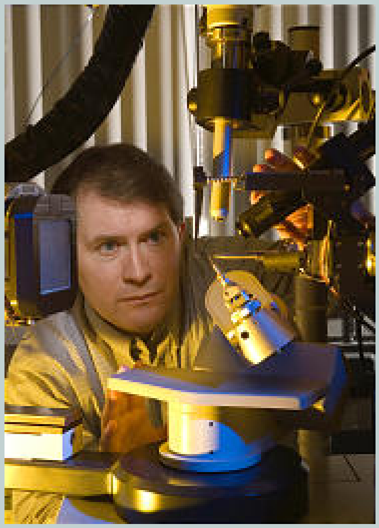
Newsletter

College of Physical and Mathematical Sciences

February 2007

In this issue:

Y. physicist zeroes in on superconductivity



Branton Campbell and colleagues hope to bring the world closer to a room-temperature superconductor.

Joe Bauman
Deseret Morning News
Monday, February 26, 2007

The discovery of a superconducting compound that would work at room temperature has been one of science's big dreams for more than 20 years. For example, the material could be used in transmission lines, and utilities would save enormous amounts of power now lost to resistance.

The dream is a step closer thanks to the research of a Brigham Young University physicist and colleagues. Branton Campbell was instrumental in solving a puzzle about differences in certain ceramic materials' superconducting properties.

Campbell, assistant professor of physics at the Provo university, teamed with Pengcheng Dai of the University of Tennessee and other scientists. They published findings in the Feb. 18 issue of the journal Natural Materials. The title of their report is a mouthful: "Microscopic annealing process and its impact on superconductivity in T'-structure electron-doped copper oxides."

In 1986, Georg Bednorz and Alex Muller made a breakthrough in physics with the discovery that nonmetallic materials — ceramics — could be used to create superconductors at higher temperatures than previously possible. Superconductors allow electricity to flow at zero resistance.

Higher is a relative term. In the past, metals were able to become superconductors at 4 to 15 kelvins — that is, 4 to 15 degrees above absolute zero. Absolute zero, the coldest possible state, is about minus-459 degrees Fahrenheit.

Bednorz and Muller found that superconductivity could happen in a ceramic material at what Campbell calls "a whopping 35 degrees kelvin." The announcement set off a scramble among scientists around the world. They searched for a new ceramic that would allow superconductivity at higher temperatures.

Eventually, materials were discovered that allowed superconductivity above the temperature of liquid nitrogen, permitting inexpensive experiments. The record, he said, is around 138 kelvins — "not anywhere close to 300, though."

Thee hundreds hundred kelvins is room temperature. People wonder if materials will be discovered that allow superconductivity at room temperature. If someone finds such a compound, he said, "fame and fortune will follow."

"You could lay rails out of the material" and have high-efficiency magnetic-levitation trains zooming across the landscape. Or high-voltage cables of the material would transmit electricity with no loss from resistance.

Meanwhile, scientists have been mystified by the fact that some copper-oxide ceramics don't become superconductors as easily as another type of the material. "Electron-doped" ceramics need to be heated and chemically treated before they work properly.

Why is that? Are two different laws of physics at work? Researchers need to understand the reason for the difference before they can work out a good theory of superconductivity in nonmetals.

January External Grants Awarded to Faculty

Department	Faculty	Project Title
Chemistry	**Reed Izatt**	Modeling and Thermodynamic Study of Selected Aqueous Chemical Reactions from 350 to 400 Degrees Cels.
Chemistry	**John Lamb**	Macrocycle-Based Ion Chromatography
Chemistry	**Milton Lee and Matt Linford**	New Diamond Materials for Chromatography
Chemistry	**Paul Savage**	Glycolipid Presentation by Cd1d (TH1/TH2 Glycolipid Adjuvants)
Mathematics and Chemistry	**John Dallon, Paul Ehrlich, and Earl Woolley**	Mathematic Differentiation of Regenerative From Scarring Repair
Geology	**John McBride**	CO_2 Sequestration in the Illinois Basin

Career Fair Preview a Hit

Kiersten Nielsen

In an effort increase student attendance at the Technical Career Fair held February 14, the Computer Science Department organized the first ever "Computer Science Career Fair Preview." The event, which took place Tuesday, February 13--the day before the fair--gave six employers from the computer science industry the chance to make presentations before a body of CS students. The companies chosen--Chief Architect, Lawrence Livermore National Laboratories (operated by the U.S. Department of Energy), Lockheed Martin, Microsoft, MIT Lincoln Laboratories (operated by the US Department of Defense), and National Instruments--hold some of the most promising opportunities for new graduates in CS but, with the exception of Microsoft, are relative unknowns to computer science students. Each company was given five minutes to inform students about their organization and available positions and then make their case as to why BYU CS students would want to work for them. After the main presentation, students were invited to chat informally with company representatives and then attend the career fair the following day.

