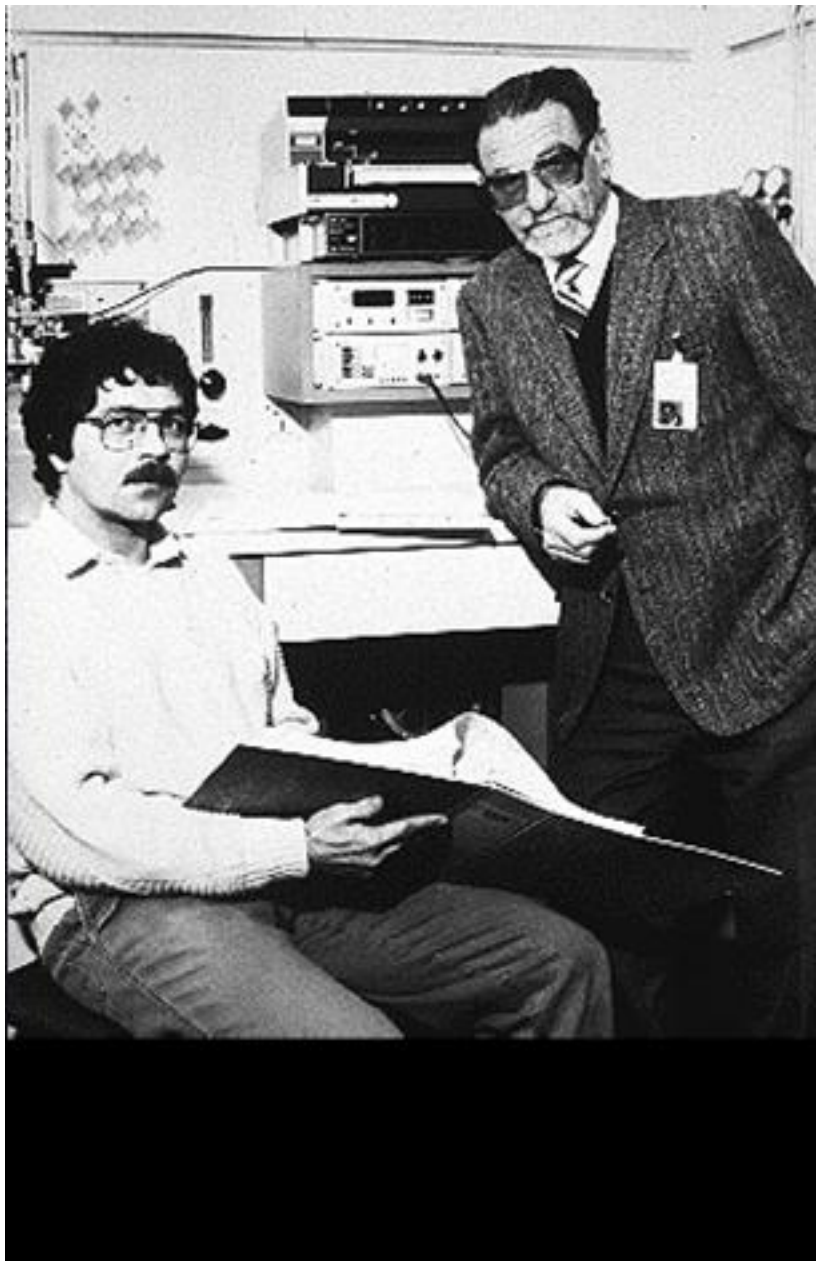
www.w2agz.com/epri-sctf6.htm

www.w2agz.com/asc06.htm



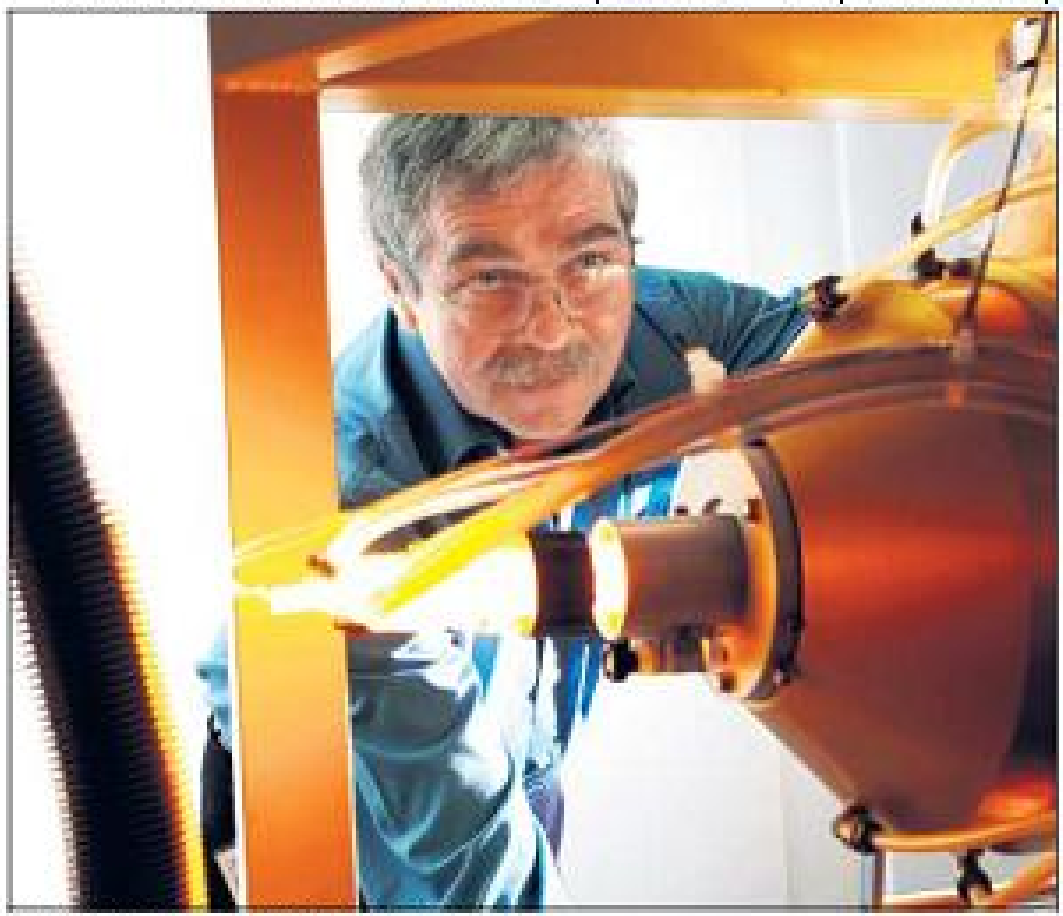
Associated Press

J. Georg Bednorz, left, and K. Alex Müller after learning they had won the Nobel Prize in physics.

2 Get Nobel for Unlocking Superconductor Secret

"Ich war wie in Trance"

Vor genau **20 Jahren** entdeckten Forscher am IBM-Labor Rueschlikon die Hochtemperatur-Supraleitung



NZZ am Sonntag – 22 Januar 2006

Search for New Cuprate Compounds at Stanford University - Update -

Paul M. Grant
Visiting Scholar in Applied Physics, Stanford University
EPRI Science Fellow (*retired*)
IBM Research Staff Member Emeritus
Principal, W2AGZ Technologies
w2agz@pacbell.net
www.w2agz.com

Steve Eckroad
Project Manager, EPRI Superconductivity Destinations 122
seckroad@epri.com

6th Annual EPRI Superconductivity Conference
Hosted by American Electric Power & Southwire, Inc.
13 - 14 September 2006, Columbus, OH

