

# Collaboration Excites Sustainable Energy Solutions



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## CURRENT RESEARCH

### Theory and experimentation combine to solve the Hubbard Problem

Eighty-five years after the formulation of Schrodinger's equation, computational quantum mechanics is a very successful field. A myriad of approximations exist that at reasonably low computational cost can get the "right answer for the right reason" for most molecules and materials. However, there is a dark secret to this success story: these methods break down for the strongly correlated electrons found in high-temperature superconducting materials. Higher temperature superconductors are central to the development of disruptive technologies for transmitting electricity without heat losses. A predictive quantum model is still lacking and is in fact deemed impossible by many. Dr. Gustavo Scuseria and Dr. Randy Hulet, of Rice University, are developing methods for computing and experimentally simulating solutions to the correlation problem as expressed in the Hubbard model--the primary model used to explain superconductivity. The convergence of radically new theoretical and experimental approaches presents a unique opportunity for advancing our understanding of strongly correlated matter.

In a recent breakthrough, Scuseria has proven that a simplified version of the very successful coupled cluster method of quantum chemistry can accurately model the near degeneracies and long-range character of strong correlation. This new theory paired with Dr. Scuseria's demonstration of an accurate and affordable description of extended systems has offered new and encouraging results. Meanwhile, Dr. Hulet has developed a new scheme to cool atoms to temperatures of a few nano-Kelvin on an "optical lattice" made from laser beams. Hulet uses atoms confined to an optical lattice to simulate the behavior of electrons in the...

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## AFFILIATION



## EDUCATION

- B.S., in Physics, 1978, Stanford University
- Ph.D., in Physics, 1984, Massachusetts Institute of Technology

## AWARDS

- Willis E. Lamb Medal for Laser Science and Quantum Optics, 2011
- NASA Medal for Exceptional Scientific Achievement, 2004
- Member of the American Academy of Arts and Sciences, 2003
- Fellow of the American Physical Society, 1996
- I.I. Rabi Prize of the American Physical Society, 1995

## RESEARCH AREAS

Technology, Computational Sciences / Mathematics, Chemistry, Materials Science / Physics

## FUNDING REQUEST

Your contributions will support the continued collaboration of Dr. Gustavo Scuseria and Dr. Randy Hulet, of Rice University as they use novel methods to solve the Hubbard Problem. Donations will fund the necessary \$400K required each year for an expected four years of support for personnel and equipment. In choosing to donate, you will play a role in developing applications of importance for energy and the environment.