IEEE Magnetics Society
Santa Clara Valley Chapter

The objective of the Santa Clara Valley Chapter of the IEEE Magnetics Society is to sponsor local seminars and publicize conferences, workshops and other information of interest to the Society's local members and technical people in the area of applied magnetics.

Web Site: http://www.ewh.ieee.org/r6/scv/mag/

2009 Meetings

1/27/09	The Evolution and Revolutions in Disk Drive Recording Dr Michael Mallary*, Seagate Research
2/24/2009	The Storage Chasm: Implications for the Future of HDD and Solid State Storage Dr. Steven R. Hetzler, IBM Almaden
3/10/2009	Nanoscale MRI – The quest for a molecular structure microscope based on magnetic force detection, Daniel Rugar, IBM Almaden
4/21/2009	Spintronics: Nanoscience and Nanoelectronics Hideo Ohno*, Tohoku University
5/26/2009	Controlling Magnetism with Light Prof. Theo Rasing*, University Nijmegen, The Netherlands

* IEEE Magnetics Society Distinguished Lecturer

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Tuesday, January 29, 2009

THE EVOLUTION AND REVOLUTIONS IN DISK DRIVE RECORDING

Dr Michael Mallary, Seagate Research

(2009 IEEE Magnetic Society Distinguished Lecturer)

Since 1956 the areal density of hard disk drives, HDDs, has increased by eight orders of magnitude through a process of evolution punctuated by a number of important revolutions. The disk evolved for three decades through many generations of painted gamma ferric oxide particulate media with in plain orientation. During this time areal density was increased from 2 kilo-bits/inch2 (2kbpsi) for IBM's RAMAC to ~20Mbpsi. The technology has seen a number of revolutions. In the mid 1980s the first (non-magnetic!) revolution was a diamond like carbon over coat for media that is key to its durability. The next revolution was the introduction of read sensors based on Giant Magneto-Resistive films with improved sensitivity. HDD proceeded to evolve up to ~100 Gbpsi on this technology base. By the mid 1990's Prof. Stanley Charap of Carnegie Mellon University calculated that longitudinal recording would start to experience thermal decay of the data at densities of ~40 Gbpsi. In response to this impeding crisis, the Ultra-High Density Recording project was initiated by Prof. Mark Kryder (CMU) under the National Storage Industry Consortium umbrella. The UHDR team established the reality of the problem and proposed strategies to delay the crisis to ~100 Gbpsi. Key amongst these was to increase tracks per inch faster than bits per inch. The UHDR theory team also determined that magnetizing the media perpendicular to the disk could extend magnetic recording by almost an order of magnitude beyond the thermal decay limit of longitudinal recording. Perpendicular HDDs are now being shipped at ~300Gbpsi. Key head innovations in achieving this density are the use of the the Shielded Pole writer invented by the author, and the Tunneling Magneto-Resistive reader with an MR effect approaching 100%. The 30-40% per year growth in areal density will soon drive perpendicular recording to its thermal decay limit near 1 Tbpsi in demonstrations and less in products. Two revolutionary technologies are being developed to deal with this. Heat Assisted Magnetic Recording will allow high anisotropy media to be written at elevated temperatures thus allowing for finer thermally stable grains to be written. Bit Patterned Media will allow the recording of a bit on a single grain as compared to scores of grains with unpatterned media. The promise and problems of these technologies will be discussed in detail.

Michael Mallary is an IEEE Fellow and Distinguished Lecturer for 2009. He received his S.B. degree in physics from the Massachusetts Institute of Technology in 1966, and Ph.D. degree in Experimental High Energy Physic from the California Institute of Technology, in 1972. He was a post doctoral fellow at the Rutherford Laboratory for from 1972-1974 and an Assistant Professor of physics at Northeastern University from 1974-1978. There he participated in an experiment at Fermi Laboratory that produced early evidence for the fifth quark using a 300 ton solid iron magnet. From 1978 to 1980 he worked at the Magnetic Corporation of America designing large superconducting magnets for MHD, MRI, energy storage and magnetic separation.