Stanford Applied Materials Team

- Ted Geballe, Emeritus Professor (discoverer of more than 100 superconductors)
- Mac Beasley, Professor of Applied Physics and former Dean of the Stanford School of Arts and Sciences (reported to Condi Rice)
- Bob Hammond, Research Professor (designed and built the GLAM MBS)
- Assisted by Gertjan Koster, Visiting Professor from the University of Twente, Hideki Yamamoto, Senior Scientist on sabbatical from the National Institute of Metals, Japan, and Wolter Siemons, PhD Candidate, Stanford and Twente Universities
- Paul Grant, Visiting Scholar in Applied Physics (Theory & Modeling)

"Possible High T_c Superconductivity in the Ba-La-Cu-O System," Georg Bednorz and K. Alex Mueller, IBM, 17th April 1986

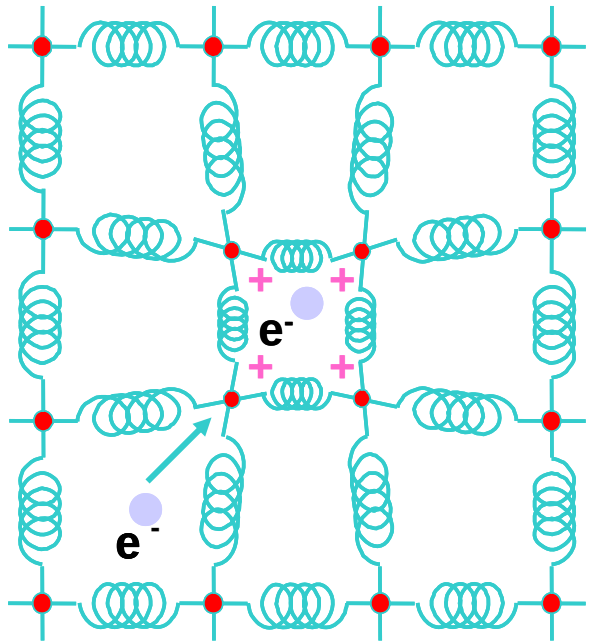
"At the extreme forefront of research in superconductivity is the empirical search for new materials"

M. R. Beasley, 1985

Superconductivity 101

Characteristic Boson Temperatures

- 300 K for phonons (LTSC)
- 500 K for magnons (HTSC ??)
- 11,000 K for excitons (RTSC ??)
- 10^9 K for gluons (quark “color” SC)



pairs

Fermion-Boson Coupling Constant

- Want this as big as possible
- Be near a critical point in LRO
- Look for materials with this property
- e.g., with metastable LRO