The National Instruments booth at the Technical Career Fair February 14, 2007, the day after the Career Fair Preview. Many of the companies noted the increased number of CS students stopping by their booths at the Fair.

In all, the "Preview" was a hit with employers and students alike. Mark Bennett, a senior in Computer Science graduating this April, liked the mix of companies that presented and appreciated the chance to learn about jobs from a variety of areas in computer science. Christopher Corob, a junior in Computer Science also believed he benefited from the Preview, remarking that it was helpful to get an idea of the different types of companies that would be represented at the fair the following day. Likewise, the participating employers, most of whom were BYU alumni, had high praise for the Preview. They were grateful for the chance to get their message out, and many commented on the increased number of CS students who stopped by their booths the next day as a result. "This was an awesome opportunity to contact a larger number of students than we would have otherwise been able to," remarked Todd Sier of National Instruments. "We definitely want to be invited back next year."

Important Dates & Events in the College

March 2007

Thursday, March 1

Abstract deadline for Spring Research Conference

CS Colloquium, Rich Caruana, "Which Supervised Learning Method Works Best for What? An Empirical Comparison of Learning Methods and Metrics", 11 AM 1170 TMCB

Math Colloquium, Ken Ribert, 4 PM 3714 HBLL

Tuesday, March 6

Statistics Seminar, Melanie Wall, "Modeling multiple latent classes", 3:20-4:10 1170 TMCB

Wednesday, March 7

Math Seminar, David Cardon, 4 PM 133 TMCB

Physics Colloquium, Dan Reichart, 4 PM C215 ESC

Thursday, March 8

CS Colloquium, David Wolpert, "Probability Collectives and Supervised Learning", 11 AM 1170 TMCB

Geology Seminar, Paul Nixon, "Resources in the Arctic National Wildlife Reserve, Alaska", 11 AM C295 ESC

Monday, March 12

Chemistry Analytical Seminar, David Castner, "The Structure and Hybridization Properties of CAN Monolayers", 4 PM W140 BNSN

Tuesday, March 13

Chemistry Biochemistry Seminar, Kakoli Mitra, "Understanding the Mechanism of Ribosome-mediated Translation and Protein Translocation at Membranes", 4 PM W140 BNSN

Wednesday, March 14

Physics Colloquium, Karine Chesnel, 4 PM C215 ESC

Thursday, March 15

Chemistry Biochemistry Seminar, Janis Weis, "Genetic Regulation of Lyme Arthritis Severity in Mice", 4 PM W140 BNSN

CS Colloquium, Family History Technology Workshop, 11 AM 1170 TMCB

Geology Seminar, Mark P. Grasmueck, "Ground-Penetrating Radar Applications in Geology", 11 AM C295 ESC

Saturday, March 17

Spring Research Conference 8 AM Martin Building

Monday, March 19

Chemistry Organic Seminar, Richard A. Bunce, "Tandem Reactions in Heterocycle Synthesis", 4 PM W140 BNSN

Wednesday, March 21

Math Seminar, Xian-Jin Li, "On Zeros of L-functions for function fields", 4 PM 133 TMCB

Physics Colloquium, Tom O'Brien, 4 PM C215 ESC

Thursday, March 22

Geology Seminar, Ron Fodor, "Hawaiian magma differentiation" perspectives from Mauna Loa lave-lake blacks", 11 AM C295 ESC

Monday March 26

Chemistry Analytical Seminar, Michael Ketterer, "Plutonium in the Environment: Forensic and Geochmical Studies with Mass Spectrometry", 4 PM W140 BNSN

Tuesday, March 27

Statistics Seminar, Mevin Hooten, 3:20-4:10 1170 TMCB

Wednesday, March 28

Physics Colloquium, Jani Radebaugh, 4 PM C215 ESC

Thursday, March 29

CS Colloquium, Russ Eberhart, "Swarm Intelligence and Extended Analog Computing", 11 AM 1170 TMCB

Geology Seminar, Donna Blackman, "Ocean Drilling Project", 11 AM C295 ESC

Continued from Page 1

Campbell and team used an ingenious approach to look at the submicroscopic crystal structures of the two type of ceramics. An extremely powerful X-ray machine at Argonne National Laboratory, near Chicago, where he once was a post-doctoral researcher, bombarded samples of the materials with ultrathin streams of X-rays.

The X-ray streams were only 100 microns wide, about the diameter of a human hair. When the X-rays bounced off the crystals, special CCD cameras equipped to detect them mapped the X-ray scatter.

