the criteria for transport to occur are given.

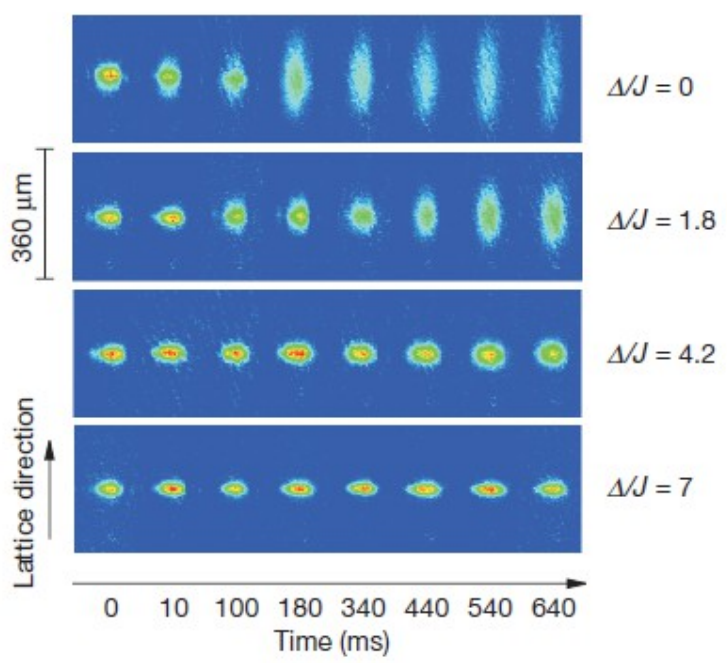
- "If the density is low enough, no diffusion takes place"