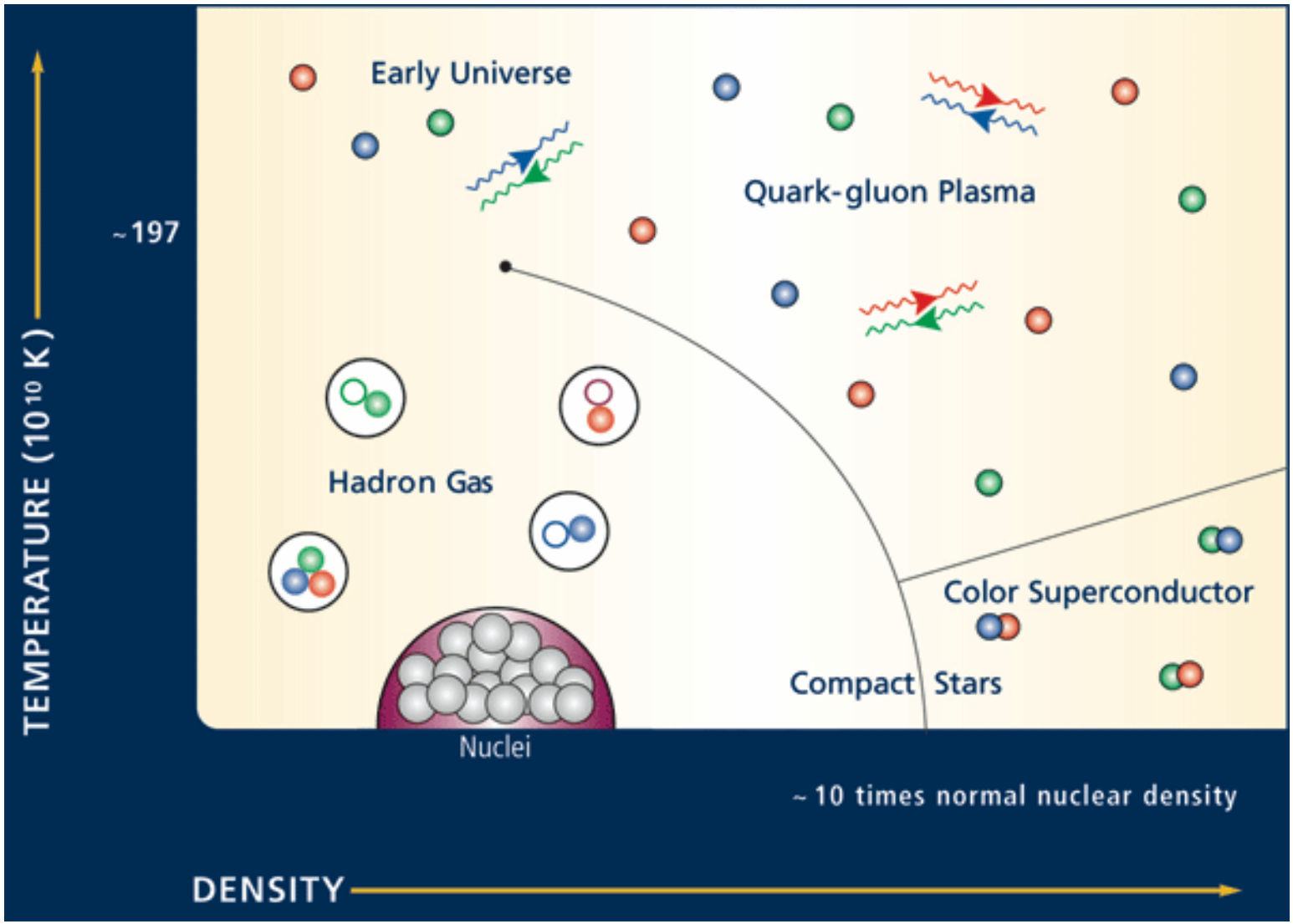
$\exp(-1/\lambda)$

75 K ,

28 ,

9.5 K (Niobium)

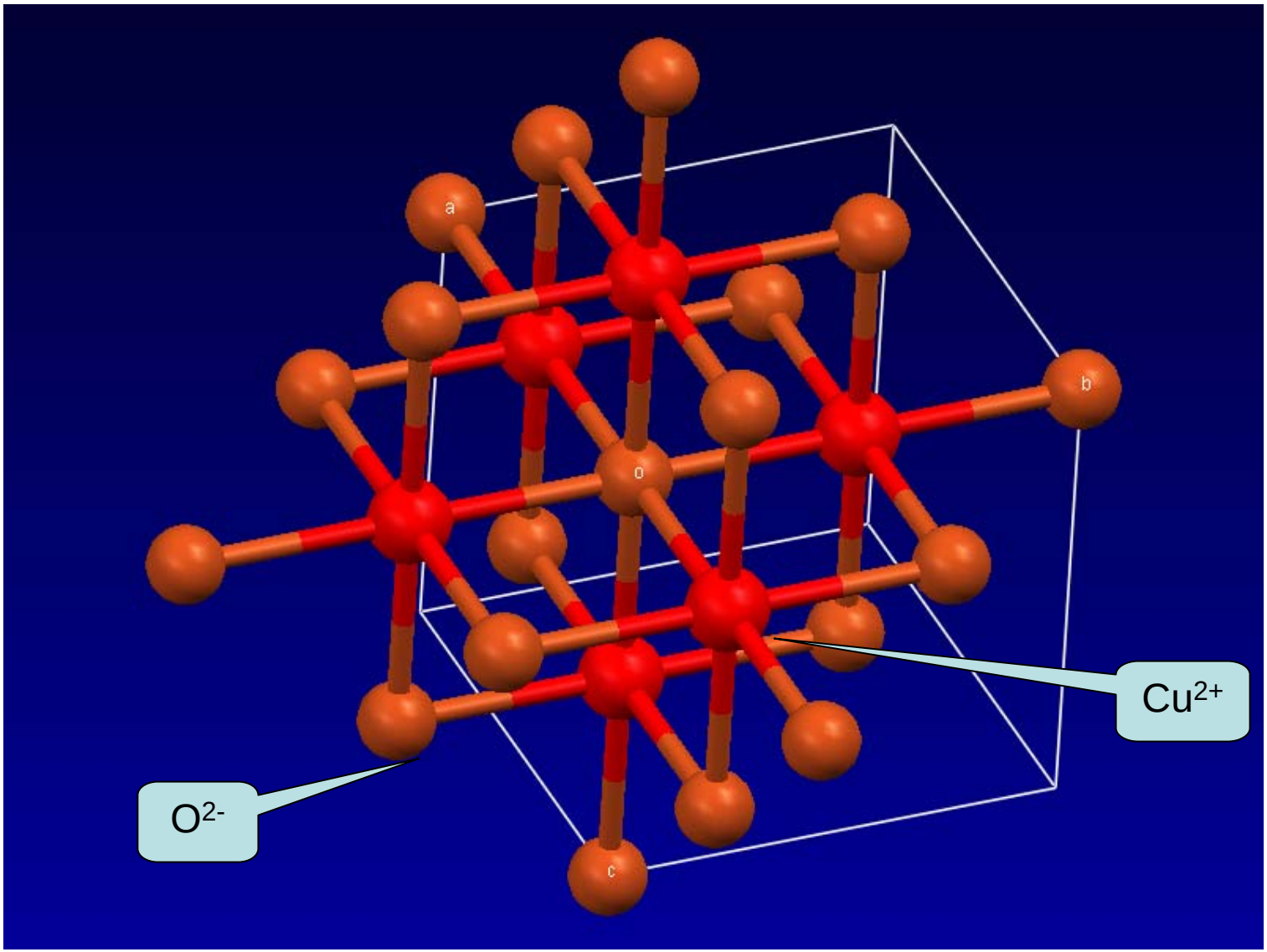
Quark "Color" SC in Neutron Stars



What to Do?

- The "mother liquor" of HTSC is in the doped copper – oxygen bond
  - The most basic form of copper oxide is the mineral tenorite, monoclinic in structure
  - Yet repeated attempts over the years to "dope it" resulted in nothing "interesting."
- Ted Geballe had had a long-standing idea
  - Try to use IBAD to force CuO into a metastable cubic phase (near an LRO critical point)
  - Then dope it and something "interesting" might show up!

CuO as Cubic MgO



Extended Hubbard Hamiltonian

Qualitative Description of the Physical Properties of Antiferromagnetic Insulators