The technique showed the material's crystalline structure, detecting individual atoms in the lattice.

Campbell compared this to putting an object on a table, turning off the lights, blasting it with BBs shot from different angles and mapping where the ricocheting BBs struck the wall — and then using the distribution of bounced BBs to figure out what the object looks like.

The scattering of X-rays showed what the materials' crystalline structures were like on a tiny scale.

Results: before heating and chemical treatment, the electron-doped ceramics were structurally flawed. Heating and chemical treatment repaired the flaws.

"I identified lattice defects that were inhibiting superconductivity and showed that when the materials were repaired, they would superconduct," he said.

Two different laws of physics were not at work. The difference in performance was because one material was imperfect before treatment.

"The theorists are knocking themselves out" trying to develop a theory of how superconductivity in ceramics works. Now that they don't have to worry about two different laws of physics, a distraction is eliminated and they are closer to understanding the phenomenon.

Will room-temperature superconductivity ever become possible?

"I'm an optimistic person, and I believe it will happen," Campbell said. "We don't know when. ... I really think we'll be clever and it will work."

College Publications

Chemistry & Biochemistry

J. Zhang, X. Sun, K. M. Smith, F. Visser, P. Carpenter, G. Barron, Y. Peng, M. J. Robins, S. A. Baldwin, J. D. Young and C. E. Cass, "Studies of Nucleoside Transporters Using Novel Autofluorescent Nucleoside Probes," *Biochemistry*, **45**, 1087-1098 (2006).

Z. Janeba, N. Maklad, and M. J. Robins, "Synthesis of 6-(alkoxymethylk)- and 6-(alkylsulfanylmethyl)furo[2,3-d]pyrimidin-2(3H)-one analogues[1,2]," *Canadian J. Chem.*, **84**, 561-568 (2006).

Z. Janeba, J. Balzarini, G. Andrei, R. Snoeck, E. De Clercq, and M. J. Robins, "Synthesis and Biological Evaluation of 5-(alkyn-1-yl)-1-(p-toluenesulfonyl) uracil Derivatives[1,2]," *Canadian J. Chem.,* **84**, 580-586 (2006).

I. Nowak, C. T. Jones, and M. J. Robins, "Selective Removal of the 2'- and 3'-0-Acyl Groups from 2', 3', 5'-Tri-0-acylribonucleoside Derivatives with Lithium Trifluoroethoxide," *J. Org. Chem.*, **71**, 3077-3081 (2006).

S. F. Wnuk and M. J. Robins, "Ribonucleotide reductase Inhibitors as Anit-herpes Agents," *Antiviral Research*, **71**, 122-126 (2006).

M. Zhong, I. Nowak, J. F. Cannon, and M. J. Robins, "Structure and Synthesis of 6- (Substituted-imidazol-1-yl)purines: Versatile Substrates for Regiospecific Alkylation and Glycosylation at N9[1]," *J. Org. Chem.*, **71**, 4216-4221 (2006).

X. Lin and M. J. Robins, "Nucleic Acid Related Compounds. 136. Synthesis of 2-Amino- and 2,6-Diaminopurine Derivatives Via Inverse-Electron-Demand Diels-Alder Reactions[+]," *Collection of Czechoslovak Chemical Communications*, **71**, 1029-1041 (2006).

M. Zhong, I. Nowak, and M. J. Robins, "Regiospecific and Highly Stereoselective Coupling of 6-(Substituted-imidazol-1-yl)purines with 2-Deoxy-3,5-di-0-(p-toluoyl)-α-D- *erythro*-pentofuranosyl Chloride. Sodium-Salt Glycosylation in Binary Solvent Mixtures: Improved Synthesis of Cladribine[1]," *J. Org. Chem.*, **71**, 7773-7779 (2006).

I. Nowak, J. F. Cannon, and M. J. Robins, "N-Oxides of Adenosine-Type Nucelosides Undergo Pyrimidine Ring Opening and Closure to Give 5-Amino-4-(1, 2, 4-oxadiazol-3- yl)imidazole Derivatives," *Org. Lett.*, **8**, 4565-4568 (2006).

J. Zhang, K. M. Smith, T. Tackaberry, X. Sun, P. Carpenter, M. D. Slugoski, M. J. Robins, L. P. C. Nielsen, I. Nowak, S. A. Baldwin, J. D. Young, and C. E. Cass, "Characterization of the Transport Mechanism and Permeant Binding Profile of the Uridine Permease Fui1p of Saccharomyces Cerevisiae," *J. Biological Chem.*, **281**, 28210-28221 (2006).