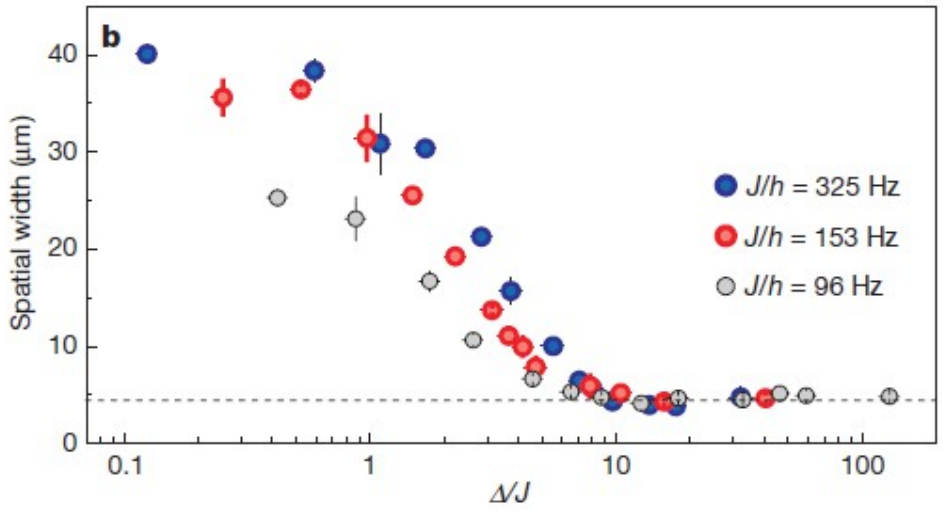
Inguscio experiment

Vol 453|12 June 2008|doi:10.1038/nature07071

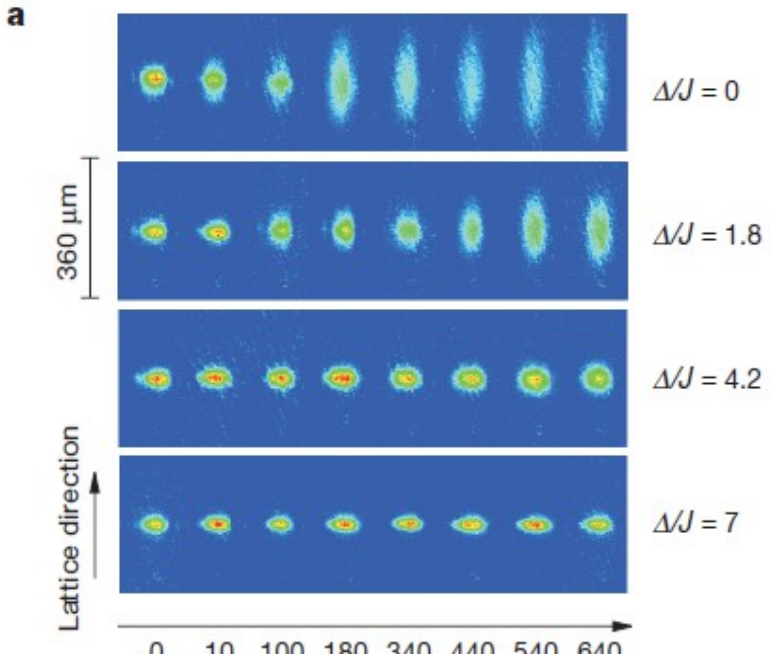


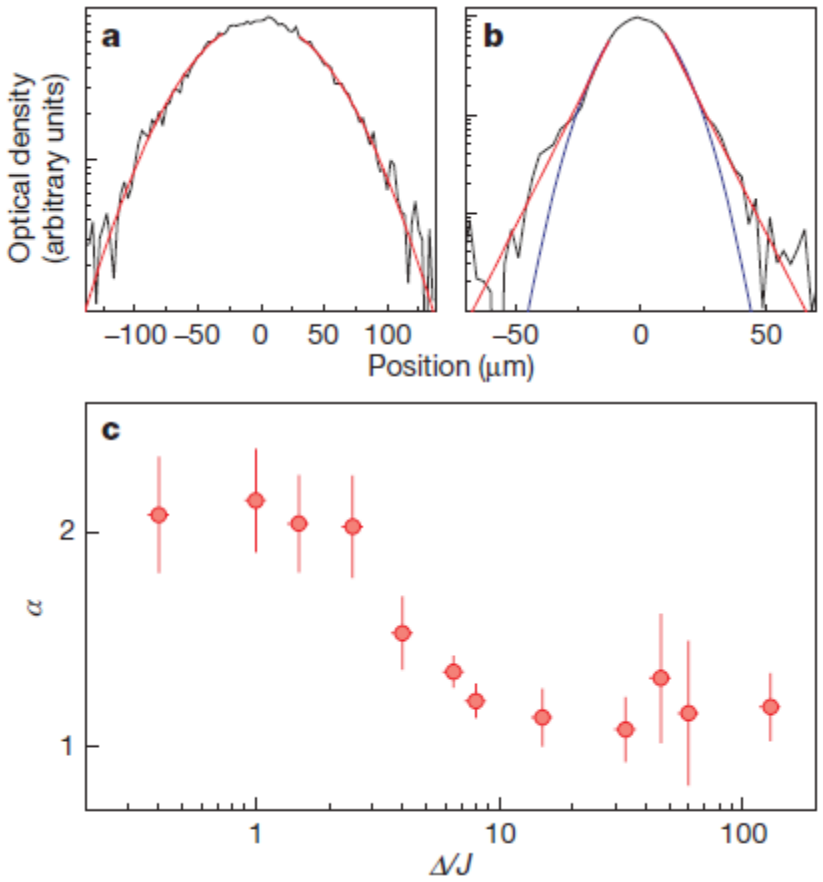




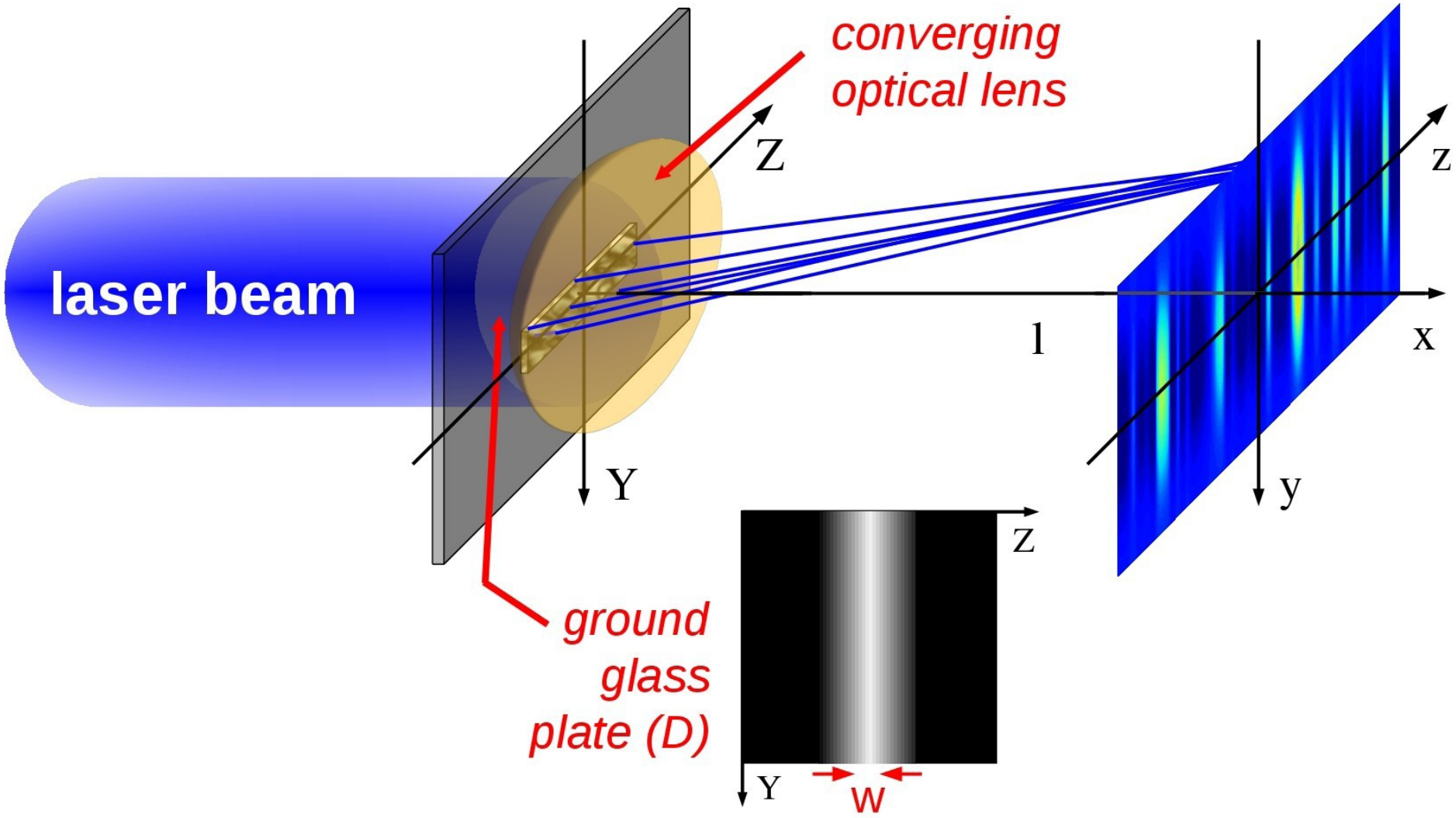


