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A Focused Group within The American Physical Society

N^0 5, February 1999, Edited by R Bruce van Dover

From the incoming Chair:

Why was a topical group on Magnetism and its Applications formed in the first place? After all, there are a number of other organizations working in a similar area. For example, the IEEE Magnetics Society sponsors a wide range of projects related to applied magnetism, including the publication of the journal "IEEE Transactions on Magnetics". It also is the sponsor of the annual Intermag meetings. Within the American Physical Society (APS), the Division of Condensed Matter Physics encompasses many interests in basic magnetics. Then, of course, most of the present and potential members of GMAG often participate in the annual Magnetism and Materials Conference, which is cosponsored by APS and the IEEE Magnetics Society.

A glance at the sessions sponsored by the Group so far gives the rationale for its existence. First, there are sessions cosponsored with Condensed Matter Physics in areas of common interest. Interestingly, there are sessions cosponsored with other APS units as well. And there are sole sponsorships of areas which might not have received attention at the APS in the absence of GMAG. In the event of sole sponsorship, a somewhat different audience is attracted than in the other venues, which helps spread the word.

One area that I want to look into is the sponsorship of the MMM. Perhaps some of you have thoughts about this already. There is a lack of parallelism in that the "holding company" for the physicists, The American Institute for Physics (AIP) is one cosponsor, but a subunit of its equivalent for the engineers, i.e., the Magnetics Society of IEEE is the other cosponsor. Wouldn't it make more sense for the APS to be the sponsor instead of the AIP? I don't know how this might affect various administrative and financial relationships, but it would have one important benefit. The physics community would be represented by active magneticians who are members of GMAG, rather than by an AIP representative who is not necessarily even in the magnetics business. Please let me know your opinions on this at <lbennett@seas.gwu.edu>.

Another concern is to increase the membership rolls of GMAG. Help us recruit new members by asking your friends why they are not members.

Prof. Lawrence H. Bennett

GMAG Chair 1999/2000

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To the GMAG Membership, from the exiting Chair:

It has been an honor and a pleasure to serve as the GMAG Chair for 1998/99. I would like to publicly and enthusiastically thank the other officers, the executive committee, and the various other committees for their work during the year. GMAG is now firmly established as a voice for "magnetism and its applications" within the American Physical Society I would like to use this "farewell" Newsletter article as Chair to comment on six issues:

GMAG and the March Meeting in general,

GMAG plans for the Centennial Meeting,

GMAG growth and recruiting,

GMAG fellow nominations and elections,

GMAG and education outreach, and

GMAG member involvement.

First, I believe that our involvement in the organization and logistics of the March Meeting, and particularly in the upcoming Centennial March Meeting, has provided valuable guidance and support to the APS which extends well beyond our numbers. Much of this derives from the involvement of many of us in both Intermag and MMM over the years. We have been able to contribute to the March Meeting logistics from a base of extended experience and conference memory. This, I believe, is very helpful to a meeting that experiences almost a complete changing of the guard every year. It will be important to continue and expand this involvement as our numbers grow.

Second, the specific GMAG contributions to the program for the Centennial March Meeting build on the progress made last year in providing a broad core of magnetics sessions and activities Several special sessions, a number of focus sessions, a large number of regular sessions, and an impressive slate of invited speakers are featured.

A separate article by Jeff Lynn summarizes these sessions and speakers. As Program Chair, Jeff has done a spectacular job of organizing and coordinating special sessions and speakers.

A special committee comprised of Bob McMichael, Dave Pappas, Stephen Arnold, Kevin Heim, and Anil Prabhakar, under the leadership of Phil Wigen, has been busy organizing and planning for a special GMAG display for the Centennial Meeting Exhibit Program. The APS has placed a significant emphasis on the exhibit aspects of this March meeting, and the GMAG contribution promises to be a good one.

Third, and speaking of numbers, GMAG has grown from 406 members in March 1998 to 452 in January 1999, for an increase of about 10%. This has happened without any focused recruiting effort. I believe that it would be in the interest of GMAG to have a committee dedicated to recruiting. Among other things, this committee could consider booths or tables at MMM, Intermag, and perhaps other topical conferences which have a large magnetics component. It might be possible to share such activities with the APS and the AIP.

