Host with the most

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Astrophys. J. **700,** 1820–1830 (2009)

HE0450-2958 is an unusual quasar (quasi- stellar radio source): there is no detectable galaxy surrounding or feeding the central black hole, although most quasars are so luminous that they often outshine their host galaxies. Nearby — 6.5 pc away — lies a highly active galaxy that produces almost four times as many stars as most active stellar nurseries. To resolve the relationship between the quasar and galaxy, and to probe unambiguously the presence of any putative co-centred host galaxy, two observational studies using infrared telescopes have been led by Knud Jahnke and by David Elbaz. At infrared frequencies, quasars and any obscuring dust clouds should be very luminous.

Both teams find no evidence for a host galaxy. However, as one of the radio jets emitted by the quasar is aligned with the galaxy, the authors suggest that the quasar may be responsible for creating its companion galaxy, which would eventually merge with the quasar and become its host galaxy. This theory would explain why the most massive black holes have host galaxies with the most stars.

Positive feedback

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Feedback is at the heart of control. By monitoring the output and feeding back into the input any deviations from the optimum, it is possible to stabilize a system in a desired state. This concept has now been applied at the quantum level: Alexander Kubanek and colleagues have used the feedback from photons to precisely control the position of a single rubidium atom in an optical cavity.

A cavity is useful because it enhances the interaction between atoms and light, but this enhancement depends on the position of the atom. As the rubidium atom moves from its optimum location, it changes the transmission of a probe laser. This change in intensity is detected in real time and used to control the power of another laser, switching to high power as soon as the atom attempts to leave the cavity and switching to low power when the atom moves towards the cavity axis. This feedback increases the time that the atom is held in the cavity by a factor of four.

Gated molecules

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The goal of molecular electronics is to build electronic devices based on controlling the conductivity of individual molecules. This could push the device density of electronic circuits towards their fundamental limit. Moreover, molecular devices could perform more complex functions than conventional silicon-based devices by exploiting the unique and more easily tailored characteristics of specific molecular species. The demonstration of a three-terminal molecular field-effect transistor (FET) by Hyunwook Song and colleagues brings these ideas a significant step closer to reality.

Most devices demonstrated so far have been two-terminal devices (such as rectifying diodes) or controlled by the tip of a scanning tunnelling microscope. But to build practical circuits, devices such as transistors in which the properties are controlled by a third 'gate' electrode are essential. The device built by Song *et al.* consists of two gold source and drain electrodes, spanned by a single organic molecule and placed over an insulated aluminium substrate that acts as a gate. Similar to the operation of a conventional FET, applying a voltage to the gate of the molecular FET increases the conductivity between the source and drain. Inelastic electron tunnelling spectra confirm that this is the result of resonant coupling to the molecular orbitals of the device.

Loss is gain

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The most stringent limits so far on some of the coefficients of Lorentz violation have been calculated using data from an unlikely source: the synchrotron losses endured at CERN's Large Electron–Positron collider, the predecessor of the Large Hadron Collider.

The possibility of a violation of Lorentz invariance, and of CPT symmetry, is encapsulated in a model known as the standard model extension. There are strong bounds on many coefficients of the standard model extension, particularly from astrophysical observations, but weaker bounds on others. Of particular interest is Lorentz violation manifest as different limiting velocities at high energies for different types of particle, such as photons or electrons.

Astrophysical sources naturally provide high-energy particles, but are often not fully understood. But the behaviour of the high-energy electrons and positrons that once coursed through the Large Electron–Positron collider, and the energy lost from these beams through synchrotron radiation, were very well understood — they had to be, to elicit precision measurements of parameters such as the mass of the *W* boson.

Brett Altschul now presents bounds on Lorentz violation using these data that are three orders of magnitude stronger than previous bounds based on laboratory measurements, and that, for one coefficient in particular, even improve on the best astrophysical bound.

Different but different

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In the closing paragraph of his classic paper 'More is different' (*Science* **177,** 393–396; 1972), which discusses emerging phenomena in solid-state physics and other branches of science, Philip Anderson referred briefly to two examples from economics, to emphasize the point that the macroscopic behaviours of a complex system can be qualitatively different from those of its microscopic constituents, and to highlight the occurrence of such phenomena across various disciplines.

Nevertheless, goals and definitions do vary across the different fields in which the relation between individual and collective behaviour is studied, as Sébastian Grauwin and colleagues point out. In physics, for example, 'equilibrium' is usually defined as the state that minimizes the global free energy, whereas in economics equilibrium is reached when no individual can further increase their own satisfaction. Bridging this gap, Grauwin *et al.* present an analytical model that can account for both cooperative and individual dynamics, and interpolates continuously between the two.