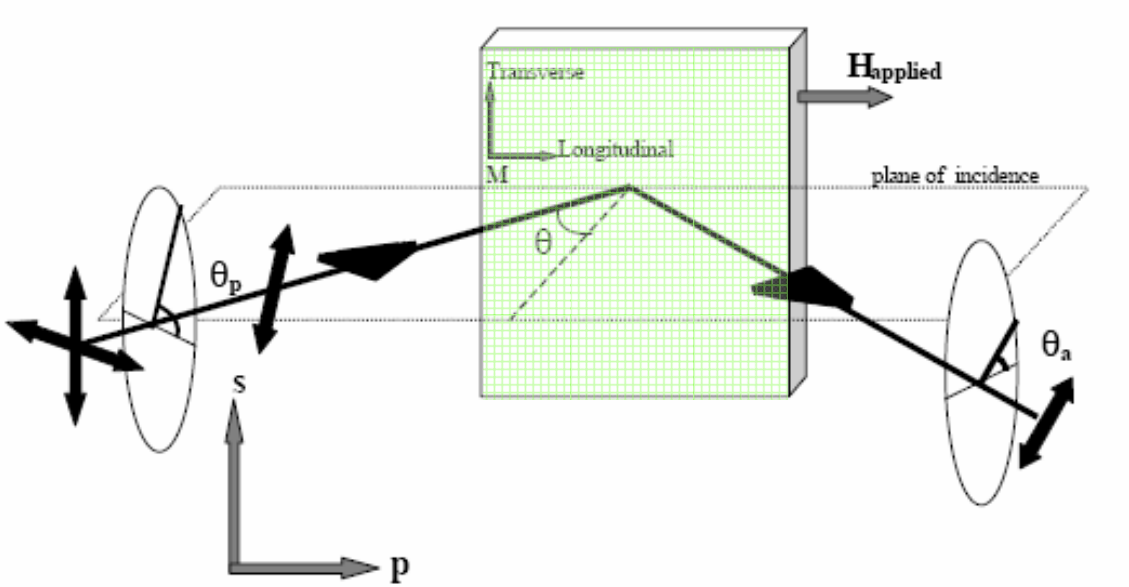
$$H = \sum_{\langle ij \rangle,\sigma} t_{ij} c_{i\sigma}^{\dagger} c_{j\sigma} + U \sum_{i} n_{i\downarrow} n_{i\uparrow} + \frac{V}{2} \sum_{\langle ij \rangle,\sigma,s} n_{i\sigma} n_{js}$$

This is the energy calculated in DFT which describes the physical properties of uncorrelated systems such as semiconductors and metals. This energy depends strongly on the interatomic bond length. “t” is the energy to transfer an electron from atom to atom, and the “c’s” create and annihilate electrons as they move from site to site.

This term represents the repulsive force between two electrons on the same ionic site. It tends to separate spins of opposite sign on nearest neighbor ions, thus producing an antiferromagnetic state. “U” is the repelling energy, and “n” is the occupation number (either) or 1) for each spin direction on ion “i”. It is independent of bond length, and thus is a simple constant for all crystallographic configurations involving the same elements.

This term is the repulsive energy between two electrons on separate ionic sites and thus dependent on bond length, but not included in the DFT formalism, and thus may play a role in setting the absolute value of the Ground State Energy for a given crystallographic configuration.

Sagnac MOKE Studies on Cubic CuO Films

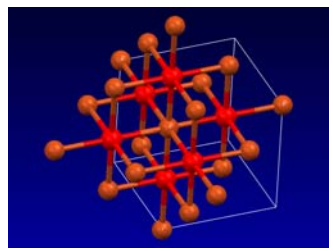


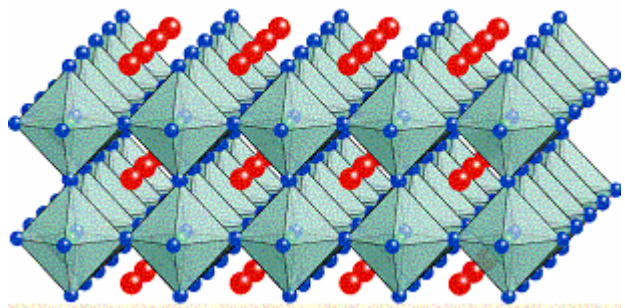
CuO (Antiferromagnetic Insulator ?)