Inguscio experiment



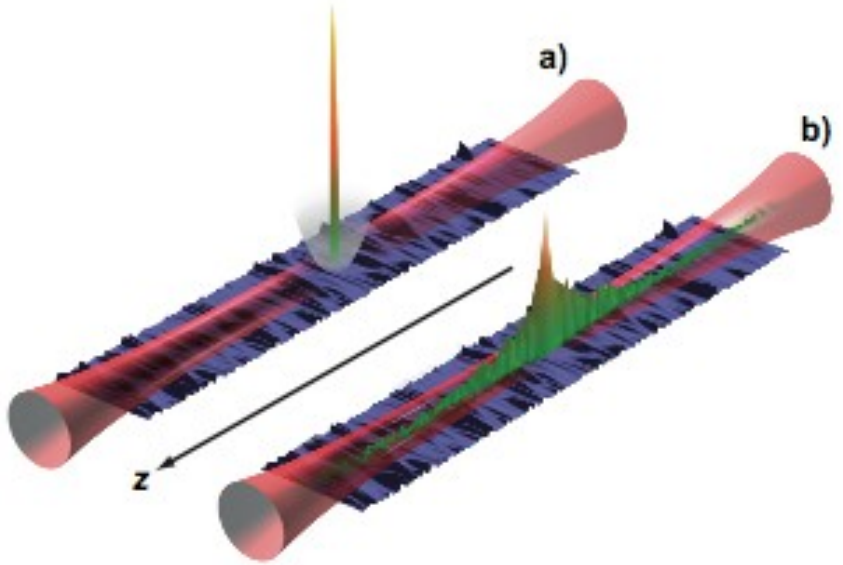


Disordered potentials



Aspect experiment (1)

- BEC in 1-D guide
- Random potential from frosted glass
- Strongly reduced transport

