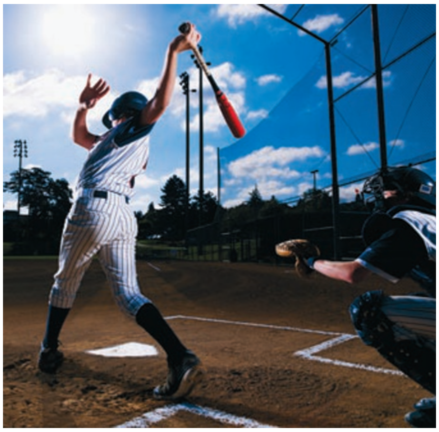
High and dry



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Am. J. Phys. **76,** 1015–1021 (2008)
The Colorado Rockies — a Major League Baseball team in Denver, Colorado — has found itself at the centre of a physics debate. Since 2002, the team has stored its baseballs in a controlled environment at 50% humidity. This move was designed to counteract the aerodynamics of the thin, dry atmosphere in Denver (the city is a mile above sea level), which causes balls to travel farther than at other venues. Nevertheless, the use of humidity control remains controversial, and has been blamed for fewer runs and home runs since 2002.

Edmund Meyer and John Bohn set out to test the effect of humidity on the aerodynamic properties of a baseball in detail. They found that increased humidity slightly increases the size, weight and density of balls, and as a result humidified balls curve slightly less than drier ones when pitched. The combined impact of humidity on baseball elasticity and aerodynamics causes humidified balls to travel about four feet less than dry ones. Interestingly, humidified balls are easier to grip, enabling pitchers to put more spin on them.

A keen eye

Science doi: 10.1126/science.1163077 (2008)
High-harmonic generation (HHG) has sparked a revolution in molecular structure studies, enabling scientists to probe the dynamics of atoms and diatomic molecules on attosecond timescales. Wen Li and collaborators have taken this a step further, and used HHG to study the dynamics of polyatomic molecules.

In HHG, an intense femtosecond laser is used to ionize an atom or molecule. Part of the electron wavepacket then propagates in the optical field and recollides with the parent ion, resulting in the emission of a high-energy photon.

Li *et al.* fired a short burst of light at a dinitrogen tetraoxide (N_2O_4) molecule, inducing large-amplitude vibrations. A second laser beam then generated X-rays from the vibrating system. In this way, the researchers could watch the electron energy levels rearrange themselves as the polyatomic molecule changed shape, and found that the dynamics involved multiple molecular orbitals.

The power of light

Nature **456,** 480–484 (2008)
The force exerted by photons has been used to great effect in optical tweezers. But until now, it has not been exploited in nanoscale integrated optical circuits. Mo Li and colleagues have shown that they are able to directly detect the optical force in such a system, and use it to drive nanoscale mechanical devices.

Their nanomechanical device consists of a freestanding waveguide, 10 μm long, which is mechanically supported by two low-loss structures and separated from a dielectric substrate by a gap. The system is integrated into a silicon photonic circuit produced using a CMOS-compatible process.

An optical force is generated when incident light evanescently couples to the substrate, owing to the lateral gradient of the propagating optical field. The force can be tuned by varying the separation between waveguide and substrate from about 0.1 to 8 pN μm^{-1} mW^{-1}. Compared with conventional electronic-based actuation schemes, this approach is just as efficient but offers bandwidth and design flexibility.

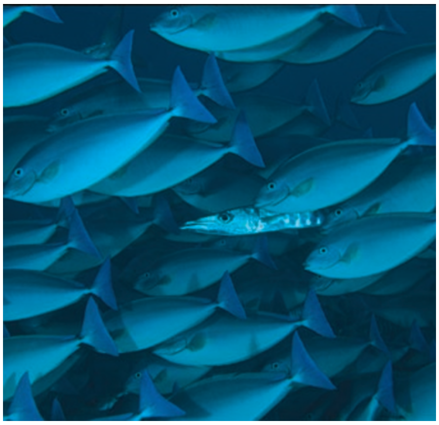
Condensate superposition

Phys. Rev. A **78,** 051601 (2008)
Superposition is a fundamental tenet of quantum mechanics: while we do not know the state of any given object, it is actually in all possible states at once, provided that we don't look and check. Now Francesco Piazza and colleagues have shown that, theoretically, a superposition of states can be created using a Bose–Einstein condensate trapped in a periodic potential.

The interparticle interactions in Bose–Einstein condensates give rise to large nonlinearities that are crucial for superposition. Piazza *et al.* propose using a trapped condensate to create and detect a superposition of states that have distinct relative phases. The superposition can be confirmed by studying the phase distribution of the interference patterns obtained after releasing the traps.

For single wells containing up to a few hundred atoms, decoherence times should be approximately 500 ms — that is, robust enough against decoherence to be within reach using current technology.

Follow the leader?



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Phys. Rev. Lett. **101,** 194502 (2008)
Schools of fish and flocks of birds are remarkable in the way that they change shape. The interactions that underpin their movement are generally poorly understood. Now, Leif Ristroph and Jun Zhang have shown that, counter-intuitively, the leader of the pack experiences less drag than those that follow behind.

When rigid objects move through a fluid, the leading body suffers more drag than those trailing it. This effect — well known to racing-car drivers and cyclists — is explained by conventional hydrodynamic drafting. But with deformable objects such as fish, or flags flapping in a breeze, this drafting is reversed.

Ristroph and Zhang inserted thin, flexible filaments ('flags') into a flowing soap film. Each filament was fixed at its upstream end to a thin wire (a 'flagpole'). When two flags were close together, the authors found that the leading flag flapped less than the trailing flag, indicating a reduction in drag for the leader. Sometimes it does pay to be out in front.