$SrRuO_3$ (Ferromagnetic Metal)

$SrTiO_3$ (Insulator)

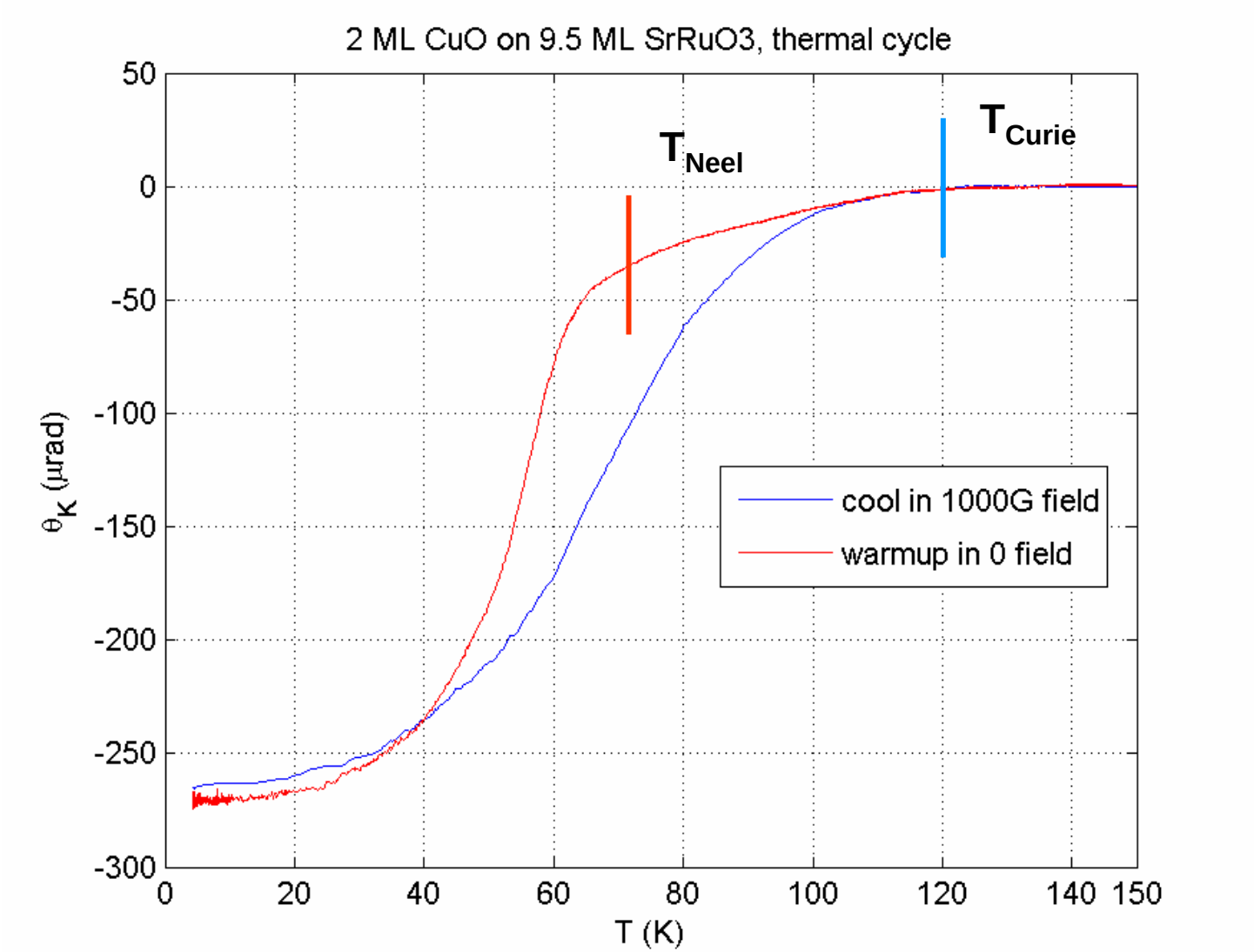
CuO



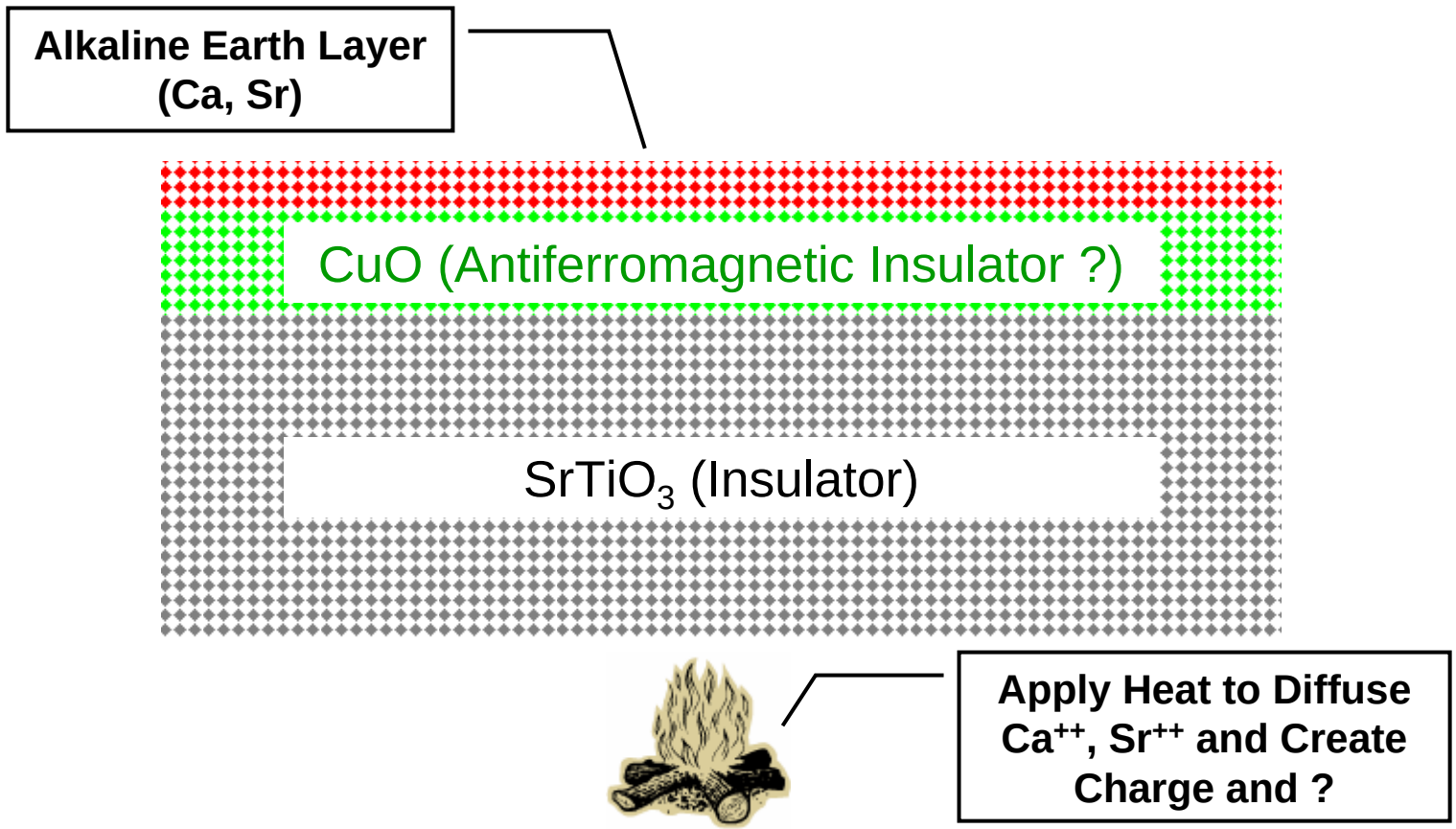


Perovskites

CuO – SRO Sagnac-MOKE



What's Next?


Alkaline Earth Layer
(Ca, Sr)
CuO (Antiferromagnetic Insulator ?)
$SrTiO_3$ (Insulator)
Apply Heat to Diffuse
Ca^{++}, Sr^{++} and Create
Charge and ?

Next Year & Beyond

- EPRI participation ends 12/31/06
  - Final Report to be issued
  - *Thank you, EPRI, for your support!*
- Project to continue through 2007
  - Supported by AFOSR
  - P. M. Grant will stay on as Stanford Visiting Scholar