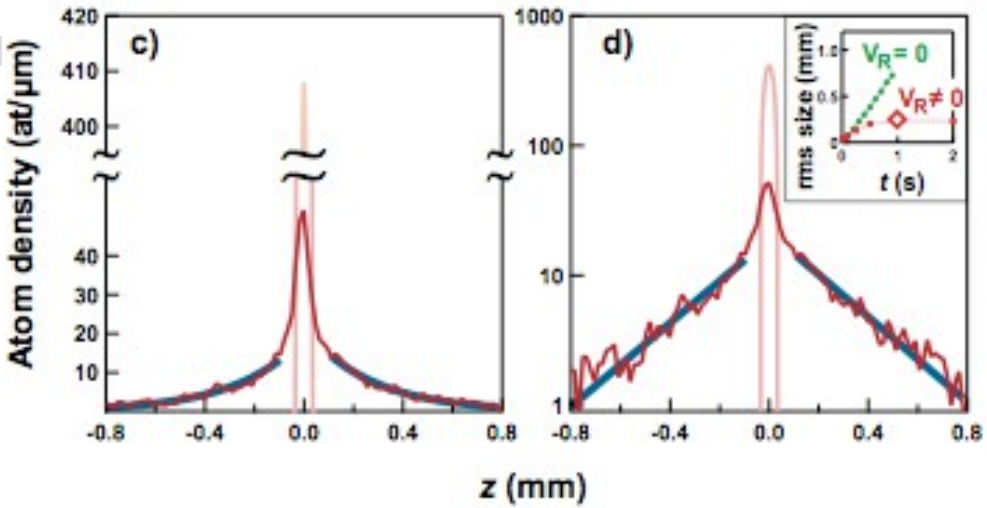


Vol 453|12 June 2008|doi:10.1038/nature07000 nature

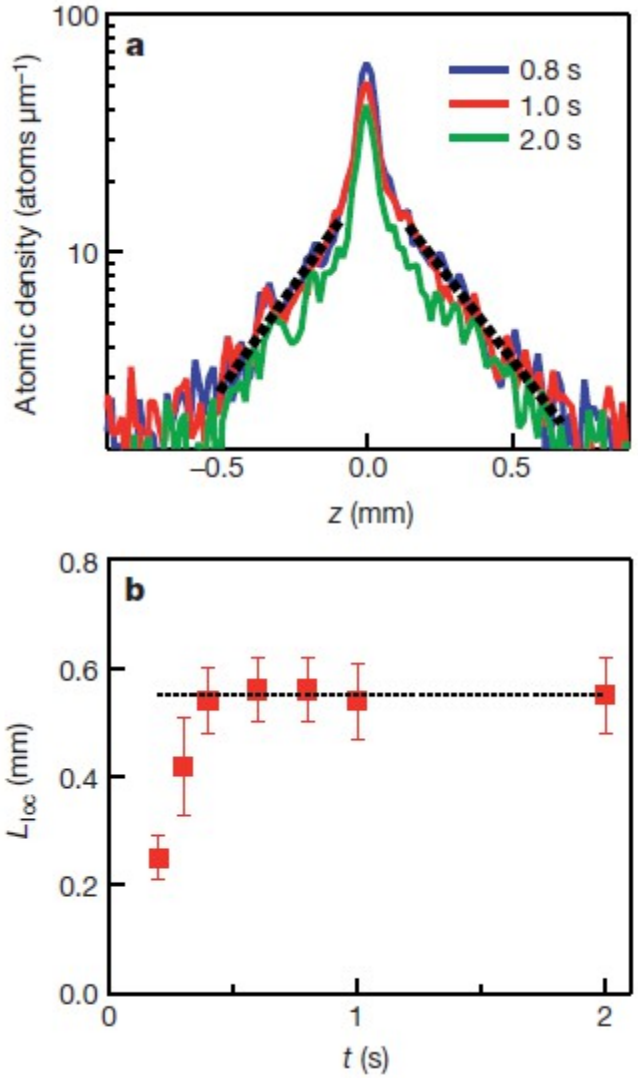
LETTERS

Direct observation of Anderson localization of matter waves in a controlled disorder

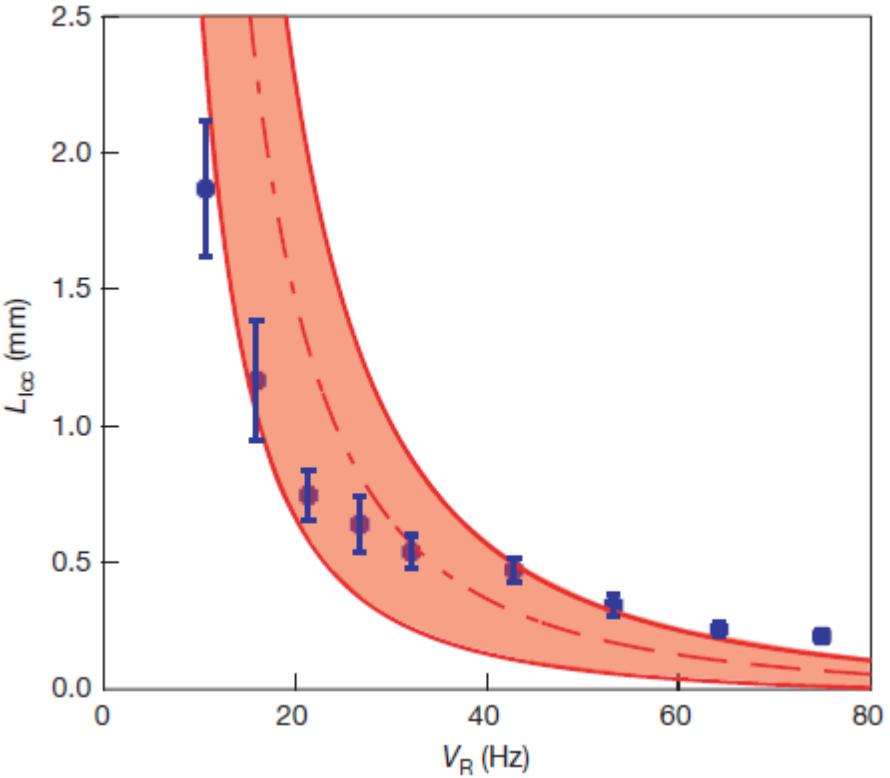
Juliette Billy[1], Vincent Josse[1], Zhanchun Zuo[1], Alain Bernard[1], Ben Hambrecht[1], Pierre Lugan[1], David Clément[1], Laurent Sanchez-Palencia[1], Philippe Bouyer[1] & Alain Aspect[1]



Results



Localisation length vs time



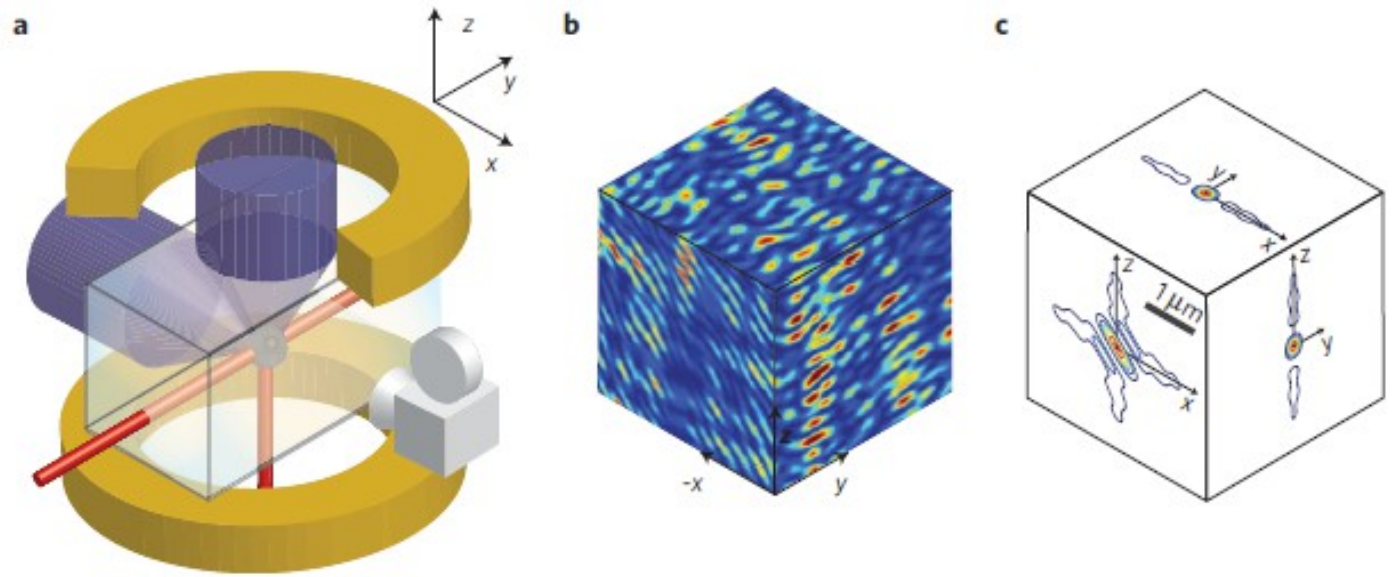
Localisation length vs potential depth

Aspect experiment (2)