In 1980 he joined the Digital Equipment Corporations effort to produce thin film heads for disk drive recording as a head modeler and designer. Here he invented the Shielded Pole perpendicular recording head which has demonstrated superior performance over the conventional monopole head and is now in very disk drive shipped today. He also invented the Diamond inductive head which doubles the effective number of turns. In addition he has contributed to the theory of: flux conduction in thin film heads at high frequency; low bit aspect ratios for high density in the thermal decay limit; and tilted write fields for improved switching. His publications and patents have significantly advanced the field of magnetic recording.

Mike Mallary is presently working on Heat Assisted Magnetic Recording, Shingle Recording and 2 Photon Recording. He has authored and co-authored 67 issued patents and 52 publications including “Our Improbable Universe” (ISBN 1-56858-301-X).

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Tuesday, February 24, 2009

THE STORAGE CHASM: IMPLICATIONS FOR THE FUTURE OF HDD AND SOLID STATE STORAGE, DR. STEVEN R. HETZLER, IBM ALMADEN

There has been a recent push to bring solid state storage into the IT storage hierarchy. NAND flash has largely displaced hard disk drives (HDD) in mobile consumer applications, effectively eliminating the use of HDD's in the sub 1.8" form factors. Based on these events, it is commonly assumed that solid state storage is poised to make significant inroads in the IT storage space.

However, forecasting the success of new technologies has been problematic. I have invented Chasm Analysis as a means for identifying the market potential for storage technologies, by examining the foundations from an economic perspective. The efficacy of the methodology will be tested against historical data. I will then perform the analysis for the evolution of HDD and flash in the IT space. The results will be instructive for other solid state technologies as well. At the end we will discover the implications for the future of HDD and Solid State Storage.

Dr. Steven R. Hetzler is an IBM Fellow at IBM's Almaden Research Center (San Jose, Calif.), where he manages the Storage Architecture Research group.

He is currently focusing on novel architectures for storage systems and on applications for non-volatile storage. Previously, he initiated work on the IP storage protocol that is now known as iSCSI, which he later named. The group under his management developed the concept from an idea to the first specification before joining with Cisco to bring the work to the Internet Engineering Task Force (IETF). His group developed the first working iSCSI demonstrations, including the first direct network-attached DVD movie multiplex.

Steven has been issued 38 patents for inventions in a wide range of topics -- including data storage systems and architecture, optics, error correction coding and power management. His most notable patents include split-data field recording and the No-ID(TM) headerless sector format, which have been used by nearly all magnetic hard-disk-drive manufacturers for a number of years. He also pioneered the first adaptive power technology for disk drives. Steven was educated at the California Institute of Technology (Pasadena, Calif.), where he received his Ph.D. and Masters degrees in Applied Physics in 1986 and 1982 respectively. He received a Bachelor of Arts in Physics in 1980 from Carleton College (Northfield, Minn.). He joined IBM Research in November 1985 and was named an IBM Fellow in 1998.

TUESDAY, MARCH 10TH, 2009

Nanoscale MRI – The quest for a molecular structure microscope based on magnetic force detection

Daniel Rugar,

IBM Research Division, Almaden Research Center, San Jose, CA

Can a microscope be built that can directly image the 3D atomic structure of individual biomolecules? Ultrasensitive detection of magnetic fields on the nanoscale may be the key.

Motivated by this quest for a molecular structure microscope, we are working to dramatically enhance the resolution of magnetic resonance imaging (MRI) using a technique called "magnetic resonance force microscopy" or MRFM. MRFM achieves a 100 million-fold improvement in sensitivity over conventional MRI by replacing the traditional inductive pickup with ultrasensitive detection of magnetic force. Combining this sensitivity improvement with novel methods for spin manipulation, we have successfully detected nanoscale ensembles of nuclear spins, such as ^{1}H, ^{13}C, ^{19}F and ^{31}P. By carefully measuring the magnetic force from the nuclear spins as a function of position, a 3D image of nuclear spin density can be reconstructed. As a first demonstration, we show a 3D reconstruction of the hydrogen in a test sample of tobacco mosaic virus particles. Spatial resolution on the order of 4 nm was obtained. Prospects for pushing the resolution below 1 nm and turning this technique into a useful tool for structural biology will be discussed.

