

lone strange antiquark.⁵ In that case, however, Bose statistics forbids an s-wave between the two diquarks. “But because the experimental evidence for the pentaquark at first seemed so compelling,” recalls Jaffe, “we speculated that maybe forming the favored antisymmetric diquark pays so well that a pair of them can bear the insult of being in a p-wave.”

The supposed pentaquark was first sighted in collisions between photons and nuclei at a synchrotron light source and at a nuclear-physics accelerator. When follow-up searches were carried out with higher statistics at particle-physics accelerators, the pentaquark signal was gone. Old particle-physics hands had wondered why, if the $\Theta^+(1530)$ really did exist, they had not found it decades ago when they were

searching in the same energy regime for positively charged baryons with positive strangeness.⁶

The B factories, by contrast, allow experimenters to find hadronic states they probably couldn’t have unearthed earlier. The 5.3-GeV B mesons created there in great profusion are just about as heavy as mesons ever get. They decay (by flavor-changing weak interactions) preferentially into mesons that carry charmed quarks. It’s among such decays that theorists expect exotic mesons to be found—if they exist.

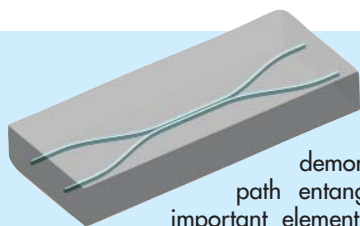
PEPII and KEKB were built primarily to study the tiny asymmetry between particles and antiparticles (see PHYSICS TODAY, May 2001, page 17). As a byproduct of that effort, Belle and BaBar have accumulated enormous reserves of B-decay data that could reveal

many more new states. “That’s a fantastic resource we’re just beginning to explore,” says Jaffe. “QCD is a beautiful and complete theory, but nobody has been able to solve it for hadronic states. We need all the help we can get to understand the confinement of quarks inside hadrons.”

Bertram Schwarzschild

References

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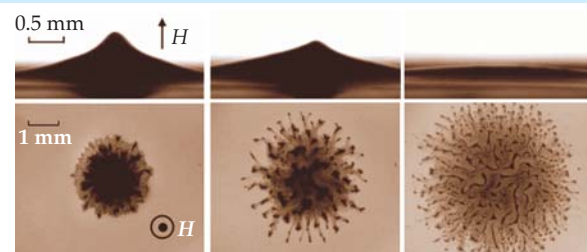


splitters, interferometers, and even a controlled-NOT gate, but combined those devices into photonic circuits. Among their demonstrated results is a high-fidelity, path entangled state of two photons, an important element for quantum computation. The silica-on-silicon photonic circuits may also be applied to quantum metrology and communication technologies. (A. Politi et al., *Science* **320**, 646, 2008.) —JNAM

Collisions between carbon dioxide molecules can affect greenhouse warming. Visible light coming from the Sun pours down daily and is reflected back from Earth’s surface as IR radiation. Extra warming occurs when some of that IR is absorbed and retained in the atmosphere. Only a trace gas in the atmosphere, CO₂ is far outnumbered by O₂ and N₂ molecules, but its growing presence (mostly due to human activity) and its ability to absorb and trap IR radiation are thought to be instrumental in producing greenhouse effects. The interactions between atoms in a single molecule generate the molecule’s dipole moment and polarizability, two properties that greatly affect how the molecule absorbs or scatters radiation. Going to the next level of complexity, a new study shows in detail how a large class of molecules, including CO₂, absorbs and sometimes scatters light energy during intermolecular collisions. Michael Chrysos and his colleagues at the University of Angers (France) and Saint Petersburg State University (Russia) have derived exact mathematical formulas that can be used to calculate how collisions between so-called linear-rotor molecules modify the molecules’ absorption spectra. During a molecular interaction, a transient supermolecular complex arises with its own degrees of freedom—distinct from those of the constituent molecules—and its own dipole moment or polarizability. The net result is that a broad band of frequencies, including many that are unavailable to single molecules, can be absorbed or scattered. The new study is important for several reasons: It allows exact calculations of how the intercepted IR photon energy is converted to kinetic energy and shared among neighboring gas molecules; it allows for the inclusion of higher-order effects, such as the simultaneous collision of three molecules;

and it provides evidence that long-range intermolecular interactions are far more important than short-range ones for absorption, a conclusion in conflict with mainstream assumptions. (M. Chrysos et al., *Phys. Rev. Lett.* **100**, 133007, 2008.) —PFS

Peaks and labyrinths in a magnetic fluid. A ferrofluid is a colloidal suspension of nanometer-sized magnetic particles in a nonmagnetic carrier fluid. As you might expect, it can be easily manipulated with external magnetic fields and often exhibits different patterns and instabilities. For example, when a sufficiently strong magnetic field is applied perpendicular to the flat surface of a ferrofluid, the Rosensweig instability produces a stationary array of peaks protruding above the surface. When



a similar field is applied to a ferrofluid droplet immersed in a confined immiscible liquid, the labyrinthine instability produces horizontal fingering as the two fluids interpenetrate. A new experiment reveals a hybrid situation in which those two normally distinct instabilities occur simultaneously. Scientists from Taiwan and Brazil immersed a ferrofluid droplet in a thin layer of a miscible nonmagnetic fluid. The images of the experiment, with a side view in the upper panels and a top view in the lower ones, show what the researchers found after switching on the field. The Rosensweig instability grows rapidly to its greatest amplitude in 0.43 s (left panels), at which time diffusion is already affecting the base of the droplet, decreasing the magnetic body force that sustains the peak against gravity and surface tension. At 1.2 s (middle panels), the peak is clearly decaying as the fingering progresses and after 5 s (right panels) the surface is again flat and radial diffusion dominates. (C.-Y. Chen, W.-K. Tsai, J. A. Miranda, *Phys. Rev. E* **77**, 056306, 2008.) —SGB ■