

Sciencewatch

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Watching charge transfer in a molecule

The transfer of an electron in a molecular bond has now been followed in time as the bond breaks, thanks to a clever pump-probe approach employed in an experiment at the Linac Coherent Light Source at SLAC. Benjamin Erk of DESY and Max-Planck Institutes in Hamburg and Heidelberg, and colleagues, have used an 800-nm infrared pulse to break gas-phase methyl iodide into a methyl group and an iodine atom, either or both of which might be positively charged. A subsequent ultrashort X-ray free-electron pulse almost exclusively ionizes the iodine M-shell electron, producing a localized positive charge on the iodine, which then



spreads across the molecule.

By looking at the charge and kinetic energies of the decay products as a function of the delay between the infrared dissociation pulse and the X-ray pulse, the team can map out how electrons are shared

Artist's concept of an exploding methyl-iodide molecule and its jumping electrons. (Image credit: SLAC National Accelerator Laboratory.)

as a function of the distance between the two fragments. The charge transfer can take place at up to approximately 10 times the normal bond length. Beyond that, the system is no longer a molecule. The results on this critical distance are in agreement with the classical over-the-barrier model.

● Further reading

B Erk *et al.* 2014 *Science* **345** 288.

How to measure cosmic acceleration directly

An exciting new proposal could directly measure cosmic acceleration not with supernovae, but with much simpler and better understood systems: hydrogen atoms. Hao-Ran Yu of Beijing Normal University and colleagues suggest that direct measurements of recession-velocity drifts (the Sandage–Loeb effect) of 21-cm absorption systems could be made at two different times to derive their acceleration.

This would constitute two measurements of the velocity of the same system and should be highly model-independent. With a modest change in data analysis and storage of a wide-sky radio survey such as the Canadian Hydrogen Intensity Mapping Experiment (CHIME), the acceleration of a Λ CDM universe (with cold dark matter and a cosmological constant) could be determined with 5 σ confidence within a decade.

● Further reading

H-R Yu *et al.* 2014 *Phys. Rev. Lett.* **113** 041303.

Nuclear monitoring with antineutrinos

With increasing concerns about nuclear proliferation, a suggestion by Eric Christensen of Virginia Tech in Blacksburg and colleagues could be of great value. The idea echoes the discovery of the neutrino by Fred Reines and Clyde Cowan, by using a large volume of scintillator to look at antineutrino collisions with protons that produce a positron and a neutron, with most of the kinetic energy

Brine on Mars

Evidence for deliquescence of perchlorate salts in the Martian polar region seemed to be in contradiction to the possible brine flows observed near the equator, the idea being that bulk deliquescence is too slow to occur during the Martian diurnal periods. Erik Fischer of the University of Michigan in Ann Arbor and colleagues have now resolved the puzzle by looking at the formation of saline solutions in Mars-like conditions in the laboratory.

They found that if only water vapour is present, there is a problem. However, if the salts are in contact with water ice, brine forms in minutes. This shows that aqueous solutions could form where salts and ice are both present on or just below the Martian surface.

● Further reading

E Fischer *et al.* 2014 *Geophys. Res. Lett.* **10.1002/2014GL060302**.



Colour-coded data from a mineral-mapping spectrometer supported the idea that the seasonal dark marks on the photo of the same Martian slope are linked to brine flows. (Image credit: NASA/JPL-Caltech/UA/JHU-APL.)

being carried by the positron. Direct energy measurements would allow the antineutrino spectrum from the reactor to be determined and – with a 20-tonne detector just outside a reactor building – could reveal the plutonium content, because plutonium emits a softer antineutrino spectrum.

Using North Korean reactors and the IR-40 reactor in Arak, Iran, as test cases, the researchers found that the removal of as little as 2 kg of plutonium could be detected within the 90 days required by the International Atomic Energy Authority. Some improvement on current technology for neutrino detectors would be needed, but this might be achievable within five years.

● Further reading

E Christensen *et al.* 2014 *Phys. Rev. Lett.* **113** 042503.

A prism in the eye

Revealing yet another remarkable feat of biological evolution, Amichai M Labin of the Technion Institute in Haifa and colleagues have shown that cells in the retina split light as a prism does, and so send specific wavelengths to different receptors to improve daytime vision. So-called “Müller” cells concentrate red and green light onto the daytime sensing cones, boosting what they get by a factor of 10, while allowing blue light to leak out to the rod cells used in night vision. The work used computer simulations of human eye cells and was confirmed in guinea-pig retinas.

● Further reading

A M Labin *et al.* 2014 *Nature Communications* **5** 4319.

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