

# This Week in Physics

SYRACUSE UNIVERSITY  
College of Arts & Sciences

Week of  
April 13, 2009

[http://www.phy.syr.edu/  
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## THURSDAY, APRIL 16

Colloquium

4:00 PM, Rm 202 (refreshments 3:30 PM)

Prof. John Clarke (UC Berkeley)

*The Ubiquitous SQUID: From Cosmology to Medicine*

The SQUID (Superconducting QUantum Interference Device) is an ultrasensitive detector of magnetic flux that combines the phenomena of Josephson tunneling and flux quantization. I briefly describe the principles of the SQUID and its practical implementation. With the aid of a superconducting flux transformer, the SQUID achieves a magnetic field noise below  $10^{-15}$  T/Hz<sup>1/2</sup>. SQUIDs are having significant impact on cosmology. It is now accepted that the major constituents of the universe are dark energy and cold dark matter, both of which are of unknown origin. Several telescopes around the world are imaging galaxy clusters at far infrared frequencies to investigate dark energy. These telescopes contain many hundreds of superconducting sensors coupled to SQUIDs. A candidate particle for cold dark matter is the axion which, in the presence of a magnetic field, is predicted to decay into a photon with energy given by the axion mass. A search for the axion is underway at the Lawrence Livermore National Laboratory. A near-quantum limited SQUID amplifier will decrease the search time by three orders of magnitude compared with that achieved with semiconductor amplifiers. In the area of medical physics, we use a SQUID to obtain magnetic resonance images (MRI) in a magnetic field of 132 mT, corresponding to a proton Larmor frequency of 5.6 kHz—four orders of magnitude lower than in conventional MRI. Low fields yield much greater differences in the relaxation time ( $T_1$ ) of different tissue types compared with high fields. In preliminary experiments, we have measured  $T_1$  in *ex vivo* specimens of surgically removed healthy and malignant prostate tissue. The values of  $T_1$  in healthy tissue are typically 60% higher than in malignant tissue, suggesting that ultralow field MRI may have clinical applications to imaging cancer.

## FRIDAY, APRIL 17

Condensed Matter/Biological Physics Seminar

11:00 AM, Rm 202

Prof. John Clarke (UC Berkeley)

*Flux 1/f Noise in Qubits and SQUIDs: The Saga Continues*