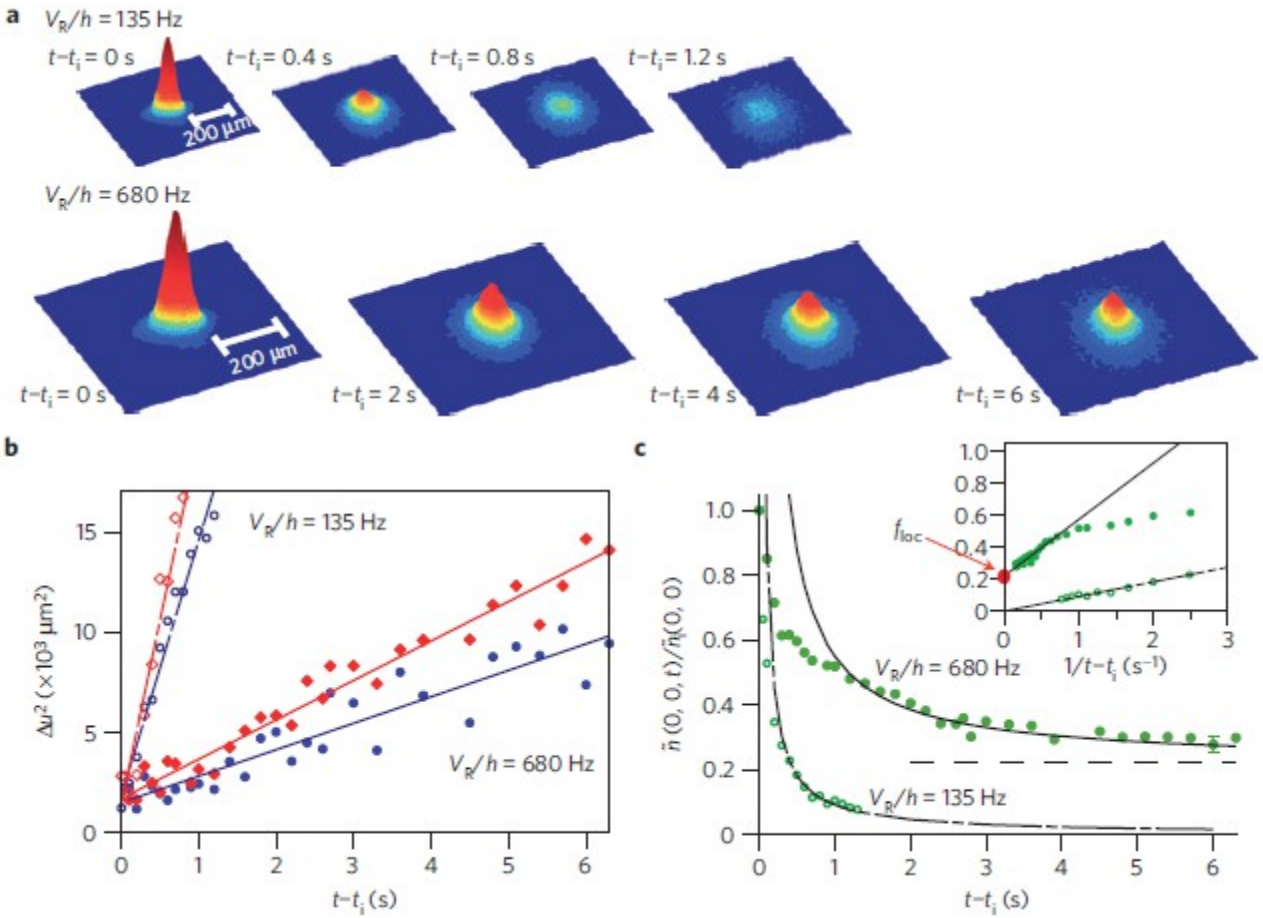
ARTICLES
PUBLISHED ONLINE: 4 MARCH 2012 | DOI: 10.1038/NPHYS2256
nature physics

Three-dimensional localization of ultracold atoms in an optical disordered potential

F. Jendrzejewski[1], A. Bernard[1], K. Müller[1], P. Cheinet[1], V. Josse[1]*, M. Piraud[1], L. Pezzé[1], L. Sanchez-Palencia[1], A. Aspect[1] and P. Bouyer[1,2]



3D results


a
V_R/h = 135 Hz
$t-t_i$ = 0 s
$t-t_i$ = 0.4 s
$t-t_i$ = 0.8 s
$t-t_i$ = 1.2 s
200 µm
V_R/h = 680 Hz
$t-t_i$ = 0 s
200 µm
$t-t_i$ = 2 s
$t-t_i$ = 4 s
$t-t_i$ = 6 s
b
V_R/h = 135 Hz
V_R/h = 680 Hz
Δu^2 ($\times 10^3$ µm^2)
$t-t_i$ (s)
c
f_{loc}
V_R/h = 680 Hz
V_R/h = 135 Hz
$1/t-t_i$ (s^{-1})
$\tilde{n}(0,0,t)/\tilde{n}(0,0)$
$t-t_i$ (s)

