

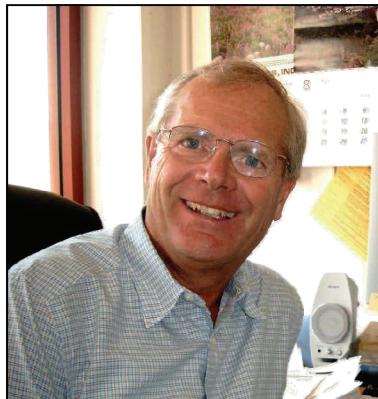


CMRR REPORT

Center for Magnetic Recording Research

Dr. Frank E. Talke Receives 2013 STLE International Award

Dr. Frank E. Talke has been selected to receive the 2013 STLE International Award. The STLE International Award established as the ASLE National Award in 1948, is the society's highest technical honor for outstanding contributions in tribology, lubrication engineering, or allied fields. It bestows lifetime honorary membership in STLE. This award recognizes Dr. Talke's hard work and dedication and will be presented at the President's Luncheon at STLE's annual meeting in Detroit on Tuesday, May 7, 2013.



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RESEARCH HIGHLIGHT

Engineering Materials for All Optical Magnetic Recording

Stephane Mangin, Visiting Scholar, CMRR

The possibilities of manipulating magnetization without any applied magnetic field have attracted the growing attention of researchers during the last fifteen years. From the discovery of spin transfer torque switching [1], the effect of electric fields on



Figure 1: Magnetic image of a saturated $[Co(5\text{\AA})/Tb(4\text{\AA})]_{x28}$ multi-layer film, where pulses of circularly polarized light were used to reverse the magnetization of certain areas. The full size of this image is about 100 mm long.

magnetic devices [2] to magnetization switching using femto- or picosecond pulsed lasers [3,4] the manipulation of magnetization on ultra-short time scales has become a fundamentally challenging topic with implications for magnetic data storage.

FROM THE DIRECTOR

This newsletter comes at a time of continued growth of activities at CMRR that is reflected in increased corporate memberships, federal grants, and the presentations at the Spring 2013 research review. We are also pleased with our continuing strong interaction with our students and our industrial partners, as part of CMRR's mission to train students for the information technology industries. Last summer, we had 15 participants in summer internships and I hope to have similar interactions or more this summer. I would encourage companies interested in CMRR students for summer interns to contact me or other CMRR faculty sooner than later. I hope we can keep this strong participation of our students with our corporate sponsors to grow in the coming years. We are also working with Sandra Ponting in the office of Research Affairs to help identify undergraduate students for internships and you will hear a brief presentation from her at the research review.



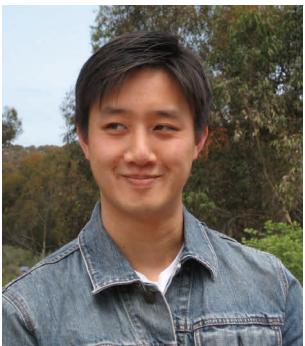
We continue to expand our educational and outreach efforts by organizing various conferences and workshops as highlighted in the newsletter. Paul H. Siegel and Steve Swanson have organized the Non-Volatile Memories Workshop (NVMW) each of the last four years and the NVMW 2013 was a great success. The workshop provides a unique showcase for outstanding research on solid state, non-volatile memories. For summer, we are organizing the International French-US Workshop; Towards low power spintronic devices to be held July 8-12. This will include participation from Academics such as Nobel Prize winner Albert Fert, leading industry representatives, start-up companies, funding agencies and venture capitalists. The participants will discuss new research developments and initiate new research conferences. We plan on having more of these workshops in future years and would like inputs on potential topics for future research reviews.



Left to right: Eric Fullerton—CMRR Director,
Dr. Frank E. Talke—Awardee,
Ralf Brunner—Western Digital

**Dr. Frank E. Talke Receives 2012
ASME/ISPS Distinguished
Institution Award**

Ralf Brunner from Western Digital presented the 2012 ASME/ISPS Distinguished Institution Award to Dr. Frank E. Talke at the Fall 2012 CMRR Research Review for his dedication to the Information Storage & Processing Systems Division, excellence in research, and contribution to the data storage industry.

**Keith Chan Wins 2012 James Clerk Maxwell Young Writer Prize**

Keith Chan from Professor Eric Fullerton's group won the 2012 James Clerk Maxwell Young Writers Prize. Keith's paper "Controlled Growth Behavior of Chemical Vapor Deposited Ni Nanostructures," co-authored with J. J. Kan, C. Doran, L. Ouyang, D. J. Smith and Eric E. Fullerton is the winning entry.

