There's more to Maxwell

There are few physics textbooks, if any, that do not concern themselves with the work of James Clerk Maxwell. His time-honoured equations, presented to the Royal Society in 1864, still, however, have more to offer. Taking a mathematical viewpoint, A. Tip has now uncovered some interesting properties of Maxwell's equations, by concentrating on issues of wave propagation rather than electrostatics (*J. Math. Phys.* **47,** 012902; 2006).

With a focus on dynamics, Tip departs from treating Maxwell's equations as a system of differential equations, and instead associates them with unitary time evolution. This is accomplished by using the same Hilbert-space formalism that arises in discussions of Schrödinger's equation. Within this framework, it can be shown, for example, that there is a decoupling of the equations of motion for the longitudinal and transverse field components of a wave propagating through a dielectric material.

Such insight is useful physically — such as in simplifying the discussion of the band structure of photonic crystals. The same approach might also give fresh view on the mathematical description of nonlinear dielectrics, a subject not widely explored so far.

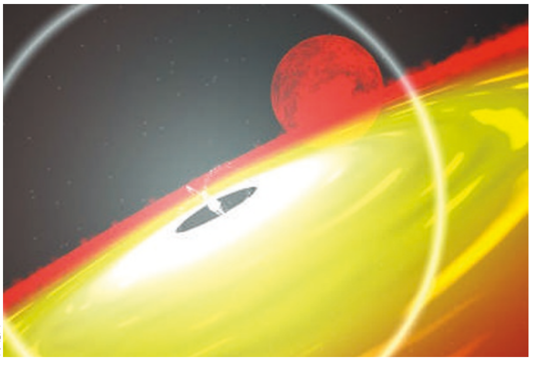
MITIGATING THERMONUCLEAR EROSION

Among the many challenges faced in the design of a viable fusion reactor is the problem of maintaining a plasma at a constant temperature of over 200 million degrees without rapidly eroding the inner walls of the reactor. Strong confinement fields go some way to preventing most of the high-energy ions of this plasma from touching these walls, but it is likely that it will be impossible to avoid this completely. Coating the walls with graphite, with its high melting point and sputter resistance, has been suggested to minimize the resulting erosion, but is frustrated by the fact that graphite reacts chemically with even a low-temperature hydrogen plasma. Thankfully, according to a study conducted by Matthew Baldwin and Russ Doerner (*Nucl. Fusion* 46, 444–450; 2006) there may be a solution to this too. They find that injecting beryllium into a deuterium plasma reduced the reactivity of graphite by binding to its surface.

Pulsing to a different beat

A pulsar is a rotating neutron star that emits from its magnetic poles intense beams of charged-particle radiation, which may periodically sweep the Earth. Some pulsars show variations in the flux density, and sometimes several rotation periods go by with no emission — a random occurrence that remains unexplained. One known pulsar behaves even more oddly. PSR B1931+24 is active for about 5–10 days, but then it suddenly switches off for 25–35 days before turning back on again.

Michael Kramer and colleagues at the Jodrell Bank Observatory have measured its rotation rate over a 160-day period (*Science Express* doi:10.1126/science.1124060; 2006). To their surprise, the spin-down rate (the rotational frequency derivative) is about 50% greater when the pulsar is active. As the energy loss due to beaming alone cannot account for this change, the authors suggest that a change in the plasma current in the magnetosphere could supply the necessary braking torque. Although the origin of this pulsar 'wind' is unclear, its presence in normal pulsars could affect estimates of their magnetic fields.



NASA

Did you hear this?

The cochlea — a coiled, tapered tube in the inner ear — plays a central role in our perception of sound. It hosts the basilar membrane, which, owing to its graded mechanical properties, can decompose incoming sound into its frequency components. Close to the cochlea's opening, the membrane is sensitive to high frequencies; moving down the duct, the sensitivity changes continuously to lower frequencies.

The role of the characteristic curvature of the cochlea is far from clear. But D. Manoussaki and colleagues propose that the spiral-shell geometry bundles the sound waves, leading to efficient amplification (*Phys. Rev. Lett.* 96, 088701; 2006).

The effect is reminiscent of the 'whispering gallery' phenomenon, which describes the confinement of sound waves, for example, close to the walls in a dome. Manoussaki *et al.* show that, similarly, reflection off a boundary of decreasing curvature progressively focuses the wave energy onto the outer wall. This is most pronounced towards the apex of the cochlea, suggesting that the greatest influence of this effect is on how we process low frequencies.

Three's a crowd

In 1970, the Russian nuclear physicist Vitaly Efimov made the stunning prediction that, under certain circumstances, three interacting particles can form an infinite series of bound trimer states, even when none of the two-particle subsystems is stable. Since then, 'Efimov physics' has been intensely studied theoretically, leading to a deeper understanding of how a handful of quantum particles interact with each other. Convincing experimental evidence for the exotic three-particle Efimov state, however, has been lacking.

Not any more — T. Kraemer and colleagues have found clear signatures of the effect in their experiments with an ultracold gas of caesium atoms (*Nature* **440,** 315–318; 2006). Using a magnetic field to fine-tune the interactions between the caesium atoms, Kraemer *et al.* studied so-called three-body recombination processes, which lead to a detectable loss of atoms from the trapped gas. Although the energy spectrum of the Efimov states could not be shown directly, the experiment seems to confirm that weakly bound trimer states do indeed exist, and heralds the next round in exploring few-body quantum systems.