Physics Open House 2012

Boston University Physics Department

Condensed Matter Theory
Condensed Matter Theory

We are a cohesive group that uses an array of theoretical methods to address relevant experimental problems in condensed matter physics.

Group Members

15 students, 3 post-docs, 7 visiting scientists/yr

David Campbell (nonlinear dynamics)
Antonio Castro Neto (graphene, now leave of absence)
Claudio Chamon (topological phases, fractionalization)
Bill Klein (kinetics and nucleation)
Pankaj Mehta (biophysics)
Anatoli Polkovnikov (quantum many-body dynamics)
Sid Redner (nonequilibrium dynamics, networks)
Anders Sandvik (quantum spin systems)
Eugene Stanley* (separate group, center for polymer studies)
Condensed matter physics deals with properties of interacting many-particle systems.

P. Anderson – more is different (Science, 1972).

“The ability to reduce everything to simple fundamental laws does not imply the ability to start from those laws and reconstruct the universe.”

“…the whole becomes not only more than the sum of but very different from the sum of the parts…”

Chaos makes deterministic predictions in large systems fundamentally impossible. Can only predict robust (universal) properties.
Research at Castro Neto’s group

Graphene: one atom thick material isolated in 2004.

Mother of fullerenes, nanotubes, and graphite

Unusual electronic spectra: Dirac Fermions

Technological revolution: atomically thin transistors; ultra-sensitive sensors; replacement for silicon.

New Science and Technology to be explored
Electron fractionalization in graphene-like structures

Transitions in and out of quantum topological phases

Quantum Glasses
Strongly-correlated electron systems and quantum spin systems

- CuO$_2$
- LaO
- CuO$_2$
- LaO
- LaO
- CuO$_2$

$c = 13.18 \text{ Å}$

$b = 3.78 \text{ Å}$

$a = 3.78 \text{ Å}$

$U$

$t$

superconductor
Research of Sid Redner

physics.bu.edu/~redner

Selected Topics

Non-equilibrium processes
  diffusion-controlled reactions
  dynamics of biological processes
  coarsening dynamics

Heterogeneous networks
  structural properties
  statistics of scientific citations

Complex systems
  consensus and frustration in social networks
  models of social competition; sports statistics
  dynamics of fads and other contagions

Extreme value/1st-passage phenomena
  global warming & record temperature events
  cell senescence
  vicious random walks
Universal quantum dynamics. Quantum geometry (together with A. Sandvik)

Interaction energy

Ising order parameter

Quantum-classical correspondence. Phase space methods.

Applications to cold atom systems

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