

## Planes of Continuous-Wave Oscillations from an Electron Nanocontact Spin-Transfer Device

by G.P. Cameron

Electrons flowing in contact with ferromagnetic material become polarized much like light can be polarized using optical filters. These polarized electrons can then transfer spin (angular momentum) to other electrons causing an oscillation in the GHz range based on the original un-polarized DC current.

Researchers first reported continuous-wave (CW) output from spin-transfer (ST) devices with spin-valve layers for both nanopillar and nanocontact device types in 2003 [1] and 2004 [2]-[4]. Nanocontact ST devices typically operate as dc-controlled, CW sources of microwave energy in the tens of gigahertz range; nanopillar ST devices typically operate as two-state memories. The previous studies did not address the problem of how to find the CW oscillation frequencies efficiently in the independent variable space.

The frequencies of continuous-wave (CW) microwave oscillations in nanocontact spin-transfer (ST) devices are found to occur in well-defined planes of frequencies, as a function of the dc current bias, the direction of the magnetic field, and the magnitude of the magnetic field. The frequency,  $f$ , of these CW oscillations for each magnetic field direction is described empirically by the equation of a plane,

$$f = a |B| + bI + c \quad \text{where} \quad |B| \quad \text{is the magnitude of the}$$

magnetic field,  $I$  is the dc bias current, and  $a$ ,  $b$ , and  $c$  are constants of the plane. The primary frequency plane described by this equation is accompanied by a smaller secondary plane. The empirical equation describing the primary plane serves as a guide for efficiently locating CW oscillations within the independent variable space.

[1] S.I.Kiselev, J.C. Sankey, I.N. Krivorotov, N.C. Emley, R.J. Schoelkopf, R.A.Buhrman, and D.C.Ralph, 'Microwave oscillations of a nanomagnet driven by a spin-polarized current,' *Nature*(London), 2003, 425, (6956), pp. 380-383

[2] W.H.Rippard, M.R.Pufall, S.Kaka, S.E.Russek, and T.J.Silva, 'Direct-current induced dynamics in  $Co_{90}Fe_{10} / Ni_{80}Fe_{20}$  point contacts,' *Phys. Rev. Lett.*, 2004, 92, (2), pp. 027201-1 - 027201-4

[3] M.Covington, M.AlHajDarwish, Y.Ding, N.J.Gokemeijer, and M.A.Seigler, 'Current-induced magnetization dynamics in current perpendicular to the plane spin valves,' *Phys. Rev. B.*, 2004, 69, (18), pp. 184406-1 - 184406-7

[4] W.H.Rippard, M.R.Pufall, S.Kaka, T.J.Silva, and S.E.Russek, 'Current-driven microwave dynamics in magnetic point contacts as a function of applied angle,' *Phys. Rev. B.*, 2004, 70, (10), pp. 100406-1 - 100406-4

## IEEE Creates Hurricane KATRINA Resources

A frequently-asked-questions page that addresses issues of concern to IEEE members, customers and conference attendees relevant to Hurricane Katrina is available on the IEEE Web site at

[http://www.ieee.org/portal/pages/newsinfo/katrina\\_faqs.html](http://www.ieee.org/portal/pages/newsinfo/katrina_faqs.html). The FAQs are accessible from the IEEE home page <http://www.ieee.org>, the myIEEE home page and the IEEE-USA Katrina page at <http://www.ieeeusa.org/about/Katrina>.

The FAQs cover a range of information about IEEE business and services, including how to change addresses, the IEEE-USA response to the hurricane and its aftermath, rescheduled conferences, annual election ballots, insurance and publications delivery. New information will be added as appropriate.

In addition, an IEEE online community was established to allow members to share information on Hurricane Katrina's aftermath, recruit help and more. Members may join at <https://www.ieeecommunities.org/ieee.katrina>.

