“The next big thing.”

Discussion, 2008 Boulder Summer School on Strongly Correlated Materials

1. Artificial Materials
2. Frustrated systems
3. New ways of looking at Quantum systems.
4. New methods of approximation/calculation.
5. New physical insight into unsolved problems
6. New experimental techniques and new materials/discoveries
7. Superconductivity

1. Artificial Materials

Achieving strongly correlated systems, such as the Fermi Hubbard model in optical lattices Qi Zhou

Analogies in artificial materials - cold atoms/optical lattices
- kondo lattice of stm atoms
kondo quantum dots
photonics/plasmonics
artificial spin ice penn state
heavy fermion in He films

Seiji Yamamoto

Materials engineered to test a theory. Along with cold atoms could include a material with a lattice of etched, depositied etc features that make it a physical manifestation of a particular many body model

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2. Frustrated systems

Are exotic models robust to realistic perturbations, or are they too fine-tuned to show up in real materials, or at finite T? Do they survive explicit symmetry breaking?

Doron Bergman

In the future, do you see quantum dimer models as an important mechanism for studying properties of Hamiltonians? Can these toy models remain relevant and or close to experiment?

Mayra Tovar

Detection of topological order, in e.g. frustrated magnets.

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3. New ways of looking at Quantum systems.

Quantal entanglement effects in condensed matter

Andrew Millis

Can we find a physical description of matter that goes beyond the Hamiltonian approach? Does Nature really do the calculations the way we do? (And if not, can we find a way to do calculations that is closer to nature?)

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4. New methods of approximation/calculation.

Better approximations to minimize the effect of the sign problem
for system sizes and problem types that were previously not tractable.

Bryan Clark

The discovery of new classes of Hamiltonian for which the projected
wavefunction is the exact ground state.

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5. New physical insight into unsolved problems

Understanding and classification of (i) non Fermi liquids and (ii) Quantum phase transitions

Tarun Grover

"Topological phases of matter" . Understand CM systems that exhibit phases and phase transitions that can not be described by the Landau theory of symmetry breaking. The ultimate goal and dream is to use these phases for topological quantum computing.

Roman Lutchyn

New composite degrees of freedom near the Mott transition where spin dynamics should be more collective.

Matasumi Udazawa

Description of strongly interacting fixed points of matter behavior.
Development of a framework that does not rely on the use of quasiparticles.
More generally, a non-fermi liquid theory. As we saw, Fermi liquid theory is in essence the non-interacting fixed point.

Pouyan Ghaemi

Solve the quantum dynamics of vortices and quasiparticles and their interactions in superconductors.

Rick Zou

A coherent explanation of T-linear resistivity in non-fermi liquids and materials exhibiting quantum critical phenomenon

Sri Raghu

Non-equilibrium quantum physics. What is the role of non-equilibrium physics in many body physics?
The sea of strongly correalted elextrons may not be so peaceful as we expected, and may possess many non-equilibrium excitations.

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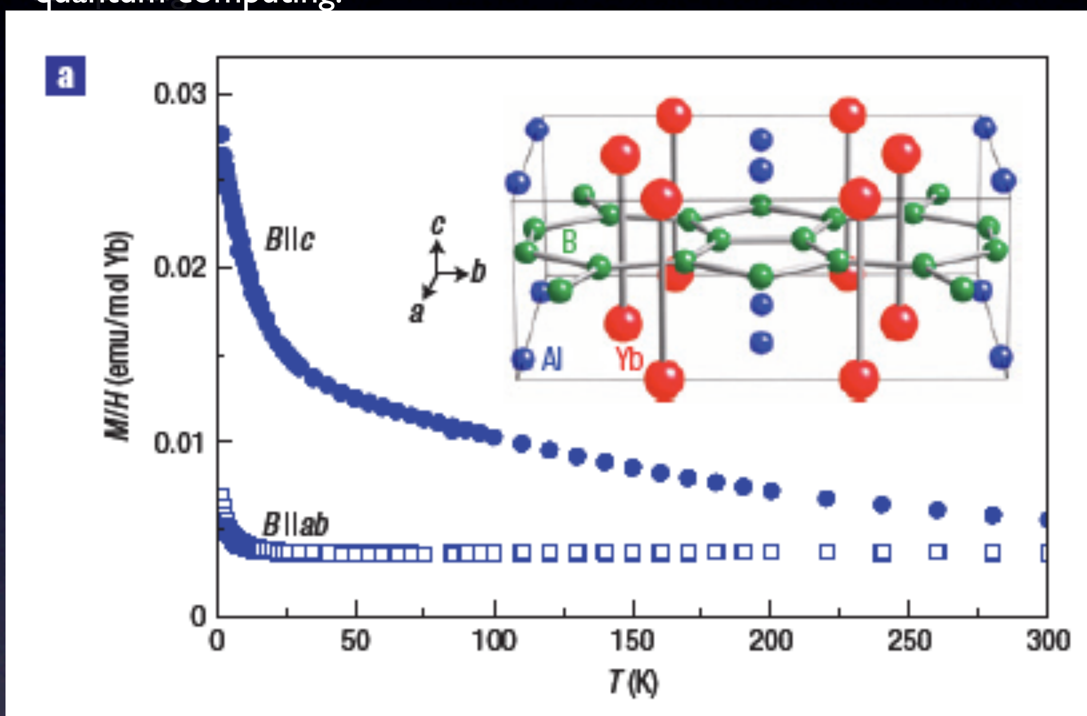