RESEARCH HIGHLIGHT

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At CMRR we have an ongoing theory, to utilize modeling and experimental project to both probe the underlying physics of so-called all-optical magnetization switching (AOS). Using circularly polarized light pulses to develop new materials classes that will enable applications of this phenomenon. Here we describe recent optical manipulation of the magnetization of carefully engineered magnetic materials and devices. We demonstrated that AOS can be observed not only in very particular rare-earth transition-metal alloys [3,4] but also in a variety of materials (alloys, multilayers and complex structures). In particular, for the first time, we show AOS as a rare-earth free heterostructure system. This is a breakthrough for application as it provides materials “compatible” with spintronic applications for data storage, memories and logic.

The use of laser pulses for magnetization switching is particularly interesting since femto-second laser pulses can reverse magnetization which is 1000 to 10 000 times faster than switching magnetization by magnetic fields [5] or spin-polarized current pulses [6]. Moreover this process is reported to be very energy efficient [7]. Here we report on engineered materials ranging from amorphous ferrimagnetic alloys to coupled transition-metal ferromagnetic heterostructures. The fact that ferromagnetic layers such as Co, [Co/Pt] and Co/Ni may be switched opens the use of AOS in spintronic devices. Figure 1 shows an example of controlled reversal of magnetization by polarized light which can be used to write on a magnetic media.

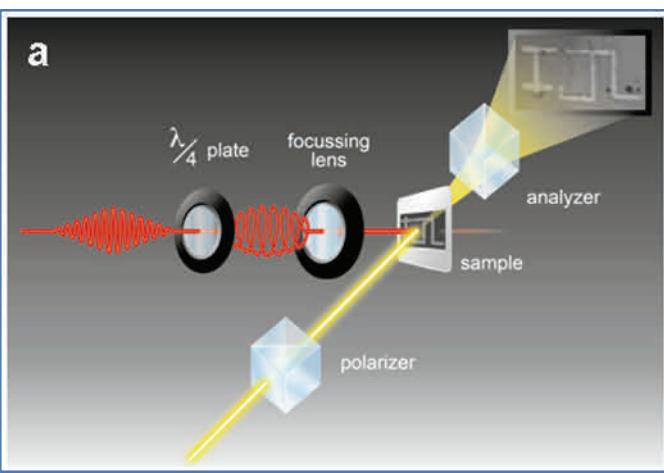


Figure 2: Experimental set-up: A Faraday imaging setup consisting of a white-light source, a crossed polarizer pair, and a CCD-camera, is used to image the magnetic domains while a polarized light is illuminating the sample. Fs-amplifier running at 1 kHz at a central wavelength of 800 nm is used to provide pulse duration close to 100 fs. The pulses are circularly polarized by a zero order quarter-wave plate and focused on the sample.

Three classes of materials with perpendicular magnetic anisotropy (PMA) have been studied 1) rare-earth (RE) –transition metal (TM) alloys 2) RE-TM multilayers and 3) synthetic ferrimagnets (SFI) which are made of two ferromagnetic layer showing two different temperature behaviors and is antiferromagnetically coupled through an Ir interlayer. This latter structure was designed to mimic the magnetic properties of ferrimagnetic material. To study the magnetization response to femtosecond laser pulses we used a set-up similar to that shown schematically in Fig. 2. The pulse duration is about 100 fs with a repetition rate of 1 kHz. Helicity of the beam is controlled by a quarter wave-plate, which allows to transform linear polarized light of the laser beam into circularly left- or right-polarized light. The average LASER power can reach 1W.

Rare-earth transition-metal alloys

In RE-TM alloys the net magnetization results from the magnetization of the RE sub-lattice and of the TM sub-lattice. In our study we used heavy rare earth elements (Gd, Tb, Dy, Ho). The exchange coupling between a heavy RE and the TM sublattices is antiferromagnetic, causing ferrimagnetic ordering.