## SECTION MEETING

Featuring: Graham P. Cameron

**Monday, October 10<sup>th</sup>, 6:30 pm**

Mayo Medical Sciences Building  
(321 3<sup>rd</sup> Avenue SW, Rochester)

► Pizza at 6:30; Meeting at 7:00 ◀

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Communications, Control Systems and Signal Processing

**Graham P. Cameron** received the B.S., M.S., and Ph.D. degrees in Electrical Engineering from the University of Minnesota. His present research interests include the electron-spin dependent devices, signal integrity, and medical applications of magnetism. His previous work includes magnetic recording head design and tester development at Seagate; piezoelectric shock sensor and low-power digital product development at Event Tracking Service; electron-spin probing of magnetic surfaces at Hitachi; and magnetic transducer and magnetic random access memory development at Honeywell.

## myIEEE site Updated

The IEEE has launched a new version of its members-only Web portal that includes significantly improved usability and functionality.

**myIEEE**, the members-only Web site, now groups benefits so that you can quickly find everything you need related to the IEEE and to your professional, community, technical research, and volunteer activities. Links have been added to email addresses of all IEEE section leaders, sorted by country and IEEE region. Members can access online benefits such as email aliases and manage various aspects of their membership such as subscriptions, all from one Web site.

IEEE members who sign into **myIEEE** are no longer required to re-enter their Web Account name and password to access their membership account. In addition, various tools and utilities used to access IEEE member benefits online have been grouped into "desktops" on **myIEEE's** left navigation.

**myIEEE** is an exclusive benefit of IEEE membership, and is available to all active IEEE members with an IEEE Web account. Visit **myIEEE** at <http://www.ieee.org/myieee>.

## IEEE Elections

Yes, its that time of year again. Your Southern Minnesota Section is asking for your help.

The section election for Chair, Vice-Chair, Secretary and Treasurer is coming soon. If you are interested in these positions or helping out in a non-elected position, please contact Dave Paulsen ([dppaulse@us.ibm.com](mailto:dppaulse@us.ibm.com)). If you have any questions about any of these positions, you may contact any current board member. This is a great way to network and get involved.

## From AWK to Google: Peter Weinberger

George W. Bush isn't the only "W" in the world. People who worked with Unix in its early days know Peter Weinberger as the "W" in the AWK programming language. Named for its creators, Alfred Aho, Peter Weinberger, and Brian Kernighan, AWK arrived in 1977 and became part of Version 7 Unix, a key release by Bell Laboratories.

Today, Weinberger works for the king of search companies, Google, where he helps create tools to better manage the mounds of information created by employees. For the rest of the interview, visit: <http://tinyurl.com/ap35b>

## Searching for Gravity@Home

The Einstein@Home project asks that you lend the idle CPU time of your home or work computer to physicists and astronomers now searching the sky for evidence of gravitational waves. The waves could result from stars exploding, black holes engulfing each other, or other acts of astronomical violence. Plus, you get a jazzy screen saver. Read more at <http://tinyurl.com/9v12r>.

## Taking the Pulse of the Earth

The IEEE has taken on an important role in support of an ambitious 60-nation enterprise to create a worldwide Earth-monitoring network to address climate, drought, and air and water quality. The decade-long project, known as the Global Earth Observation System of Systems, will bring together data gathered by thousands of gages, sensors, buoys, weather stations, and satellites measuring conditions across the land, oceans, and atmosphere. Find out more at <http://tinyurl.com/amuug>

## So Now You Are a Manager

Not all engineers promoted to management love the job, and some don't like it at all. The likely reason for dissatisfaction is a lack of training. All managers must learn the importance of communicating effectively, building relationships, using time efficiently, and seeing the big picture. Find out how at <http://tinyurl.com/dazfu>.



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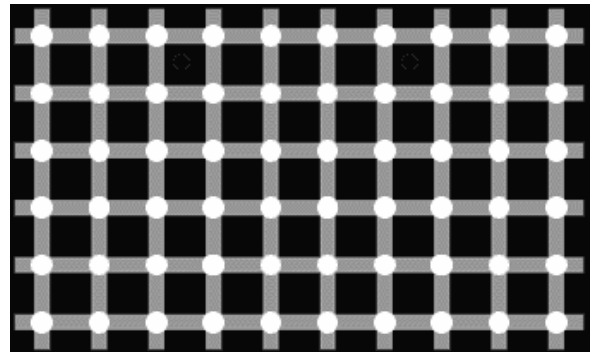
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