Optical lattices

Optical lattices

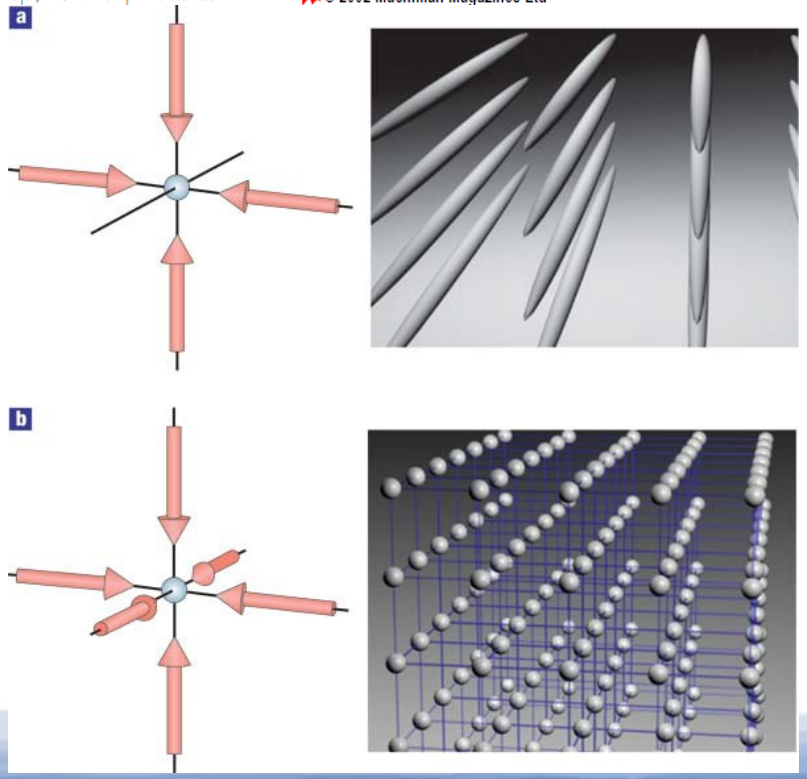
articles

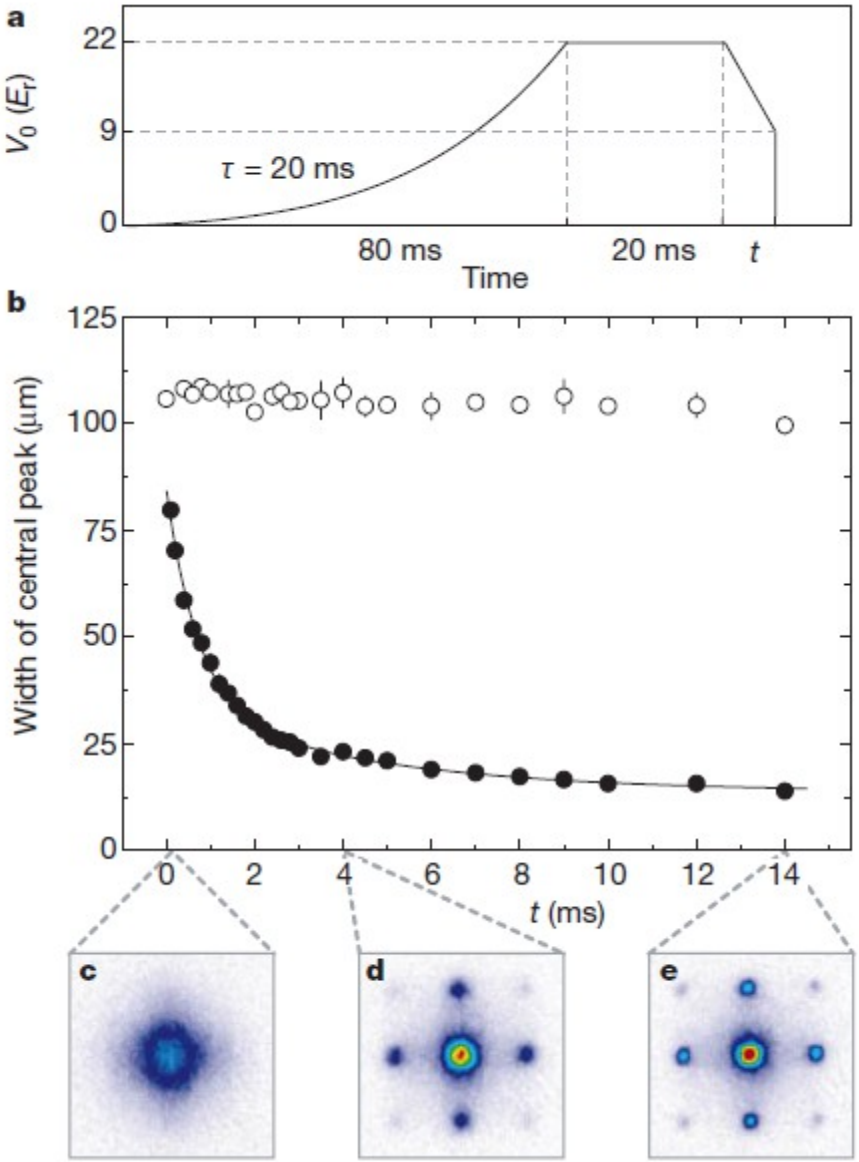
Quantum phase transition from a superfluid to a Mott insulator in a gas of ultracold atoms