RESEARCH HIGHLIGHT

Depending on the concentration and temperature the net magnetization of the alloy can be either along the RE magnetization sublattice for large RE concentrations or along the TM magnetization. For a certain composition at a given temperature ($T_{M\text{comp}}$: magnetization compensation temperature) the two sub-lattice magnetizations compensate and the net magnetization is zero. Note that due to the different Landé factor of RE and TM spins, the angular momentum compensation temperature is always slightly higher than the magnetization compensation. More than 30 different alloys have been grown by sputtering Gd_xFeCo_{1-x} , Tb_xCo_{1-x} , Dy_xCo_{1-x} , Ho_xFeCo_{1-x} on a Glass/Ta(4nm) substrate and subsequently covered with Ta(4nm) to avoid oxidation. All the samples have shown strong PMA. For Tb-Co alloys, the PMA is sufficiently strong to enable sub-10 nm islands to be fabricated that are thermally stable. As presented on Fig. 3, while sweeping the laser beam, two types of behavior have been observed that can be defined as thermal switching (Fig 3.a) and AOS (Fig 3.b). Thermal switching is characterized by the formation of small magnetic domains with random up or down orientation and those states are found to be independent of the helicity. This is similar to what is observed for thermally demagnetized samples. On the other hand, AOS is characterized by the deterministic magnetization reversal of the material under the beam, where the orientation of the magnetization depends on the helicity of the laser as shown on Fig 3b.

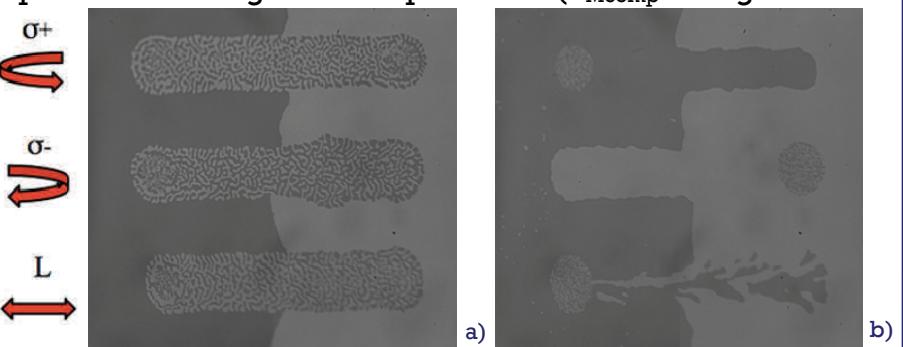


Figure 3: two different samples were studied a) $[Co(8\text{\AA})/Tb(4\text{\AA})]_{x21}$ and b) $[Co(5\text{\AA})/Tb(4\text{\AA})]_{x28}$ for each sample three types of polarized beam were swept over the sample: from top to bottom right circularly polarized light (s^+), left circularly polarized light (s^-) and linear polarized light (L)

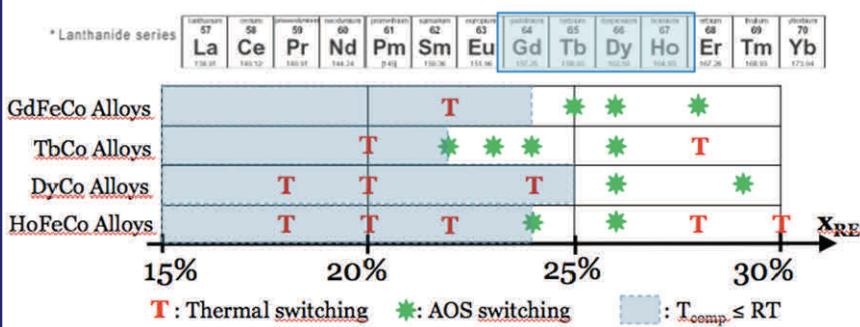


Figure 4: Types of RE-TM alloys studied for AOS as a function of the alloy concentration. Red T represents thermal switching and green stars represent AOS. The regions shaded in blue correspond to alloy compositions where the compensation temperature is below room temperature.

When trying to identify which compositions show thermal switching and which show AOS, we find that AOS is observed only for a given range of compositions. (Fig.4). A careful analysis demonstrates that AOS is observed only when the alloy has a compensation temperature larger than room temperature.

Rare-earth transition-metal multilayers

In order to investigate the role of the atomic order in the material we have grown multilayers such that the amount of each species stays constant but the thickness of each material varies. A $Tb_{26}Co_{74}$ alloy clearly shows AOS (volume ratio about 50/50). In multilayers with equal Co and Tb thickness AOS can be observed for a multilayer periodicity up to 5 nm as presented in Fig. 5.

