Superlight (in Theory, Anyway)

Today's top-notch optical fibers can conduct light signals for tens of kilometers. But over greater distances, absorption, scattering, and other signal-degrading effects make boosting necessary. That can become an expensive and technically difficult requirement, especially for optical cables running along on the ocean floor. Wouldn't it be grand if optical communication could take advantage of a phenomenon akin to superconductivity, which lets electrons propagate indefinitely, resistance-free, through certain materials?

Theorist Ze Cheng of the Chinese Center for Advanced Science and Technology in Beijing thinks such "superlight" is possible, at least in hypothetical crystals that fit his exotic theoretical bill. In the 11 November *Physical Review Letters*, Cheng proposes a mechanism by which fleeting vibrations of the crystal lattice called virtual transverse-optical (TO) phonons would bind the photons of light into pairs that could propagate through the crystal without scattering. Cheng likens the photons' pas de deux to the pairing of electrons that accounts for the resistance-free flow of electricity in low-temperature superconductors.

In Cheng's superlight scenario, laser light entering a so-called nonlinear polar crystal—a material in which certain properties, such as its index of refraction, change with the intensity of light—would "shake" the crystal lattice, inducing virtual TO phonons. The phonon-photon dynamic would link the photons together into pairs, whose binding energy would overcome the photons' tendency to scatter out of the crystal. The result, according to Cheng: The crystal becomes a "superwaveguide," analogous to a superconductor, that channels light perfectly.

Several quantum optics experts who have read Cheng's paper, including physicist Richard Slusher of AT&T Bell Laboratories, are intrigued, though they suspect that there are holes somewhere in Cheng's daunting theoretical presentation. "It looks like a fun theoretical exercise, but it probably can't be realized," Slusher says, adding that he doubts a crystal with the extreme nonlinear properties required to realize the phenomenon could be made.

Physicist Raymond Chiao of the University of California, Berkeley, concurs. But he's more sympathetic to the idea that photon pairing reminiscent of the electron pairing in superconductors could someday be demonstrated. In the 9 September *Physical Review Letters*, Chiao and his colleagues Ivan Deutsch of Berkeley and John Garrison of Lawrence Livermore National Laboratory published their own theory of photon coupling, in which photon pairing emerges from complicated atom-photon interactions. Chiao says that binding mechanism would be much stronger than the photon-phonon interactions described in Cheng's theory.

But Chiao wouldn't bet on any superlight-powered leap in optical communications technologies. Even if photon pairing could eliminate all scattering losses from optical fibers, Chiao thinks absorption—a phenomenon for which electricity has no parallel—would darken the picture. "I believe that absorption would kill this superlight."

Until someone actually tries to make superlight, of course, that verdict won't be final. In his paper, Cheng suggests several experiments that could tip the balance between him and superlight doubters—but only if someone figures out how to make the highly nonlinear polar crystals needed for the tests. ■ IVAN AMATO

A Galaxy Is Born

Galaxies, like the baby boomers here on Earth, are all getting older together. To see them in their youth, astronomers have to use their telescopes as time machines, catching light that started toward Earth billions of years ago. Robert Brown and Paul Vanden Bout of the National Radio Astronomy Observatory are pushing that strategy to the limit, peering four-fifths of the way back to the Big Bang. By using the 12-meter millimeter-wave telescope on Kitt Peak in Arizona, they've studied a galaxy at its very infancy—and for the first time they've seen some of the features that distinguish galactic youth from middle age.

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> —Robert Brown

Michael Rowan-Robinson of Queen Mary and Westfield College, London, first spotted the galaxy earlier this year—a faint signal picked up by the infrared IRAS satellite. But when Brown and Vanden Bout observed the object at radio wavelengths, they found a hint of something unusual: In the millimeter wavelength range, the galaxy shines 100 times brighter than our own galaxy. The radiation, they concluded, had to be coming from a vast shroud of dust, heated by a concentration of intense young stars—the kind of stars expected to populate a newborn galaxy.

A closer look at the millimeter-wave spectrum revealed the spectral signature of carbon monoxide, mingling with the dust. From the brilliance of the spectral lines, Brown estimates a staggering figure for the amount of gas: 100 times the mass of our own galaxy. And that gas adds a new detail to the picture of early galactic evolution. "The gas is just astonishing," says Brown. "We didn't really know what we would see," he continues. "What it is telling you is that galaxies—perhaps all galaxies—formed from a gas-rich phase very early on in the universe."

The composition of the gas is also making news among other astronomers and cosmologists because it confirms that the first stars formed earlier than some scenarios for the formation of stars and galaxies suggest. The red shift of the newborn galaxy shows it existed only 3 billion years after the Big Bang, and it must have taken shape even earlier than that to give molecules like carbon monoxide time to form. Carbon monoxide's constituent elements, in turn, could only have been forged in earlier stars. The first generation of those stars, Brown and Vanden Bout conclude, must have lived and died within a billion years after the birth of the universe.

But astronomers aren't ready to conclude that all galaxies once looked like this one. Anthony Tyson of AT&T Bell Laboratories, for example, wonders whether this infant galaxy is a typical specimen. Its extraordinary brightness at millimeter wavelengths suggests to him that "something peculiar has to be going on." Brown agrees, adding that in order to know if this object is typical, he will have to observe many more of them—something he is planning to do. When it comes to understanding the evolution of galaxies, says Princeton University cosmologist James Peebles, "we are still in kindergarten." ■ FAYE FLAM