

Y-type and other interactions are available online.) The two mathematicians found that the interactions usually occur, albeit briefly, at shallow depths within two hours of low tide; tend to come in groups; and are remarkably robust against



changes in depth, wind perturbations, and even breaking. The diverse wave structures are well modeled using a 2D nonlinear wave equation. The same equation, note the researchers, approximates the propagation of tsunamis, and the pair warns that similar nonlinear interactions could significantly amplify a tsunami's destructive power. (M. J. Ablowitz, D. E. Baldwin, *Phys. Rev. E* **86**, 036305, 2012.) —RJF

Different photons in, indistinguishable photons out.

Device fabrication being an imperfect art, single photons from solid-state systems such as quantum dots are not identical; a collection of dots designed to emit at nominally the same frequency will actually produce a range of frequencies. That phenomenon, called inhomogeneous broadening, is an obstacle to experimentalists who need a stream of identical photons—say, in applications requiring entanglement. One way to overcome the obstacle is to tune the solid-state devices themselves; applying appropriate strains, for example, can change the internal structure of the devices so they all give off photons of the same frequency. Now Kartik Srinivasan of NIST, his postdoc Serkan Ates, and other collaborators have demonstrated an alternative approach: Let the devices emit as they will, but use nonlinear optics to convert

the frequencies of the resulting photons. When a source photon and light from a pump laser interact in a nonlinear crystal, the result could be a photon whose frequency



is the sum of source and pump frequencies. As schematically indicated in the figure, with carefully tuned pump-laser frequencies ω_{p1} and ω_{p2} and input photons of different frequencies ω_{s1} and ω_{s2} , Srinivasan and colleagues produced photons with the same frequency ω_c . The research team established that the output photons were indeed identical by observing their telltale interference. In the future, such frequency conversions may enable photons to communicate between the nodes of a quantum internet. (S. Ates et al., *Phys. Rev. Lett.* **109**, 147405, 2012.) —SKB

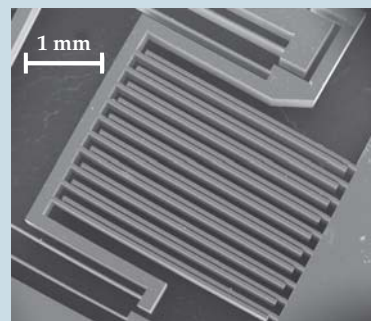
Filter-free separation of particles by shape.

Mahdokht Masaali of Dino Di Carlo's group at UCLA and her collaborators have devised a new microfluidic method to separate

micron-scale particles of the same size but different shape. The method's novelty lies in its simplicity. Whereas other shape-separation methods involve complex geometries, arrays of baffles, or some sort of symmetry-breaking external field, the UCLA method relies on differences in how particles tumble freely as they flow through a rectangular channel. Both pairs of channel walls are close enough (a few tens of micrometers) that the flow's transverse velocity gradient extends to the center of the channel. As the particles are carried by the flow, the velocity gradient pushes them toward the walls, while a force induced by the walls pushes them away. For rods and other particles with high aspect ratios, the outward force predominates far more than it does for spheres and low-aspect-ratio particles. The upshot is a shape gradient across the flow that can be exploited by sending the central part of the flow down one outlet and the outer part down another. In one run, Masaali and her collaborators extracted up to 96% of spheres from a 50–50 mix of spheres and rods. Possible applications for the technique include separating healthy red blood cells from diseased, misshapen ones; sorting man-made nanoparticles; and segregating single-celled organisms in various stages of cell division. Indeed, the UCLA team has confirmed that its method can separate budding and nonbudding yeast cells. (M. Masaali et al., *Phys. Rev. X* **2**, 031017, 2012.) —CD

A transparent microactuator from a single piece of glass.

The allure of combining optics and mechanics is strong, with applications in displays, adaptive optics, and many other technologies. But as devices continue to shrink, their fabrication becomes ever more complicated. Working at Eindhoven University of Technology in the Netherlands, Yves Bellouard and Bo Lenssen have developed a relatively simple method to manufacture a complex



actuator out of a single glass substrate. First they use low-power femtosecond pulses, applied in a predetermined pattern, to selectively and simultaneously change both the glass's refractive index and its susceptibility to chemical etching. And because the transparent material is affected only at the focal point and only when the laser exceeds a certain power threshold, regions below the glass surface can be altered with pinpoint accuracy. Next, they etch the device in a chemical bath, which erodes the glass an order of magnitude faster in the laser-painted regions. Finally, when the sculpture is complete, a transparent coating of indium tin oxide is deposited to form electrodes and capacitors. How does the device work? As seen in the image, the teeth of two combs interleave. Each pair of parallel prongs forms a capacitor and, with a suitable voltage applied and only one comb free to move, an electrostatic force induces the smaller gaps between the combs to further shrink, producing useful motion (a video is available online). Being transparent, the Eindhoven actuator could be useful in microscopy, adaptive optics, interferometry, or even tunable resonant optical cavities. (B. Lenssen, Y. Bellouard, *Appl. Phys. Lett.* **101**, 103503, 2012.) —SGB ■