RESEARCH HIGHLIGHT

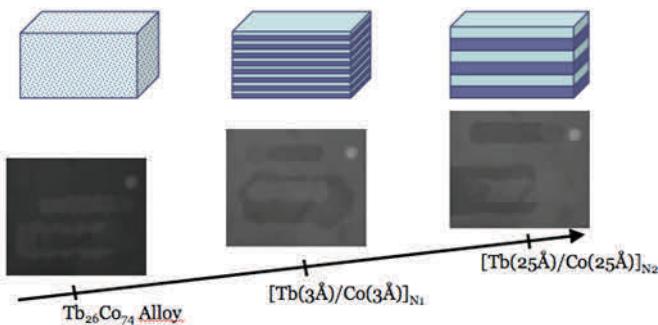
Synthetic ferrimagnetic layers

Figure 5: Polarized beam (polarized light ($s+$), left polarized light ($s-$)) have been swept over the sample. All optical switching can be observed for three different samples (a TbCo alloy, a $[Tb(3\text{\AA})/Co(3\text{\AA})]_{N1}$ multilayer and a $[Tb(25\text{\AA})/Co(25\text{\AA})]_{N2}$ which have identical amounts of Tb and Co.

Up to now all reported studies of AOS switching have been on RE-TM ferrimagnetic alloys or multilayers. To determine if this phenomenon is unique to RE-TM based materials, we fabricated synthetic ferromagnetic heterostructures that mimic the properties of RE-TM alloys. We designed magnetic multilayers of two different magnetic layers where the magnetizations of the two layers have different temperature dependence, and are antiferromagnetically coupled via a thin Ir layer. These structures have no rare-earth elements. Example structures are $Ta4\text{nm}/Pd3\text{nm}/[Co(t_1)/Ir(0.4\text{nm})/CoPt(t_2)/Ir(0.4\text{nm})]xN/Pd3\text{nm}$. The Ir layer thickness was chosen to maximize antiferromagnetic coupling and the surface anisotropy of the Co-Ir layers supports PMA. The thickness ratio of t_1 and t_2 are chosen such that at room temperature the CoPt layer moment is larger than the Co layer. However, CoPt has a lower Curie temperature compared to Co. Consequently, the CoPt layer moment decreases faster than the Co layer moment resulting in a compensation temperature for the structure. This class of heterostructures has been analyzed. For samples where the two magnetizations compensate at a temperature larger than room temperature AOS, is observed.

From these studies we can conclude that the presence of two magnetization sublattices compensating each other at a certain temperature is a key element for AOS. The common denominator of the diverse structures showing AOS presented is that two magnetic sub-lattices showing two different temperature dependences can be magnetically compensated while heated. These results offer valuable information to understand the underlying fundamental mechanisms involved. More importantly it opens a new pathway to design complex materials using well-known thin-film techniques where the magnetization can be controlled by the application of light.

This work is a collaborative effort of: Stephane Mangin, Matthias Gottwald, Charles-Henri Lambert, Daniel Steil, Robert Tolley, Michel Hehn, Gregory Malinowski, Mirko Cinchetti, Sabine Alebrand, Pang Lin, Shaya Fainman, Martin Aeschliman, and Eric Fullerton.

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[5] I. Tudosa et al. *Nature* 428, 831-833 (2004).

[6] D. Bedau, H. Liu, J-J Bouzaglou, A.D. Kent J.Z. Sun, J.A. Katine, Eric E Fullerton and S. Mangin, *Appl. Phys. Lett* 96 022514 (2010)

[7] M. Savoini, R. Medapalli, B. Koene, A. R. Khorsand, L. Le Guyader, L. Duò, M. Finazzi, A. Tsukamoto, A. Itoh, F. Nolting, A. Kirilyuk, A. V. Kimel, and Th. Rasing *Phys. Rev. B* 86, 140404(R) (2012).

Better, Cheaper, Faster Ways for Making (and Destroying) Memories by Tiffany Fox, Calit2

San Diego, Calif., March 21, 2013 — For literary types, memory is often linked with Marcel Proust's madeleine cookie, which, in a single bite, launches a nostalgic reverie that lasts through seven volumes.

But for scientists and engineers at the University of California, San Diego, 'memory' in the computing sense is all about a different kind of sweet: layer cake.

By following a so-called "layer-cake approach" to data storage and retrieval, all components of such systems evolve in tandem, so that advances in hardware don't rapidly eclipse advances in software, or vice versa. UC San Diego's annual Non-Volatile Memories Workshop (NVMW), now in its fourth year, is an opportunity for the many academic researchers working in the field of non-volatile memories to partner with industry representatives "and bring all the layers together to nudge academics in the right direction," said Steven Swanson, associate professor of Computer Science and Engineering in UCSD's Jacobs School of Engineering.