Fourth, I would like to especially thank our standing committees on Fellow Nominations and GMAG election candidates. The Fellow Nominations Committee, with Larry Bennett as Chair and Phil Wigen and Jan Herbst as members, nominated two outstanding GMAG members for fellowship under the group's quota and recommended three other GMAG members for fellowship to the Society at large. Further information on these nominations and recommendation should be available soon. The Election Committee (Dave Sellmyer, chair, Larry Rubin, and Eric Fullerton) has also assembled an impressive slate of candidates for GMAG officer and executive committee positions. By the time you receive this newsletter, you should have already VOTED! This will be a banner year for "new blood," as the slate contains candidates for both the Chair Elect and the

Vice-Chair positions. Be sure to vote if you have not already done so!

Fifth, I would like to suggest of one additional special GMAG committee to focus on magnetics education. As many of you know, graduate recruiting has suffered a severe downturn in many science and engineering disciplines over the past years. The continuing expansion of magnetic recording technology drives the demand for more, not fewer, qualified scientists and engineers in fundamental and applied magnetics. In my opinion, a GMAG committee to address this critical issue could play a valuable role. This committee might also establish a liaison with its active counterpart within the IEEE Magnetics Society. The combined efforts of two such dedicated groups within the APS and the IEEE could have an important impact on this problem.

Finally, I would like to issue a call for more GMAG member involvement. The vitality and effectiveness of any group such as GMAG, and its value to the members, depends on the involvement of the members. One need not be an officer or an executive committee member to be a vital contributor. I hope that many of the membership who have joined the group, but have not yet become involved, will decide to take an active role. It is easy to do, it does not take much time, and your effort can have a real impact. It is also a lot of fun.

Best wishes to Larry Bennett as he assumes the Chair of GMAG for 1999/2000.

I hope to see many of you in Atlanta in March.

Best wishes,

Carl Patton

January 22, 1999

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GMAG Symposia and Focus Sessions for the Centennial Meeting

Jeff Lynn (NIST), Chair, Program Committee

Jim Rhyne (University of Missouri--Columbia)

Jeff Urbach (Georgetown University)

The sorters meeting for the March portion of the program was November 20-21, and David Jiles, Jeff Lynn, David Pappas, Carl Patton, Vince Harris, and Andrei Slavin helped to sort the magnetism category, along with members from DCMP and DMP. There are many sessions that are sponsored by GMAG, and the full program is available electronically at

http://www.aps.org/meet/CENT99/BAPS/index.html

Of particular note are the following Invited Symposia and Focus Sessions sponsored by GMAG.

Centennial symposium on the History of Magnetism, sponsored jointly with DMP (organized by Jim Rhyne of GMAG and Dan Pierce of DMP).

Session UA01, 8:00 Thursday, 25 March. Ballroom I of the Georgia World Conference Center (GWCC).

Graham, Foner, Wolf, Fisher, Gruenberg

We are also sponsoring two other symposia:

Magnetism in Technology, sponsored jointly with FIAP (organized by Stu Wolf of FIAP).

VC08, 11:00 Thursday, 25 March. Room 364W, GWCC

Coey, Kryder, Parkin, T. Zhu, J. Zhu

Spin Polarized Tunneling, sponsored by GMAG (organized by Jagadeesh Moodera).

SC36, 14:00 Wednesday, 24 March. Room 158W, GWCC

Jansen, Maekawa, Slonczewski, Tedrow, Wiesendanger

Three focus sessions were organized by GMAG. The session on Environmental Magnetism did not receive a sufficient response to have a viable session. The other two proposed focus sessions had enough abstracts for two full sessions.

Nonlinear and Macroscopic Quantum Phenomena (Organized by Andrei Slavin)

EC36. Monday, 22 March. 10:30, Room 158W, GWCC

Chudnovsky

Nonlinear Magnetic Excitations: Solitons, Instabilities and Chaos

LC36. Tuesday, 23 March. 13:15, Room 158W, GWCC.