Markus Greiner*, Olaf Mandel*, Tilman Esslinger†, Theodor W. Hänsch* & Immanuel Bloch*

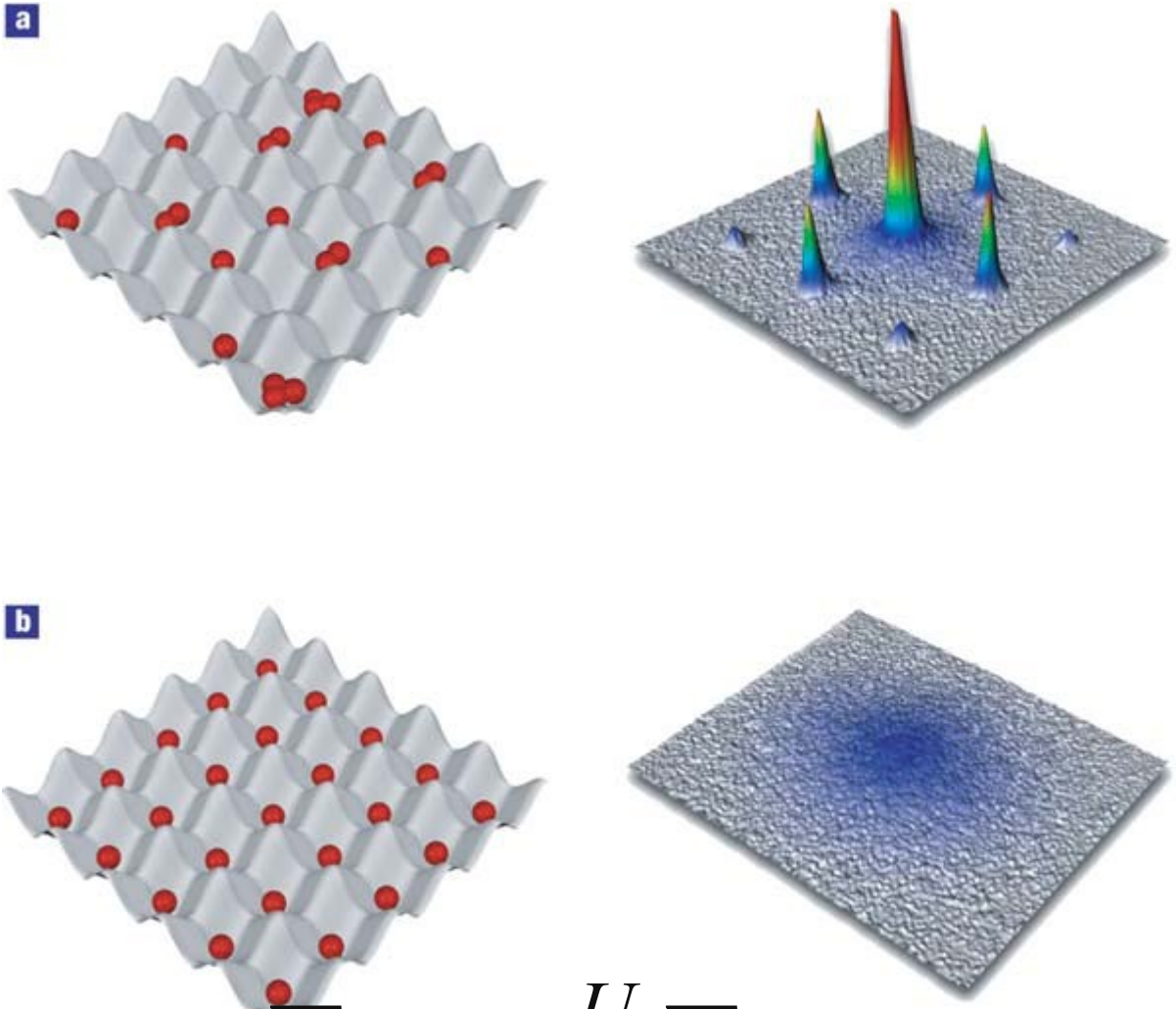
* Sektion Physik, Ludwig-Maximilians-Universität, Schellingstrasse 4/III, D-80799 Munich, Germany, and Max-Planck-Institut für Quantenoptik, D-85748 Garching, Germany
† Quantenelektronik, ETH Zürich, 8093 Zurich, Switzerland