Swanson is also co-director of the Non-Volatile Systems Laboratory and an affiliate of the Center for Magnetic Recording Research (CMRR), which hosts the workshop. CMRR is a partner of the UCSD division of the California Institute for Telecommunications and Information Technology (Calit2). Also representing UCSD at the conference were graduate student Adrian Caulfield (who presented a talk on "QuickSAN: A Storage Area Network for Fast, Distributed Solid State Disks"), post-doctorate Arup De ("Minerva: A Compute Capable SSD Architecture for Next-Generation Non-Volatile Memories"), and Ph.D candidate Minghai Qin ("Inter-cell Interference Free Codes for Read/Write in Flash Memories").

Non-volatile memories are crucial components of modern computing systems — components that make it possible to store increasingly large amounts of information in smaller spaces, at faster data transfer speeds and at lower cost to the consumer.

"What struck me most about this year's conference is that the vast majority of papers are from academics, but 65 percent of the more than 200 attendees are from industry," added Swanson. "Together, we're figuring out how to integrate application-specific storage and other components into a working, coherent system while still managing power costs. Eventually, this research will make it possible to run more interesting apps and programs on your smartphone, and make your battery last longer."

One form of non-volatile memory making major inroads is magnetoresistive random access memory, or MRAM. The workshop's keynote address, presented by Everspin Technologies Vice President of R&D Jon Slaughter, addressed his company's progress in developing and commercializing MRAM.

MRAM, which has been in development since the 1990s, uses magnetic elements to store data in lieu of electric charge or current flows used by conventional RAM chip technologies. It's faster than flash memory (an industry mainstay) and unlike flash, suffers no degradation over time. Some visionaries in the field predict MRAM will eventually become dominant for all types of computer memory, heralding its potential as a much anticipated "universal memory."



Keynote Speaker Jon Slaughter of Everspin Technologies outlined the merits of a new kind of computer memory called magnetoresistive random access memory, or MRAM.

"Right now there's a huge worldwide race to get out the next generation of MRAM, which is spin-torque MRAM," noted Slaughter. Spin-transfer torque is a technique for writing data to a "cell" that uses less electrical current than other write techniques. This consequently reduces latency, or the time delay experienced by a computing system.

Spin torque also improves MRAM density, or the number of cells that can be packed onto a single chip. The more cells one can cram onto a single silicon wafer, the greater the yield and the lower the cost. Although MRAM cells can suffer from "false writes," or errors when scaled down to the nanometer level, spin-torque transfer mitigates this tendency.

"Everspin is the only company that ships spin-torque MRAM, and we're now sampling working parts to customers," he added. "Spin-torque is a particular flavor that's new, and everyone is very excited about it. This is a field where we're quickly building on discoveries that come from



Associate Professor Steven Swanson of UCSD (right, green shirt) discusses trends in non-volatile computer memory with attendees at UCSD's 2013 Non-Volatile Memory Workshop.

researchers, and with all the huge interest in the industry, there are untold amounts of money being thrown at this technology.

"I don't know which discoveries today are going to become products 10 years from now," added Slaughter, "but I see a lot of great things happening."

Ten years is something of a magic number for the data storage industry. Although 10 years might seem like an eternity for consumers, a decade is usually about how long it takes new forms of memory to make their way from the lab to the laptop.



UCSD Prof. Paul Siegel is one of the organizers of the workshop and a veteran of both industry and academia.

"Usually the discovery is made by an academic working at a primitive level, meaning it might be the first time people are observing a certain phenomenon," explained Paul Siegel, professor of Electrical and Computer Engineering at UCSD and a former director of CMRR. "Taking those primitive discoveries and manufacturing them at the chip level is a long road from that first observation. My guess, however, is that as the pace of research speeds up, the pace of commercialization will also advance."

"To predict how memories will evolve in 20 years," added Swanson, "look at what you can do now for infinite money and then predict based on the cost going down."

Predicting how technologies will evolve over two decades is especially important for Ron Stofan's clients, many of whom are more interested in destroying data than in storing or retrieving it. Stofan is president of Garner Products, Inc., a manufacturer since 1959 of degaussers and other devices that either magnetically erase or physically destroy hard drives for commercial clients such as banks and health institutions, as well as the U.S. government. (He notes his company still has a warranty card issued from the basement of the White House during the Nixon administration.)

Stofan attended this year's NVMW to see what new technologies are now emerging that might change the way data is stored and retrieved decades from now. He says keeping up with advances in memory requires constant vigilance.