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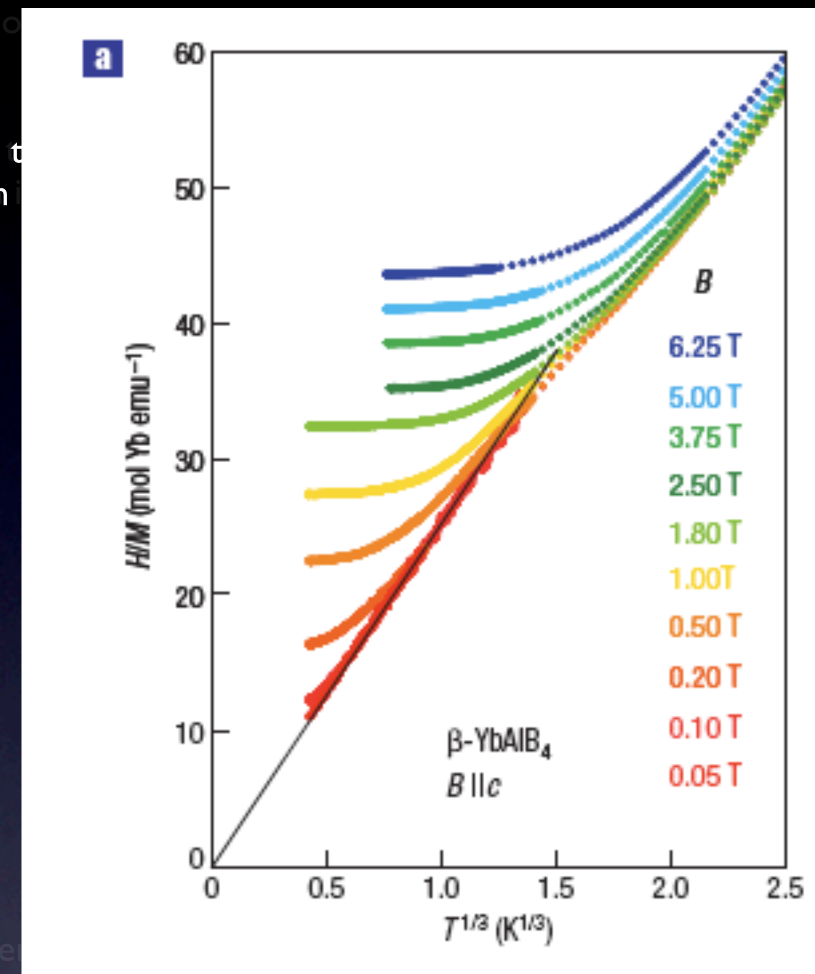

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Near field infrared spectroscopy. A way to defeat the diffraction limit and obtain the dielectric constant of a material with a resolution of approx 10 nm.

Alex Schafgans

Room temperature ferromagnetic Semiconductors

Ion Garate

The discovery of a system where non Abelian quasiparticles can be seen and better - be manipulated!

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The discovery of a material which exhibits a Fractional QHE in the absence of an external magnetic field.

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7. Superconductivity

Can new Iron-based superconductors help to solve the high Tc problem? What are the differences and similarities between the iron-based and copper based superconductors?

Daoxin Yao

Iron based superconductivity.

Jiansheng (Jason) Wu

Something people are more and more sure of, is that more high Tc SCs will be discovered in the future. But where?

Jian Wu.

Yet another accidental experimental discovery of a room temperature sc even before anybody understand the theory of "high Tc" superconductivity.

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THANK YOU!