I. Nowak and M. J. Robins, "Addition of Difluorocarbene to 4',5'-Unsaturated Nucleosides: Synthesis and Deoxygenation Reactions of Difluorospirocyclopropane Nucleosides[1]," *J. Org. Chem.*, **71**, 8876-8883 (2006).

S.P. Ziemer and E.M. Woolley, "Thermodynamics of proton dissociations from aqueous threonine and isoleucine at temperatures from (278.15 to 393.15) K, molalities from (0.01 to 1.0) $mol \cdot kg^{-1}$, and at the pressure 0.35 MPa: apparent molar heat capacities and apparent molar volumes of zwitterionic, protonated cationic, and deprotonated anionic forms," *J. Chem. Thermodynamics* **2007**, 39, 67-87.

S.P. Ziemer and E.M. Woolley, "Thermodynamics of proton dissociations from aqueous methionine at temperatures from (278.15 to 393.15) K, molalities from (0.0125 to 1.0) $mol \cdot kg^{-1}$, and at the pressure 0.35 MPa: apparent molar heat capacities and apparent molar volumes of methionine, methioninium chloride, and sodium methioninate," *J. Chem. Thermodynamics* **2007**, 39, 493-506.

J.S. Jones, S.P. Ziemer, B.R. Brown, and E.M. Woolley, "Apparent molar volumes and apparent molar heat capacities of aqueous magnesium nitrate, strontium nitrate, and manganese nitrate at temperatures from 278.15 K to 393.15 K and at the pressure 0.35 MPa," *J. Chem. Thermodynamics* **2007**, 39, 550-560.

M.B. Blodgett, S.P. Ziemer, B.R. Brown, T.L. Niederhauser, and E.M. Woolley, "Apparent molar volumes and apparent molar heat capacities of aqueous adonitol, dulcitol, glycerol, *meso*-erythritol, *myo*-inositol, **D**-sorbitol, and xylitol at temperatures from 278.15 K to 368.15 K and at the pressure 0.35 MPa," *J. Chem. Thermodynamics* **2007**, 39, 627-644.

S.P. Ziemer and E.M. Woolley, "Thermodynamics of the first and second proton dissociations from aqueous aspartic acid and glutamic acid at temperatures from (278.15 to 393.15) K and at the pressure 0.35 MPa: apparent molar heat capacities and apparent molar volumes of zwitterionic, protonated cationic, and deprotonated anionic forms at molalities from (0.002 to 1.0) $mol \cdot kg^{-1}$," *J. Chem. Thermodynamics* **2007**, 39, 645-666.

Computer Science

J. Dinerstein, P.K. Egbert, and D. Cline "Enhancing Computer Graphics Through Machine Learning: A Survey," *The Visual Computer*, 23(1), pp. 25-43, 2007.

J. Dinerstein, P.K. Egbert and D. Ventura, "Learning Policies for Embodied Virtual Agents through Demonstration", *Proceedings of the International Joint Conference on Artificial Intelligence*, pp. 1257-1262, 2007.

J. Menke, T. R. Martinez, A Bradley-Terry "Artificial Neural Network Model for Individual Ratings in Group Competitions," *Journal of Neural Computing and Applications*, 2007.

A. Peterson, T.R. Martinez, "Finding the Real Difference Between Learning Algorithms," *Journal of Theoretical and Experimental Artificial Intelligence*, 2007.

X. Zeng, T. R. Martinez, "Using Decision Trees and Soft Labeling to Filter Mislabeled Data," *Journal of Intelligent Systems*, 2007.

Geological Sciences

Stofan, E. R., C. Elachi, J. I. Lunine, R. D. Lorenz, B. Stiles, K.L. Mitchell, S. Ostro, L. Soderblom, C. Wood, H. Zebker, S. Wall, M. Janssen, R. Kirk, R. Lopes, F. Paganelli, J. Radebaugh, L. Wye, Y. Anderson, M. Allison, R. Boehmer, P. Callahan, P. Encrenaz, E. Flamini, G. Francescetti, Y. Gim, G. Hamilton, S. Hensley, W. T. K. Johnson, K. Kelleher, D. Muhleman, P. Paillou, G. Picardi, F. Posa, L. Roth, R. Seu, S. Shaffer, S. Vetrella, R. West 2007. "The lakes of Titan," *Nature* , 445, 61-64, doi:10.1038/nature05438.

Physics & Astronomy

K. L. Gee, S. Hales Swift, V. W. Sparrow, K. J. Plotkin, and J. M. Downing, "On the potential limitations of conventional sound metrics in quantifying perception of nonlinearly propagated noise," *Journal of the Acoustical Society of America* **121**, EL1-EL7 (2007).

Statistics

B.J. Collings, "Tennis (and Volleyball) Without Geometric Series," *College Math Journal,* **38,** 55-57, (2007).