"Right now, if someone overwrites data, there's technology out there that can still retrieve that data. The government, at the level of the Department of Defense and National Security Administration, has rescinded overwrite erasure policy due to these problematic areas."

Degaussing (demagnetizing a hard drive) has therefore become commonplace, but "after that I recommend physical destruction," he said. "People like to see physical destruction. It's like the visual satisfaction and feeling of security people get from shredding a piece of paper."

And when Stofan says "physical destruction," he means it. His company now manufactures a patent-pending accessory to the Garner PD-5 Physical Hard Drive Destroyer made of two beds of nails, which pierce through solid-state hard drives to break and crack all of the data chips. The PD-5 can also destroy two hard drives simultaneously in 18 seconds, ultimately mangling the data platters and making them unreadable.

By contrast, Stofan recently saw a photo of a hard drive that someone had shot with a 45-caliber pistol. He noted that the bullet merely lodged in the data platters, leaving the majority of the information undamaged and retrievable.

In the future, even physically destroying a hard drive might not be enough to keep nefarious types from accessing data. Stofan noted that his company works with CMRR Associate Research Scientist Fred Spada of UC San Diego to have his products evaluated in terms of emerging threats, and still people go to extremes to destroy their data.

"One lady brought her hard drives in to a tradeshow to be degaussed and physically destroyed," he recalled. "When we put the hard drives in the PD-4 Physical Hard Drive Destroyer, we noticed liquid coming out of the drives. It turns out she had submerged them in a sink of water and then frozen them thinking this would protect her data. Fortunately she recognized this was insufficient and came to us to properly eliminate her data."

"When people want data gone, they really want it gone."



Ron Stofan (right), president of Garner Products, Inc., attended this year's NVMW to see what new technologies are now emerging that may change the way data is stored and retrieved decades from now.



11th Annual Shannon Memorial Lecture

To commemorate the achievements of Claude Elwood Shannon an endowed lectureship has been established at the University of California, San Diego.

Each year an outstanding information theorist will be selected to present the Shannon Memorial Lecture. The date of the lecture will be on or about Shannon's birthday (April 30th).

A bust of Shannon, situated in the lobby of the Center for Magnetic Recording Research, bears a plaque with the following inscription:

Claude Elwood Shannon (1916-2001) Father of Information Theory

"His formulation of the mathematical theory of communication provided the foundation for the development of data storage and transmission systems that launched the information age"

— Dedicated October 16, 2001. Eugene Daub, sculptor.

May 1, 2013

Prof. Abbas El Gamal

Stanford University

2012 Claude E. Shannon Award Recipient

will present a lecture entitled

Networks with Point-to-point Codes



Shannon's celebrated channel coding theorem established the fundamental limit on information flow over point-to-point channels and showed the existence of codes that achieve this limit. The ensuing 65 years have witnessed the development of ingenious practical codes that approach the Shannon limit. These codes are now widely used in communication networks and storage systems.

Results from network information theory, however, suggest that we may need to develop new types of codes to improve the achievable rates in networks with multiple sources and destinations and shared resources. How well do point-to-point codes perform over such networks relative to their information flow limits? Do we need to spend another 65 years (or more) to develop new "network codes"?

Professor El Gamal will argue that (random) point-to-point codes, when coupled with more sophisticated decoders than the ones in use today, can perform extremely well, and sometimes optimally, over several multiple access, broadcast, interference, and relay networks. In some other scenarios, we may need to develop new network codes.

This talk is based on joint work with Bernd Bandemer, David Tse, Francois Baccelli, and Young-Han Kim.

**3:00 PM – Reception, CMRR
4:00 PM – Lecture, Calit2 Auditorium - Atkinson Hall
University of California, San Diego**

CO-SPONSORED BY:



The Information Theory and Applications Center
WEBSITE: <http://ita.ucsd.edu>



California Institute of Telecommunications
and Information Technology
WEBSITE: <http://www.calit2.net/>

International French-US Workshop

Toward low power spintronic devices

July 8th – 12th, 2013 in La Jolla, California

The aim of this workshop is to gather the scientific and engineering communities in the fast growing field of spintronics and its applications. The workshop will cover the innovation process from scientific discovery to creating new products, including STT-MRAM, oscillators, and novel magnetic memory and logic structures. It will provide attendees opportunities to discuss new developments and to initiate collaborations and research projects. The workshop will benefit from the attendance of well-known contributors from academy, industry, and startups, but also from funding agencies and venture capital firms.

