A Cooler Approach to Quantum Matter

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CURRENT RESEARCH

Exploring the behavior of exotic quantum materials to enable future technologies

Dr. David Weld at the University of California, Santa Barbara will tell you that his group's work on exotic quantum matter is truly basic research, but the ultimate goal of this research is to lay the groundwork for future technologies that will change the world.

Quantum mechanics is well-understood at the level of single particles like electrons. For groups of as little as a few dozen interacting particles, however, our exact theoretical understanding completely breaks down. Since a few grams of any material contain more electrons than there are stars in the universe, this "quantum many-body problem" is the main barrier to progress in understanding the behavior of complex electronic solids.

Dr. Weld's lab aims to revolutionize our understanding of quantum materials using an experimental technique called "quantum simulation". The basic idea is to use ultracold atoms to build tunable quantum systems with which to mimic the behavior of exotic materials. The overarching goal is a better understanding of quantum matter, which may open the door to a wide variety of future quantum technologies with transformative energy applications. Specific examples include next-generation thermoelectrics, non-thermalizable states of matter, and high-temperature superconductors.

Results of this research will have immediate relevance to four of the five "grand challenges for science and the imagination" identified by the US Department of Energy:

- How do we control materials processes at the level of electrons?
- How do we design and perfect atom- and energy-efficient synthesis of revolutionary new forms of matter with tailored properties?...

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AFFILIATION

University of California, Santa Barbara

EDUCATION

- B.A., in Physics, 1998 ,Harvard University
- Ph.D., in Physics, 2006 ,Stanford University

RESEARCH AREAS

Technology, Materials Science / Physics, Space

FUNDING REQUEST

Your contributions will help Dr. Weld's lab build and maintain two ultracold atom machines which cost about one million dollars each and $100K per machine per year to maintain. The lab is also seeking funding on the order of $500K for a "quantum gas microscope" which would allow manipulation and readout of samples at the single-atom level. Finally, funding is always being sought to enable talented postdoctoral researchers, graduate students, and undergraduates to join the Weld lab research team.