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Extremes and Enhancing Functionality of Thermal Conduction

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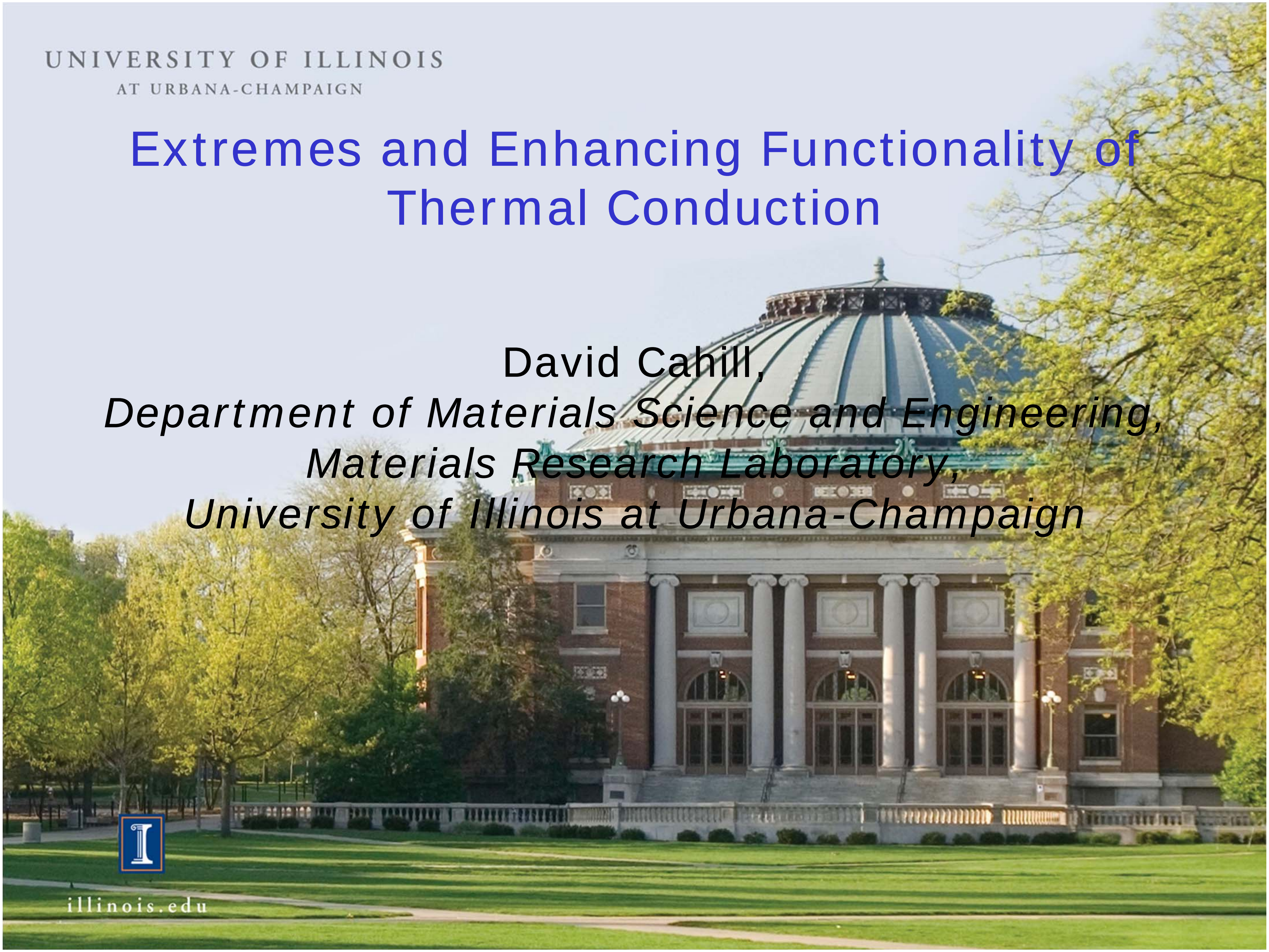

Scientific activities (Kuhn)

- We, as a community, have many examples of compelling “normal science”
  - transport in nanostructures and nanostructured materials
  - phonon mean-free-path distributions and connection to size and frequency-dependence
  - transport in graphene (2D) and nanotubes (1D)
  - interface conductance: weak, dissimilar materials, roughness, electron-phonon, metals, liquid-solid, vapor-solid
  - non-equilibrium between excitations (phonon-phonon, electron-phonon, magnon-phonon)
  - transport polymer crystals and liquid crystalline polymers
  - Wiedemann-Franz law in organic semiconductors

Scientific activities (Kuhn)

- Scientific “discovery” is driven by “problems”.
- What “problems” do we have in our community?
  - How close can we approach the perfect thermal insulator?
  - Are there routes to thermal conductivity higher than diamond? How can we create respectably high thermal conductivity in compliant materials?
  - How can we enhance thermal function, e.g., implement a passive temperature regulator, an active solid-state heat switch, or an efficient solid-state heat pump?
  - What thermal science of materials can we use to record information on few nanometer lengths scales at high rates with low energy use?

Materials, materials, materials

- Fullerene derivatives have a thermal conductivity a factor of 3 smaller than amorphous polymers. Could a foamed polymer be designed that exploits this science and thereby give the world a better thermal inslulator?
- Liquid crystal polymer fibers have a thermal conductivity of 20 W/m-K. Can this physics be exploited to design compliant interface materials or practical plastic heat exchangers?
- We can electrochemically modulate the thermal conductivity of Li_xCoO_2 by a factor of 2. Thermal conductivity of VO_2 films changes abruptly by a factor of 2 at the metal-insulator transition. Can this science of enhanced thermal function be extended to make solid-state thermal regulators, switches, and rectifiers?