Two special sessions will be dedicated to fostering research cooperation between French and US researchers with emphasis on: fundamental science, innovation and education of the next generation of scientists.



Invited speakers

A. FERT (Nobel Prize 2007): CNRS/ Thales (France) *
 J. Z. SUN: IBM-Yorktown Height (USA) *
 J. A. KATINE: HGST-WD- San Jose (USA)*
 I. SCHULLER : UC San Diego (USA) *
 K. LEE: Qualcomm- San Diego (USA)*
 A. HOFFMANN: Argonne National Laboratory (USA)*
 T. ONO, Kyoto University (Japan)*
 Y. OTANI: University of Tokyo and RIKEN (Japan) *
 D. APALKOV: Samsung Electronics - Grandis (USA) *
 D.L STEIN: New York University (USA)*

S.S.P. PARKIN : Stanford / IBM –Almaden (USA)*
 B. DIENY: Spintec (France) *
 B. CAMBOU: Crocus (France)
 J. VOGEL: Institut Neel (France) *
 D. RALPH: Cornell University (USA) *
 T. NOZAKI : Ozaka University (Japan) *
 V. LOMAKIN: UC San Diego (USA)*
 L.VILLA: INAC-CEA (France) *
 R. COWBURN: University of Cambridge (UK) *
 J. ÅKERMAN: University of Gothenburg (Sweden)

*confirmed speakers

The workshop will facilitate 30 minute presentations for invited speakers and 15 minute presentations for selected contributing speakers. There is also a poster session which will allow subjects to be discussed in depth.

Registration will be accepted until June 1, 2013

<http://nanomag.ucsd.edu/iwst/>

Scientific committee

- E. E. Fullerton : University of California, San Diego
- A. Kent : New York University
- D. C. Worledge : IBM Yorktown
- S. Mangin : University of Lorraine/CNRS, France
- D. Ravelosona : University of Paris Sud/CNRS, France
- J.P. Nozière : Spintec, University Joseph Fourier/CNRS

Organizing committee

- I. Villanueva : University of California San Diego
- P. Lambert: University of Lorraine
- E. Boyaux, University Paris Sud

NEW SCHOLARS/STUDENTS/STAFF

Visiting Scholar



Dr. Hironori Uchikawa received his PhD in Engineering from Tokyo Institute of Technology in 2012, with his thesis: "Spatially Coupled Codes and Their Applications." He joined Prof. Siegel's STAR group in March 2013. His current research activities focus on coding for flash memories and distributed storage systems.



Veeresh Taranalli received his B.Tech degree in Electronics and Communication Engineering from the National Institute of Technology, Karnataka, India in 2009. He is currently a Masters student in the ECE department at UCSD and working in Prof. Siegel's STAR group. Veeresh is interested in coding theory and its applications in wireless communication and storage. His current research interest is in the development of decoding algorithms for polar codes.

Graduate Students



Arup De is a Ph.D. student in CSE department of UCSD, working with Prof. Steven Swanson and Prof. Rajesh Gupta in the Non-Volatile Systems Laboratory. His research interest is computer architecture, particularly focusing on architecture of storage arrays for next generation non-volatile memories. Other areas of interests are embedded systems design and reconfigurable computing. He is currently a Lawrence Scholar at the Lawrence Livermore National Laboratory working with Maya Gokhale.



Simon Couture is a 1st year Ph.D. student in the Electrical and Computer Engineering department. He obtained his M. Sc. A in electrical engineering from University of Montreal, Canada in 2011. Working under the supervision of Professor Vitaliy Lomakin, his research interests are numerical methods in micromagnetics, electromagnetism and magnetic materials for high frequency applications.



Meenakshi Sundaram is a 3rd year Ph.D. student in the department of Computer Science and Engineering. Before joining UCSD in 2010, he worked at SanDisk India Device Design Centre, Bangalore as Product Application Engineer for 3 years. His research interest focuses on operating systems optimizations and storage architecture design for next generation non-volatile memories.



Alex Phan received his B.S. degree in Bioengineering from UCSD in 2011. He will start his Mechanical Engineering Ph.D. program in the Fall 2013. Since joining Prof. Talke's Group in January, he has been developing an intraocular pressure (IOP) sensor in order to establish the relationship between IOP and optic nerve damage.

