Mixed message

Phys. Rev. Lett. (in the press); preprint at http://arxiv.org/abs/0901.4584 (2009)

Vitaly Efimov predicted in 1970 that three interacting bosons can form an infinite series of bound trimer states, even when none of the two-particle subsystems is stable. This prediction is widely independent of what the potential between the particles is: it is true for the strong interaction between nucleons as well as for the van der Waals force between neutral atoms. It also holds for systems of unlike particles, as Giovanni Barontini and colleagues now observe.

Experimental evidence of Efimov's exotic three-particle state was obtained only in 2006, in a system of ultracold alkali atoms. The same platform has since been used to observe an Efimov spectrum of two such states, with the predicted scaling between them (see page 586 of this issue).

But whereas these experiments dealt with three identical atoms, the trimers that Barontini *et al.* created consisted of distinguishable particles — ^{41}K and ^{87}Rb atoms. Such systems might provide useful insight in nuclear physics, for example, in the situation of a core nucleus surrounded by two loosely bound neutrons.

Molecular light switch

Nature **460,** 76–80 (2009)

It would not be an overstatement to say that semiconductor transistors have revolutionized the world we live in, having enabled the rapid processing and transfer of information. It looks likely, however, that in the future the electrons used as the data carriers will be replaced by photons. But the difficulty with an optical transistor is that photons don't readily interact with each other.

The approach taken by Jaesuk Hwang and colleagues is to use a fluorescent dye to mediate between two light beams. Previous simulations have indicated that light can interact strongly with a point-like dipole if the beam is tightly focused enough. This idea is now extended to show that stimulated emission from the dipole is also possible.

The device comprises a single molecule of dibenzanthanthrene embedded in an organic crystal. A pulsed laser beam controls the populations of the ground and excited state of the molecule. This in turn enables attenuation or amplification of a second continuous wave beam — the characteristic behaviour of a transistor.

Plasmonic transparency

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In certain coherently driven atomic systems, quantum interference between two laser fields can cause a narrow window of transparency to open in an otherwise opaque optical absorption spectrum. Known as electromagnetically induced transparency (EIT), its effect has been most strikingly demonstrated in the slowing of the group velocity of a light pulse to less than 17 m s^{-1}. But although the resonant characteristics that support EIT are not unique to atomic systems, it has been difficult to reproduce similar behaviour in the solid state.

By exploiting the resonant optical characteristics of two different nanowire structures, Na Liu and colleagues show that it is possible to build a plasmonic metamaterial that exhibits EIT-like behaviour. The basic unit structure of this material consists of a single gold nanobar, which acts as a broadband strongly radiative dipole antenna, stacked above a pair of parallel gold nanobars, which acts as a narrow-band non-radiative quadrupole antenna. Resonant coupling between the radiative and non-radiative modes of the two antennas gives rise to EIT.

Spin pinned

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It's now more than 20 years since the 'proton spin crisis' erupted in particle physics. Data on muon–proton scattering from the European Muon Collaboration, published in 1988, suggested that the quarks inside the proton contributed less than 30% of the total spin of the particle, although as much as 60% had been expected.

The rest of the spin must be contributed by the gluons that bind the quarks, and by the quark and gluon angular momenta; quite how much is due to the gluons is the subject of the latest result from PHENIX, one of the detectors at Brookhaven's Relativistic Heavy-Ion Collider.

Following other studies from COMPASS at CERN and HERMES at DESY, and earlier results from PHENIX itself, the new measurement is extracted — using next-to-leading-order perturbative quantum chromodynamics — from observations of the production of π^0 mesons in collisions of polarized protons. The result, unfortunately, doesn't boil down to a straight percentage (owing to theoretical uncertainties and the limits on the kinematic region accessible in the experiment), but it does reinforce a consistent picture of the spin structure of the proton, and the gluon-spin contribution, arising from the different experiments.

The dirt on corrugations

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Anyone who has driven long distances over unpaved dirt roads will be familiar with the washboard-like corrugations that can develop. Smoothing out these corrugations can be expensive; understanding how they form and how they might be prevented is thus of potentially great value.

It is commonly assumed that corrugations are created by the forced oscillation of the suspension systems of the cars that pass over them. But their period is usually far from the natural frequency of a typical car's suspension.

To try to resolve the mystery, Anne-Florence Bitbol and colleagues have built an experiment to recreate similar effects in the lab. This involves dragging either a cylindrical wheel or a fixed rectangular plough blade around the circumference of a circular bed of sand. Above a certain speed, they find that both the wheel and the plough produce corrugations in the sand, proving that suspension effects are indeed unimportant. Moreover, they find that the speed at which the corrugations form changes with the weight and angle of attack of the plough, in a manner similar to that of the skipping of stones across the surface of a lake.

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