Daniel Rugar is currently Manager of Nanoscale Studies in the IBM Research Division, and a Consulting Professor of Applied Physics at Stanford University. Dr. Rugar has a long history of contributions to the field of scanning microscopy. He began his work in microscopy as a Ph.D. student in Applied Physics at Stanford University, where he developed a gigahertz frequency scanning acoustic microscope operating in superfluid helium with nanometer spatial resolution. He joined IBM in 1984 and made important contributions to the development of atomic force microscopy (AFM) and magnetic force microscopy (MFM), especially for imaging magnetic materials and for applications to data storage.

He is co-inventor of the thermo-mechanical recording technique that is the basis of the IBM "Millipede" AFM storage device. His research group pioneered mechanical detection of ultrasmall forces, achieving the current record of 800 zeptonewtons in a 1 Hertz bandwidth. In 1992, he became inspired by the possibility of combining magnetic resonance imaging (MRI) with ultrasensitive force detection to allow force microscopes to "see" below the surface and take three-dimensional images. He made the first demonstrations of magnetic resonance force microscopy (MRFM) in 1992 and has worked to improve its sensitivity and spatial resolution ever since. After improving the sensitivity by 7 orders of magnitude, this work reached a key milestone in 2004: the manipulation and detection of an individual electron spin. His current work is focused on three-dimensional nanoscale imaging based on MRFM detection of nuclear spins, with a long term goal of developing a microscope that can directly image the 3D atomic structure of molecules.

Dr. Rugar has published over 100 scientific papers and holds 19 patents. He was the 1999-2000 Distinguished Lecturer of the IEEE Magnetic Society. He received the 2004 Scientific American 50 award for research leadership in the field of imaging and the 2005 World Technology Award for Materials. He has also received IBM internal awards for contributions to scanning probe microscopy, near field optical data storage and single electron spin detection. He is a fellow of the American Physical Society (APS), the American Association for Advancement of Science (AAAS) and the Institute of Electrical and Electronic Engineers (IEEE).

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Tuesday, April 21, 2009

Place: Western Digital, 1710 Automation Parkway, San Jose
Cookies, Pizza & Conversation at 7:00 p.m. Presentation at 7.30 -8.30 p.m.

SPINTRONICS: NANOSCIENCE AND NANOELECTRONICS

PROF. HIDEO OHNO, TOHOKU UNIVERSITY

(2009 IEEE Magnetic Society Distinguished Lecturer)

Spintronics explores the physics of interplay between spin and charge in condensed matter. It is one of the most active areas of magnetism. In particular, electrical manipulation of spin and magnetization in nanostructures allows us not only to study the interplay but can also be utilized to reverse magnetization direction, which is of great importance to nanoelectronics. In my lecture, I describe the nanoelectronics side and the science side of spintronics by discussing two topics that delineate the significance and technological importance of such spin manipulation in condensed matter.

I am sure not many of the audience are old enough to remember that magnetic memory was once preferred main memory for modern digital computers. There were reasons it was replaced by semiconductor memories. However, with the advances in spintronics, i.e. the recent development of giant tunnel magnetoresistance and current-induced magnetization switching in magnetic tunnel junctions, it appears that a comeback of magnetic memory may be possible, which now combines the nonvolatile capability of magnetic nanostructure with all the functionalities of current and future complementary metal-oxide-semiconductor (CMOS) integrated circuits. I also show that this hybrid magnetic tunnel junction/CMOS integrated circuit approach can solve many of the major challenges current integrated circuit technology are facing.

On the science side and on out further in the future, I turn to hole-induced ferromagnetism in Mn-doped III-V semiconductors (in particular, GaAs and InAs). This offers a variety of opportunities to explore new and/or unique spintronics physics. Ferromagnetism and magnetization in these materials can be manipulated by various means; by changing its carrier concentration by electric fields and/or by spin-current flowing along with the electric current. In the latter, our latest study on an empirical scaling law found in the creep regime of the current-driven domain walls showed that spin-torque driven creep is quite different from magnetic-field driven (and thus energy driven) creep, belonging to a new and different universality class. In the former, an electrical control of magnetization direction through manipulating magnetic anisotropy by electric-fields was shown to be possible. This opens up a unique opportunity for manipulating magnetization direction solely by electronic means, not resorting to magnetic-field, spin-current, mechanical stress, nor multiferroics..

