PHYSICS COLLOQUIUM MONDAY APRIL 11, 2016

3:00 pm

RNS 290

TITLE

Magnetism and Mu dynamics in Vanadium Dioxide compounds and other current research interests

PRESENTER

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ABSTRACT

Vanadium Dioxide (VO_2) compounds show a metal-semiconductor transition (MST) near room temperature (stoichiometric VO_2 is metallic T > T_{MST} ≈ 340K and semiconducting T< T_{MST}) that is accompanied by a structural transition; both can be triggered by thermal, optical, electrical or barometric means. This ultra fast ($t \sim 10^{-12} - 10^{-3}$[sec] timescale) transition has been studied for decades and there is still considerable disagreement regarding the mechanism(s) responsible for these transitions. Incorporation of a few atomic percent of hydrogen in VO_2 stabilizes the metallic phase down to 200 K. Other impurities such as tungsten, titanium, gold, chromium or fluorine lower or raise T_{MST} *without* significantly modifying the electronic, optical or switching properties. The *effects* that dopants have on the material properties are fairly well known, however, the *role* these dopants play in modifying them is far from understood. [1]

Our group has been working on characterizing the local magnetic environment and understanding the properties of hydrogen in VO_2 compounds by way of Muon Spin Rotation and Relaxation (MuSR) experiments and long wavelength neutron diffraction measurements. MuSR measurements implant 100% spin polarized and positively charged muons (μ^+: $q = +e$, $S = \frac{1}{2}$, $m_\mu \approx \frac{1}{9} m_p$, τ_μ~2.2 μs) in a material where the μ^+ directly probes the local [microscopic] magnetic and electronic environment while also serving as an experimentally accessible analog to a hydrogen impurity. [2]

This talk will discuss our recent MuSR experiments focused on investigating the Mu/H properties within VO_2 compounds and the newly discovered (by us) low temperature magnetic phase [3]. Additionally, this talk will provide an introduction to MuSR and a brief summary of some of our other recent projects, which include

- Mu/H formation, stability and motion in transparent conducting oxides [4]
- Characterization of the Mu impurity in SiGe alloys
- Magnetism in Mn doped II-IV-V_2 chalcopyrites
- Survey of spin polaron candidate materials

Additional detail and references are available at www.phys.ttu.edu/~pmengyan .

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[1] i.e.: F.J. Morin, *Phys Rev Lett* **3** (1959) 34.; M.M. Qazilbash, et al., *Science* **318** (2007) 1750.; M.S. Laad, et al. *Phys Rev B* **73** (2006) 195120.; A. Pergament, *Phys: Condens Matt* **15** (2003) 3217.; A. Cavalleri, et al. *Phys Rev Lett* **87** (2001) 237401-1

[2] J.H. Brewer, in *Encyclopedia of Applied Physics*, edited by G.L. Trigg, (VCH, New York, 1994), Vol 11, pp.23-53.; A. Yaouanc and P.D. de Reotier, *Muon Spin Rotation, Relaxation and Resonance: Applications to Condensed Matter* (Oxford Press, New York, 2011).

[3] P.W. Mengyan, et al, *J Phys Conf Ser* **551** (2014) 012017

[4] i.e.: R.C. Vilao, et al. *Phys Rev B* **92** (2015) 081202(R).; P.W. Mengyan, RB1520339: Effects of IR Illumination on Mu Dynamics and Mu^0 Formation in TiO_2. *RAL/ISIS Experimental Reports*. (2015)