New lasing technique inspired by brightly colored birds

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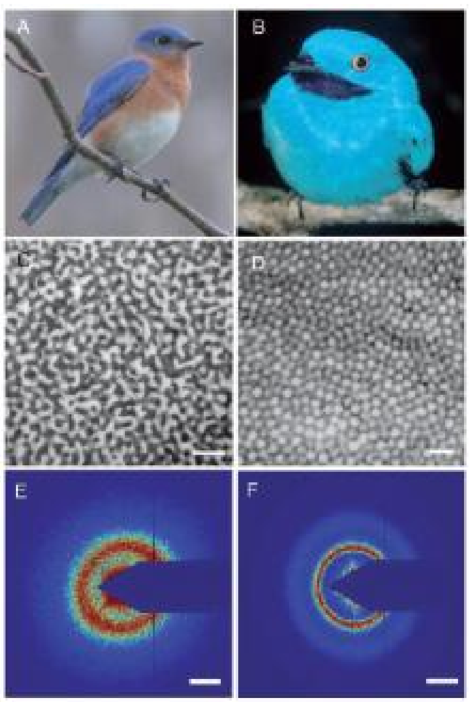

(A) Male Eastern Bluebird (Sialia sialis, Turdidae). (B) Male Plum-throated Cotinga (Cotinga maynana, Cotingidae). (C) Channel-type beta-keratin and air nanostructure from back contour feather barbs of S. sialis. (D) Sphere-type beta-keratin and air nanostructure from back contour feather barbs of C. maynana. (E & F) Small-angle X-ray scattering data from the channel-type feather barb of S. sialis, and the sphere-type feather barb of C. maynana. Scale bars in (C, D) 500 nm, (E, F) 0.025 (1/nm) of spatial frequency. Photo credits: (A) Ken Thomas; (B) Thomas Valqui. Courtesy of Hui Cao Research Laboratory

(PhysOrg.com) -- Researchers at Yale University have succeeded in building a new kind of laser based on the way brightly colored birds show their colors. Building on the new approach to creating laser beams, whereby holes are drilled in a material in such a way as to trap light inside for a long enough period of time to create the laser light they are after, researchers Hui Cao, Heeso Noh and their colleagues describe in a paper they've published in *Physical Review Letters*, how they've emulated the way birds use air holes to display their colors.

In traditional lasers, light is bounced back and forth (trapped) between mirrors with a so-called gain material between them that amplifies the light until it is of sufficient strength to pass through one end of the semi-transparent mirror, producing the beam. More recently however, optics researchers have found that another way to hold on to the light is to drill air holes in a material that causes the light to become trapped as it moves between the holes.

The air holes in the material can be placed either in a clear ordered fashion, producing just one strong wavelength, or in random fashion which allows for multiple wavelengths but isn’t very efficient; something that grows in importance as the laser power desired grows and uses more energy when it is produced.

The new technique falls somewhere in-between, in that at first glance the air holes appear to be random, but upon closer inspection, turn out to be ordered after all. This is where the brightly colored birds come in; nature has given them feathers with air pockets that at first glance appear to be randomly spaced, but under closer scrutiny it’s revealed that there is in fact, order underneath; the result is some light is trapped and bounced around inside and between them, allowing the amount of light to build up before ultimately escaping and giving the birds their brilliant hues.

To recreate the effect in the lab, the research team drilled holes in a 190 nanometer slice of gallium arsenide, a particularly good plastic for lasers, 235 to 275 nanometers apart, and which also had a layer of quantum dots that shine brilliantly when struck with just one photon. As suspected, when the wafer was lit up, it produced a laser of about 1,000 nanometers, which made it far more efficient than random lasers; after more tests were made it was found that the wavelength produced could be changed by altering the amount of space between the holes.

Though it’s not yet clear how the new type of laser will be used, it does seem likely the new approach will be used to help bring down the costs of lasers, and perhaps more importantly, the amount of energy needed to rum them.

More information: -- Control of Lasing in Biomimetic Structures with Short-Range Order, Phys. Rev. Lett. 106, 183901 (2011) DOI: 10.1103/PhysRevLett.106.183901

Abstract
We demonstrate lasing in photonic amorphous structures that mimic the isotropic nanostructures which produce noniridescent color in nature. Our experimental and numerical studies reveal that lasing becomes most efficient at certain frequencies, due to enhanced optical confinement by short-range order. The optimal lasing frequency can be tuned by adjusting the structure factor. This work shows that lasing in nanostructures may be effectively improved and manipulated by short-range order.

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