Hideo Ohno received the B.S., M.S. and Ph.D. degrees from the University of Tokyo in 1977, 1979 and 1982, respectively. He spent one year as a visiting-graduate student at Cornell University, Ithaca, USA from 1979. He joined the Faculty of Engineering of Hokkaido University, Sapporo, Japan in 1982. He was a visiting scientist at IBM T. J. Watson Research Center from 1988 to 1990. He moved to Tohoku University, Sendai, Japan as Professor in 1994, where he is currently Director of Laboratory for Nanoelectronics and Spintronics, Research Institute of Electrical Communication. He has authored and coauthored more than 300 papers that cover the areas of semiconductor materials and devices to physics and applications of spin-related phenomena in semiconductors as well as in metal-based nanostructures. Professor Ohno received the IBM Japan Science Award (1998), the IUPAP Magnetism Prize (2003), Japan Academy Prize (2005), Presidential Prize for Research Excellence, Tohoku University (2005) and the 2005 Agilent Technologies Europhysics Prize. He has been a Fellow of the Institute of Physics (IOP) since 2004, an honorary professor of Institute of Semiconductors, Chinese Academy of Sciences since 2006 and a Fellow of the Japan Society of Applied Physics (JSAP) since 2007. Tohoku University appointed him as a distinguished professor in 2008.

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Tuesday, May 26, 2009

Place: Western Digital, 1710 Automation Parkway, San Jose

Cookies, Pizza & Conversation at 7:00 p.m. Presentation at 7.30 -8.30 p.m.

CONTROLLING MAGNETISM WITH LIGHT

Prof. Theo Rasing

Institute for Molecules and Materials, Radboud University Nijmegen, The Netherlands

The interaction of light with magnetic matter is well known: magneto optical Faraday or Kerr effects are frequently used to probe the magnetic state of materials. or manipulate the polarisation of light . The inverse effects are less known but certainly as fascinating: with light one can manipulate magnetic matter, for example orient their spins. Using femtosecond laser pulses we have recently demonstrated that one can generate ultrashort and very strong (~Tesla's) magnetic field pulses via the so called Inverse Faraday Effect. Such optically induced magnetic field pulses provide unprecedented means for the generation, manipulation and coherent control of magnetic order on very short time scales, including the complete reversal of a magnet with a single 40 femtosecond laser pulse. In principle this opens the way for all-optical recording of magnetic bits at extremely high data rates. The basic ideas, including their limitations, behind these discoveries will be discussed and illustrated with recent results.

Theo Rasing (26 May 1953, Didam) obtained his degree in physics (cum laude) from the Radboud University Nijmegen in 1976, where he also gained his doctorate in 1982. After postdoctoral stays at UC Berkeley (IBM fellowship) he became staff scientist and deputy program leader at the Lawrence Berkeley Laboratory, where he developed nonlinear optical techniques for surface and interface studies. In 1988 he was appointed associate and in 1997 full professor of physics in Nijmegen. He is the founder and director of the Nijmegen Centre for Advanced Spectroscopy (NCAS), member of the board of the Dutch NanoNed and founder of NanoLab Nijmegen that makes its expertise and infrastructure available to the commercial sector. In 2007 he received the Physica Prize from the Netherlands Physical Society and in 2008 he received the Spinoza price, the highest scientific award from the Netherlands Organisation for Scientific Research NWO. To date, his research has yielded more than 300 publications in international journals, including Nature, Science and Physical Review Letters. He is also the initiator and coordinator of various large national and international partnership programmes.

Theo Rasing is a pioneer in the development of new linear and nonlinear optical techniques for studying and manipulating molecules and materials with an emphasis on nanometer length and femtosecond time scales. His research is mostly focused on the static and dynamic properties of magnetic nanostructures and multilayers. For this he developed the technique of Magnetization induced Second Harmonic Generation and various ultra sensitive pump-probe methods. His most recent and most successful research in the field of spin dynamics is that into the manipulation of magnetism using light.

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