Visiting Graduate Students



Charles-Henri Lambert is a PhD Student in Physics at Institut Jean Lamour in Nancy under the supervision of Professor Mangin. His research interests are focused on the different spin transfer phenomena in magnetic structures. He is currently visiting the group of Prof Fullerton to study the mechanism of magneto-optical interaction in perpendicular ferrimagnets, which are potential candidate for the next generation magnetic recording.



Jörg Schröter received his Master's degree at Dresden University of Technology, German in 2012. His major was Mechatronics with specialization in micro electro mechanical systems. During his one year stay at CMRR he will focus on the study of hard drive slider flying height in Prof. Talke's lab.



Jean-Baptiste Puel received his B.S. in Engineering with a major in Physics and Materials Science from "Ecole des Mines" Nancy in 2010. As a master's student, his first internship was at Holst Center (Netherlands) working on Oled Devices. After an exchange program at the Pontificia Universidad Católica de Chile, he joins Vitaliy Lomakin's group in March 2013 where he is doing his master thesis on micromagnetic simulations to study the spin transfer in spin valves.

Undergraduate Students



Khang Nguyen is a third-year undergraduate student majoring in Chemical Engineering, B.S. at University of California, San Diego. He is originally from Hayward, California. He is currently part a lab assistant in Spada's group working on a secure erase project.

(continues on Page 12...)

SELECTED PAPERS AND TALKS

Professor Raymond A. de Callafon

H. Fang, J. Wang, and **R. A. de Callafon**. "Nonlinear Gaussian filtering via radial basis function approximation." In *Decision and Control (CDC), 2012 IEEE 51st Annual Conference on*, pp. 6042-6047. IEEE, 2012.

Y. Han and **R. A. de Callafon**. "Identification of Wiener-Hammerstein benchmark model via rank minimization." *Control Engineering Practice* (2012).

H. Fang and **R. A. De Callafon**. "On the asymptotic stability of minimum-variance unbiased input and state estimation." *Automatica* (2012).

Professor Eric Fullerton

N. Eibagi, J. J. Kan, F. E. Spada and **E. E. Fullerton**, "Role of dipolar interactions on the thermal stability of high-density bit-patterned media", *IEEE Magnetic Letters*, vol. 3, 4500204-1-4 (Sept. 2012).

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Professor Sungho Jin

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Professor Paul H. Siegel

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Professor Frank E. Talke

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Undergraduate Students



Jonathan Trisnadi is a third year undergraduate majoring in physics at UCSD. He plans to obtain his degree in 2014 and move directly into graduate school to pursue a Ph.D. Jonathan's current research is on materials for bio and space applications.



Staff Member

Julie Matsuda graduated from the University of California San Diego in Fall 2012 with a Bachelors in Management Science. Since joining the CMRR family in January, she is loving the friendly environment and all the learning experiences. Her dream is to see the world and travel to all its beautiful places.

GRADUATE STUDENTS NEAR COMPLETION

Student	Level	Advisor	Dept.	Area of Research
Brian Butler	Ph.D.	Paul H. Siegel	ECE	The Error Floors of LDPC Codes
Vasu Kanekal	M.S.	Paul H. Siegel	ECE	Signal Processing
Veeresh Taranalli	M.S.	Paul H. Siegel	ECE	Coding Theory, Decoding algorithms for Polar Codes
Sudharsan Seshadri	M.S.	Steve Swanson	ECE	Architecture for Next-Generation Non-Volatile Storage Systems
Stanley Hyunsu Kim	Ph.D.	Sungho Jin	MSE	Synthesis, Characterization and Photocatalytic Applications of Semiconductor Nanostructures
Laura Connelly	Ph.D.	Sungho Jin & Ratnesh Lal	MSE	Atomic Force Microscopy, Technology Development, Ion Channels, Neurodegenerative Disease

2013 Qualcomm Innovation Fellowship



Minghai Qin

CMRR is proud to announce two deserving winners of the 2013 Qualcomm Innovation Fellowship, **Minghai Qin** from Professor Paul H. Siegel's group (CMRR) and **Lele Wang** from Professor Young-Han Kim's group (ECE). The two UCSD engineering graduate students were part of the 8 fellowship recipients chosen out of 138 applicants.



Lele Wang

"Qualcomm Innovation Fellowship is focused on recognizing, rewarding, and mentoring innovative PhD students across a broad range of technical research areas, based on Qualcomm core values of **innovation, execution and teamwork**. The Innovation Fellowship is open to students from a variety of top US based and international schools "

Lele and Minghai's innovative ideas on "Practical Coding Techniques for Network Communication" earned each of them \$50K in fellowship grant from Qualcomm. Congratulations to both.

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