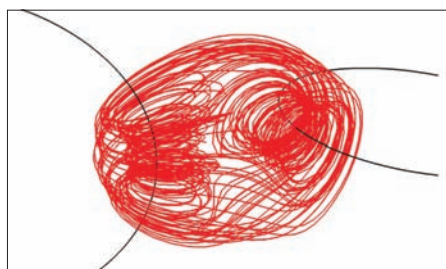


Simple circuits create chaos

Textbooks usually show magnetic fields as simple loops around current-carrying wires, but what happens with the many convoluted wires that make up electrical circuits? Quite remarkably, Makoto Hosoda of Osaka City University in Japan and colleagues have shown that typical magnetic fields are wildly complicated and, indeed, chaotic. Even two circular current loops at right angles to each other produce elaborately knotted fields, which are chaotic in the sense that, when following the field lines from two nearby points, the researchers find wildly diverging trajectories.

Such complex fields are well known in plasma physics, but finding them in simple circuits has come as something of a surprise. The good news is that it might be that the chaos avoids the build-up of fields that could



Induced magnetic field lines wrap around perpendicular current loops in a chaotic fashion. (Courtesy Hosoda et al. 2009.)

otherwise disrupt small devices, allowing them to operate stably.

Further reading

M Hosoda et al. 2009 *Phys. Rev.* **E80** 067202.

GRB observation vindicates relativity

Recent theories of quantum gravity have suggested that the speed of light could vary slightly with the energy of the photons involved, thus violating the Lorentz invariance that underlies the special theory of relativity. Now observations of photons from a gamma-ray burst by the Large Area Telescope (LAT) and the Gamma-ray Burst Monitor (GBM) on the Fermi Gamma-ray Space Telescope have set stringent limits on such effects.

Fermi observed GRB 090510 on 10 May 2009, when it triggered both the LAT and the GBM, and photons detected by the LAT included one with an energy as high as 31 GeV. Given the large distance to GRB 090510 (around 7000 million light-years),

this made it possible to search for small variations in the photons' speed by comparing arrival times over a wide energy range starting at around 100 MeV.

AA Abdo and colleagues used the observations to show that linear variations in the speed of light with energy are ruled out at 1.2 times the Planck scale ($E_{\text{Planck}} = 10^{19}$ GeV). On the negative side this is a remarkable constraint on quantum gravity theories, while on the positive side it suggests that quadratic effects could be testable in similar observations.

Further reading

AA Abdo et al. 2009 *Nature* **462** 331.

Ion mystery has been solved

Among the many mysteries of water is the origin of the Hofmeister series. This is a 120-year-old list of ions that describes their effects on the structure of water – most notably, how they alter the strength of hydrophobic interactions with proteins. The science behind the series has remained a

puzzle since the list was created by Franz Hofmeister when he was studying proteins in Prague in the late 1880s.

Now Yan Levin of the Federal University of Rio Grande do Sul in Brazil and colleagues may have found the key to understanding the series. Their detailed calculations of the polarization of water around various ions and its effect on surface tension provides a list that not only matches experimental measurements of surface tension, but also reproduces the Hofmeister series, making a link between

Defining amperes

The present definition of the ampere is arbitrary, so it would be good to have a physically meaningful absolute measure for current. Ville Maisi at the Centre for Metrology and Accreditation in Espoo, Finland, and colleagues have managed to gang together 10 single electron transistors to make something like a 10-electron “turnstile”, which can produce a precise current of 100 pA.

This is a factor of 10 higher than previously possible. Scaling to higher currents, to a real current standard in terms of electron charge per second, appears to be within sight.

Further reading

V Maisi et al. 2009 *New Journal of Physics* **11** 113057.

Spintronics comes in from the cold

Saroj Dash and colleagues at the University of Twente in the Netherlands have demonstrated the injection and detection of spin in silicon at room temperature, together with its control via a weak magnetic field.

Polarized electrons or holes enter and leave silicon from conducting ferromagnets via tunnelling, retaining spin lifetimes of 140 ps in n-type silicon and 270 ps in p-type silicon, with drift distances large enough to make interesting devices possible. Previous injection and detection of spins in non-magnetic semiconductors has been restricted to n-type materials below 150 K.

Further reading

Saroj P Dash et al. 2009 *Nature* **462** 491.

polarization, water–ion–air surface effects and water–ion–protein interactions.

The work has wider implications because it also explains the tendency of highly reactive halogen ions to move to the surfaces of water droplets – an important and until now mysterious phenomenon in atmospheric chemistry.

Further reading

Yan Levin et al. 2009 *Phys. Rev. Lett.* **103** 257802.