NATURE | VOL 415 | 3 JANUARY 2002 | www.nature.com



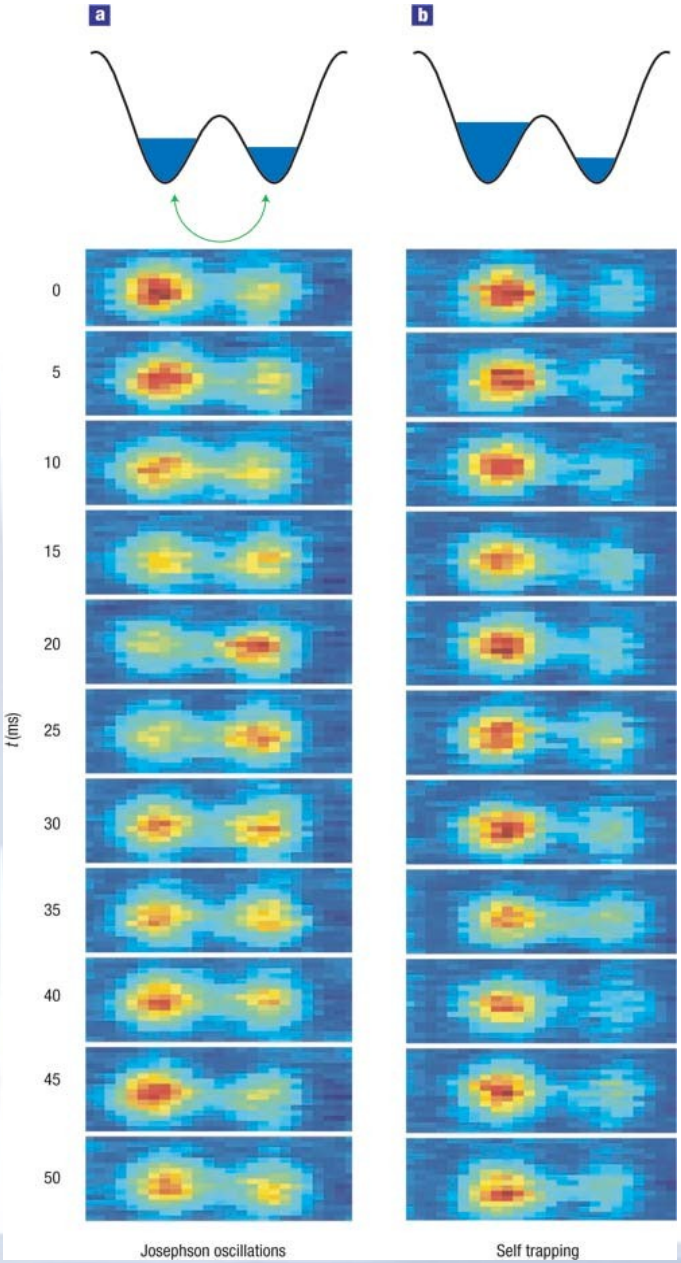


The central result



$$H = -J \sum_{ij} a_i^{+} a_j + \frac{U}{2} \sum_i n_i (n_i - 1)$$

Double well potential



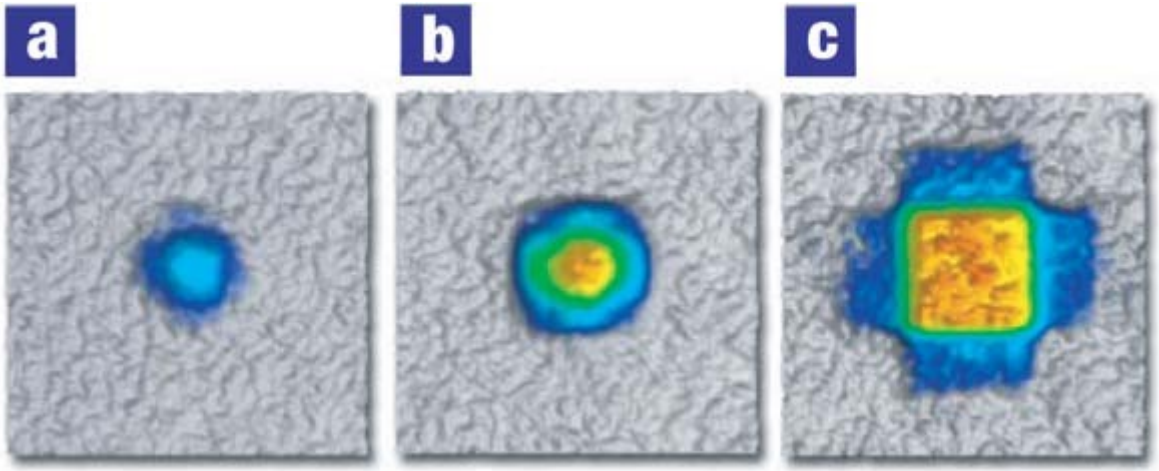
- Josephson junction
- For almost equal populations, oscillations
- For large population difference, self-trapping

PRL 95, 010402 (2005) PHYSICAL REVIEW LETTERS week ending 1 JULY 2005

Direct Observation of Tunneling and Nonlinear Self-Trapping in a Single Bosonic Josephson Junction

Michael Albiez,[1] Rudolf Gati,[1] Jonas Fölling,[1] Stefan Hunsmann,[1] Matteo Cristiani,[2] and Markus K. Oberthaler[1]
[1]*Kirchhoff-Institut für Physik, Universität Heidelberg, Im Neuenheimer Feld 227, D-69120 Heidelberg, Germany*
[2]*CNR-INFM, Dipartimento di Fisica E. Fermi, Università di Pisa, Largo B. Pontecorvo 3, I-56127 Pisa, Italy*
(Received 7 December 2004; published 27 June 2005)

Fermions



- Vary fill factor, leading to varying Fermi energy
- Adiabatically lower lattice
- Map crystal momentum to free momentum
- Köhl, M., Moritz, H., Stöferle, T., Günter, K. & Esslinger, T. Fermionic atoms in a 3D optical lattice: Observing Fermi-surfaces, dynamics and interactions. Phys. Rev. Lett. 94, 080403 (2004).

Physics in Auckland

- Exciting physics in an exciting place!
- Contact m.hoogerland@auckland.ac.nz