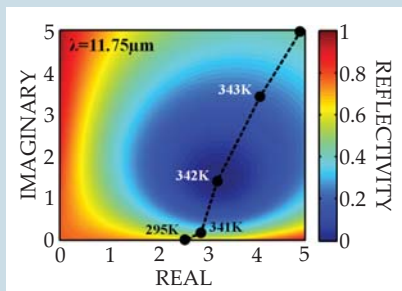


physics update

These items, with supplementary material, first appeared at <http://www.physicstoday.org>.

An ultrathin film as near-perfect IR absorber. Optical interference patterns, whether from an oily puddle, lens coating, or countless other thin films, are ubiquitous. They



are most noticeable in materials that suffer little optical loss and whose thickness is on the order of the wavelength. But much thinner films can also generate strong interference effects. The trick, as researchers led by

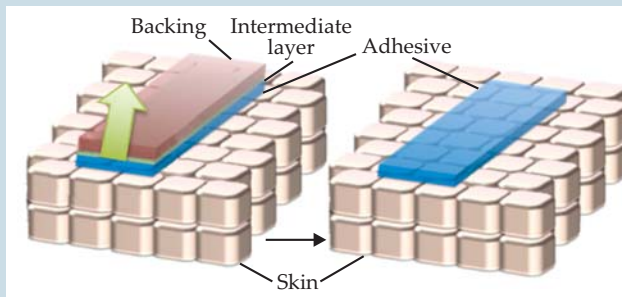
Harvard University's Federico Capasso recently discovered, is to use a dielectric that's strongly absorptive as well as ultrathin. Such "lossy" dielectrics can produce reflecting interfaces with phase shifts that substantially differ from 0 or π , making it possible to engineer an absorption resonance. Capasso's group, in collaboration with researchers from four other universities, has now exploited that finding to develop a device that can absorb nearly all IR light that shines on it. Composed of a 180-nm-thick film of vanadium dioxide on a sapphire substrate, the device is simple and its reflectivity tunable. The researchers were able to reduce the reflectivity of 11.6- μm light from a high of 70–80% to 0.25% by raising (or lowering) the substrate temperature into VO_2 's metal-insulator transition until they reached a resonance close to 343 K. Their measured reflectivities around that temperature closely match their calculated values, shown here as a function of the real and imaginary components of the refractive index; the black line marks the trajectory of the complex index with temperature. The researchers envision the device as a component in various optical systems, including bolometers, modulators, and thermal emitters. (M. A. Kats et al., *Appl. Phys. Lett.* **101**, 221101, 2012.) —RMW

Fractionally charged particles not yet seen. Quarks have fractional charges $\pm e/3$ and $\pm 2e/3$. But the force that binds them into hadrons is so strong that quarks cannot be free particles. Nor has any other fractionally charged particle been seen to date. But there's no obvious theoretical impediment to the existence of fractionally charged free particles, if they're immune to the strong nuclear force. And indeed, fractionally charged massive particles (FCHAMPs) with no strong interactions are anticipated by some extensions of particle theory's standard model. Those proposed extensions predict, as a function of the putative FCHAMP's mass and charge, the production rate for oppositely charged pairs of them in col-



lisions between high-energy protons. The telltale signature of an FCHAMP would be its anomalously low energy loss by ionization of materials in a detector. Now the collaboration that runs the gargantuan CMS detector (shown in the photo) at CERN's Large Hadron Collider reports that it has found no evidence of FCHAMP production in the debris from almost 10^{14} p–p collisions during the LHC's 2011 run. The more massive the FCHAMP, the lower should be its production rate. Given the null result, the collaboration assigns a lower mass limit (at 95% confidence) of about 400 proton masses (m_p) if the FCHAMP charges are $\pm 2e/3$, and 260 m_p if they are $\pm e/3$. The theories under scrutiny don't limit fractional charges to those values, but the production rate would increase with increasing charge. (CMS collaboration, <http://arxiv.org/abs/1210.2311>.) —BMS

With medical tape, no pain means great gain. Medical tapes that affix breathing tubes and other life-saving devices to the skin are not only sticky, they are strong. After all, they must resist both wear and the shear forces between skin and tape that might dislodge the attached vital equipment. For babies and elderly patients, however, the tape itself poses a danger. When it is peeled off, it can tear sensitive skin and lead to discomfort and sometimes permanent scarring or worse. In the US, medical tape removal is responsible for



1.5 million injuries annually. To address the problem, a team led by Jeffrey Karp (Brigham and Women's Hospital and MIT) designed a tape that takes advantage of today's effective, nonirritating adhesives and durable backings, but that can be removed without injuring skin. Their innovation was to coat the backing with a nonadhesive layer and then use a laser to etch out microscopic regions of that intermediate material so that adhesive and backing layers could come in contact. That technique enabled the researchers to create a tape that distributes shear forces over a large area but that localizes stress when peel forces are applied. The result, as illustrated in the figure, is that the tape easily pulls off above the adhesive and leaves a tacky layer that can be easily removed with gentle rubbing. (B. Lulicht, R. Langer, J. M. Karp, *Proc. Natl. Acad. Sci. USA* **109**, 18803, 2012.) —SKB

When the universe was slowing down. As the light from a distant object travels toward Earth, it can pass through clouds of gas that leave an absorption imprint on the light's spectrum. On a cosmological scale, the so-called Lyman-alpha lines due to intervening neutral atomic hydrogen—which normally emits in the UV and is therefore unobservable by ground-based telescopes—are redshifted into more accessible spectral regions. The farther the object, the more complex the absorption spectrum can be; for quasars the hydrogen