Patton

Magnetism in Soft Matter (Organized by Weili Luo, University of Central Florida)

UC36. 8:00 Thursday, 25 March. Room 158W, GWCC. Odenbach

WC36.14:00 Thursday, 25 March. Room 158W, GWCC.

Editors note:

Following is a another brief technical article on a timely subject. As with the last article on Magnetic Refrigeration, we hope that you will find it interesting. If you enjoy finding this sort of article in our newsletter, let us know. Better yet, suggest another topic and author so we can solicit a contribution. Best of all, volunteer to write a similar article!

—Bruce van Dover

Spin Tunneling In Ferromagnetic Junctions

potential for memory, read head and sensor elements

Jagadeesh S. Moodera

Francis Bitter Magnet Lab, Massachusetts Institute of Technology

Cambridge, MA02139

Spin-dependent quantum tunneling devices are three-layer thin film structures, the resistance of which can be modulated by the relative orientation of the magnetization(M) of the two ferromagnetic (FM) electrodes in a small applied magnetic field,H (see Fig.1). By choosing FMs with different coercive fields (H_C), one can form devices which switch from high to a low resistance state in a small H. The possibility of such spin-dependent tunneling between two FM films has been realized recently. Large junction magnetoresistance (JMR) is observed at ambient conditions, in a small applied field (even less than 1 Oe). The breakthrough in observing a JMR of over 10% at room temperature came about in 1995, by using ultra thin Al_2O_3 as the insulator between FM films such as permalloy, Co, CoFe etc. Currently, values larger than 37% at room temperature have been reported. Even higher percentages may be expected with the use of the so called half-metallic ferromagnetic materials such as CrO_2, NiMnSb and manganate compounds.

(editor's note: Figure 1 unfortunately did not reproduce in HTML)

Fig.1 The principle of spin tunneling and magnetoresistance in a ferromagnet - insulator - ferromagnetic trilayer junction (Julliere’s model). The arrows show the magnetization directions.

Spin polarized tunneling, discovered in 1970 by Tedrow and Meservey, laid the foundation for the FM-I-FM model described by Julliere. It was shown by Meservey and Tedrow that the tunneling electrons from a ferromagnetic metal were spin polarized and that the electron spin is conserved in the tunneling process. FM-I-FM tunneling sets itself apart from other transport phenomena (such as GMR multilayers and CMR materials where a large magnetoresistance has been observed) in that the tunneling current is strongly dependent on the tunneling probability (through the insulating barrier, which is usually < 2 nm thick) and the density of states of the electrodes which comprise the junction. The size of JMR is related to the product of the conduction electron spin polarizations of the FM films. Besides being extremely interface sensitive, the JMR has been observed to be intrinsically dependent on the applied voltage bias across the trilayer.

