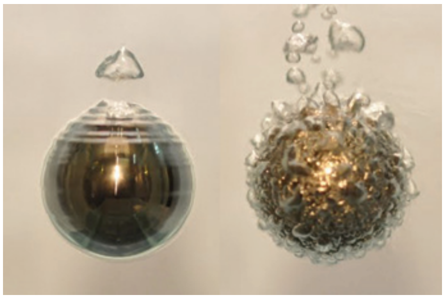
Slippery when hot

Phys. Rev. Lett. (in the press)



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When a liquid comes into contact with an object that is significantly hotter than the liquid's boiling point, several unusual effects arise. The rapid evaporation of the liquid at the point of contact forms a layer of gas that insulates it from the solid and slows the rate of subsequent evaporation, compared with the situation in which the solid is only just above the liquid's boiling point. This layer also acts as a cushion beneath a liquid droplet that levitates and allows it to glide almost effortlessly across a hot surface. Such behaviour, known as the Leidenfrost effect, is familiar to anyone who has dropped water into a hot frying pan.

Ivan Vakarelski and colleagues show that similarly dramatic effects occur when a hot steel ball is dropped into a low-boiling-point liquid. At temperatures just above the liquid's boiling point, the ball generates a chaotic stream of gas bubbles. But at around three times the boiling point and above, a smooth continuous layer of gas forms around the ball. This drastically reduces the drag on the ball as it falls through the liquid, more than doubling its terminal velocity when compared with a cold ball.

Far from ideal

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Compared with all other phase transitions, Bose–Einstein condensation is unique in that it is a purely quantum-statistical phenomenon. Naaman Tammuz and colleagues have now experimentally confirmed the theoretical picture that Albert Einstein used to explain the effect. But they also show that even weak interparticle interaction leads to substantial deviations from the ideal, non-interacting case considered by Einstein.

Einstein's saturation picture is based on the theoretical observation that once the total number of particles in a bosonic system exceeds the critical value of particles that can be accommodated in the excited states, then the addition of any more particles leads to a macroscopic occupation of the ground state — a Bose–Einstein condensate forms.

Such saturation-driven condensation does not require any interaction between the particles. But in experiments there will always be some interaction, even if it is, as in the case of dilute atomic gases, fairly weak. Tammuz *et al.* now demonstrate that with the amount of interaction present in typical ultra-cold gas experiments, the purely statistical picture clearly does not hold. However, measurements at different interaction strengths enabled them to extrapolate to the non-interacting case, where they indeed recovered Einstein's predictions.

A switch in time

Appl. Phys. Lett. **98,** 161114 (2011)

Photonics, using light as a carrier of information much as electrons are used in electronics, promises communication and computation at speeds much higher than current systems. Just as tiny electrical switches — transistors — revolutionized electronics, optical switches are needed for the full implementation of photonic circuits. Georgios Ctistis and colleagues have now developed the fastest optical switch so far.

Optical switches are generally based on effects that change the refractive index of a material. However, the switching speed is limited by the response time of the medium, which is typically much slower than the full potential offered by optical signal processing. Ctistis *et al.* have circumvented this problem and achieved an optical switching time of as little as 0.3 picoseconds using a semiconductor microcavity.

Strong laser pulses change the optical properties of the microcavity and thereby control when probe light at a specific wavelength is transmitted. The key to the advance in speed was to ensure that the sum energy of the control and probe photon was smaller than the semiconductor bandgap. This suppressed two-photon-absorption processes that would otherwise overwhelm the switching effect.

Exoplanets unbound

Nature **473,** 349–352 (2011)

Gravitational lensing — whereby gravity can bend light — was originally proposed by Isaac Newton, although 200 years passed before Albert Einstein correctly calculated the deflection using his theory of general relativity. The foreground 'lens' effectively magnifies the light coming from a background source, and the displaced light can be measured directly by a powerful telescope: it's an effective means of searching for planets. In the case of a Jupiter-sized foreground object, the transient lensing effect lasts a couple of days, and is detectable by the surveys Microlensing Observations in Astrophysics (MOA) and Optical Gravitational Lensing Experiment (OGLE).

Takahiro Sumi and collaborators report the results of both groups in their surveys of the Galactic Bulge within the Milky Way. They found a population of exoplanets that do not seem to be bound to any detectable host stars. MOA detected ten Jupiter-sized exoplanets, of which seven were also observed by OGLE. Their origin is a mystery, although the authors speculate that they may have formed in protoplanetary disks and were subsequently scattered into unbound, or possibly very large, orbits.

From the top

Phys. Rev. D **83,** 091501 (2011)

As Fermilab's Tevatron enters its last months of running and CERN's Large Hadron Collider fires up fully, the baton passes, along with various 'wrinkles' in the experimental data — measurements that don't quite tally with the standard-model predictions but whose statistical significance is not (yet) convincing enough.

Among them is the so-called forward–backward (FB) asymmetry in the production of pairs of top and anti-top quarks: the details of quantum chromodynamics indicate that the spatial distribution of the pairs is not isotropic but subtly distorted. The FB asymmetry measured is larger than expected, and at odds with the standard model by as much as three standard deviations.

Biplob Bhattacherjee and colleagues have investigated what more can be done with Tevatron data to understand this effect, and what the LHC can offer — working instead with a 'one-sided' FB asymmetry, because the LHC has two colliding proton beams, not the proton–antiproton collisions of the Tevatron. It could be possible soon, they say, to decide whether these data indicate the existence of either a Z' or a W' particle, which are possible additions to the standard model.