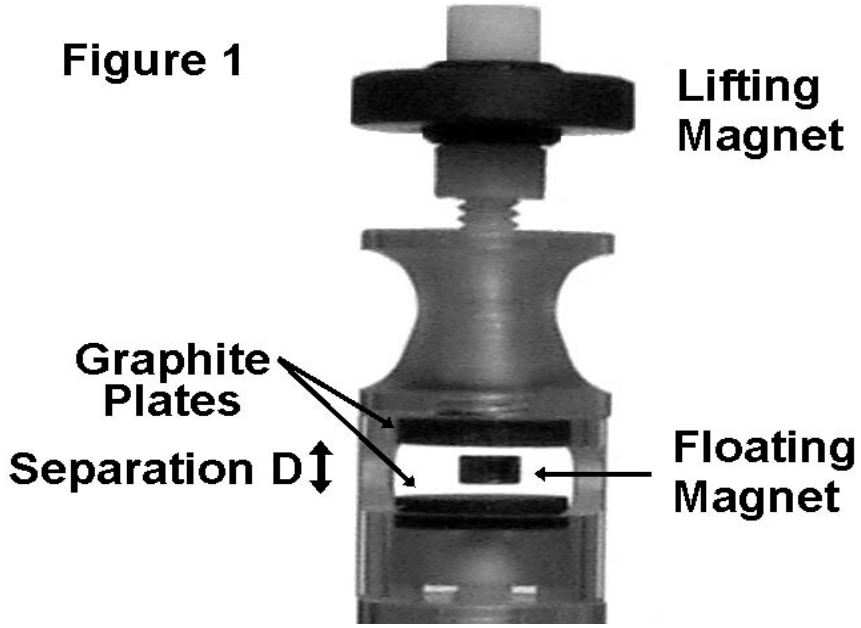

Fig. 2. Resistance versus applied magnetic field for a Co /Al_2O_3 / $Ni_{80}Fe_{20}$ tunnel junction at room temperature showing the behavior as expected from Julliere's model. The position and the shape of this curve are determined by the coercive fields of the FM electrodes—the hysteresis loop can be modified by exchange biasing one of the FM films. The sensitivity can also be optimized by the growth conditions of the FM films. The arrows indicate the direction of magnetization in the two FM films. The high resistance state can be maintained at H=0, if H is turned down to zero after reaching the peak value, showing the memory effect. This state is stable even in the absence of electrical power to the junction.

The large resistance, large magnetoresistance, and the temperature and magnetic field range of operation of these devices make them compatible with sensor and memory requirements, and superior to other such magnetic devices. The FM junctions show a nonvolatile memory effect suitable for application as magnetic random access memory element. The small size, higher sensitivity factor(>5%/Oe), radiation insensitivity and ultra low power requirement make the JMR structures attractive as read head sensors as well, with the possibility of achieving magnetic storage densities up to 100Gb/in^2.

Companies such as NVE Inc., IBM, HP, Motorola, Philips, Fujitsu, NEC, TDK and Toshiba have already made great progress towards the application of this new phenomenon into device technology. The progress just in the last two years has been phenomenal due to the extreme potential of this technology for applications involving computers, nonvolatile magnetic random access memory elements, sensors for medical instrumentation and automobiles. Several patents have already been issued. It appears that JMR devices have by far the best properties of all currently available technologies—the possibility of their use magnetic storage is exciting.

J. S. Moodera et.al Phys. Rev. Lett. **74**, 3273 (1995); **80**, 2941 (1998)
Y. Lu et. al J. Appl. Phys. **83**, 6515 (1998)
R. Sousa et.al Appl. Phys. Lett. **73**, 3288 (1998)

1999 Business Meeting

The 1999 GMAG business meeting will be held in conjunction with the APS Centennial Meeting at 6:00 pm, Tuesday, March 23, 1999 at the Georgia World Congress Center, Room 158W, as listed in the Centennial Program. Please come and offer your opinions

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GMAG Officers

(please hyperlink to the officers page of this website)

Calendar of Upcoming Magnetism Meetings

(please hyperlink to the calendar page of this website)

Please hand this to a colleague interested in **Magnetism and its Applications**

Join GMAG today

YOUR group needs you!

GMAG is the topical group of the American Physical Society that represents the interests of Physicists working in Magnetism and its Applications. In two years we have grown to well over 400 members. Your membership counts with us. Your GMAG vote counts even more, because unlike some of the larger units in the APS you can really have impact

and influence on how APS represents our subject area.

Here’s how you join. As an APS Member it only costs $6.

If you are an APS member and want to add the Topical Group on Magnetism and its Applications:

Mail a check for US$6.00 to the APS noting the name of the topical group and your name or membership number. The address is: The American Physical Society, One Physics Ellipse, College Park, MD 20740. Or go to the APS page for "Application to add units" (http://www.aps.org/memb/unitapp.html) and follow the easy instructions for adding a unit to your existing membership. You may use a credit card as payment if you select our secure server. Or call the APS at 301-209-3280 and tell one of the Membership Representatives that you want to join the topical group.

If you are NOT an APS member you may join the APS and the Topical Group on Magnetism and its

Applications:

Go to the APS Membership Page (http://www.aps.org/memb/index.html) and follow the easy instructions for applying. You may use a credit card as payment if you select our secure server, or download an application, fill it out, and mail it or fax it to the APS with your payment. Call the APS at 301-209-3280 and tell one of the Membership Representatives that you would like an application mailed to you.