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Brightly Colored Bird Feathers Inspire New Kind of Laser

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By [Lisa Grossman](#)

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May 6, 2011 |

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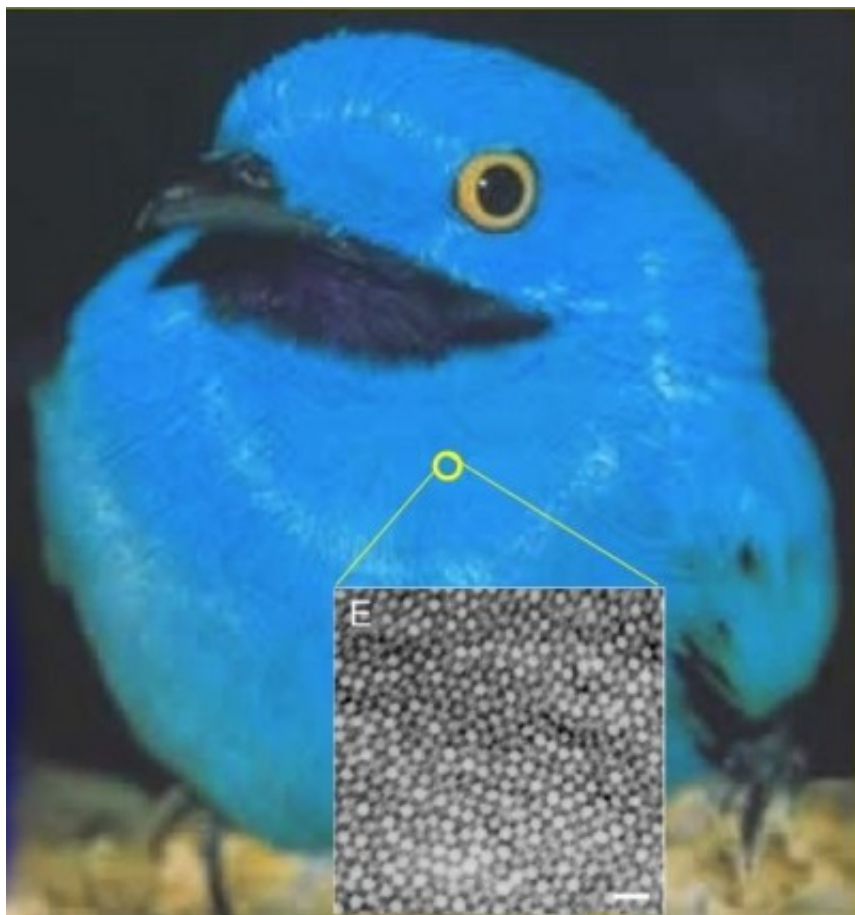
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A new kind of laser captures light just like some colorful bird feathers. The device mimics the nanoscale structure of colorful feathers to make high-intensity laser light with almost any color. Lasers work by trapping light in or near a material that can emit more photons with the same wavelength, or color. Incoming photons excite the atoms in the material, and make them spit out more identical photons. But to get enough photons for a bright beam of laser light, the photons need to hang around in the material for a long time.

One way to buy time for photons is by forcing them to bounce back and forth. Traditional lasers do this by bouncing the photons between two mirrors. In recent years, physicists have built lasers from slabs of specialized glass with air holes drilled in them. Light can get trapped on a particular path between the holes, and bounce around long enough to make laser light. Physicists have tried arranging the holes in both tightly ordered and completely random patterns. But both of those options had drawbacks — ordered lasers only work at one wavelength and are expensive to build, and random lasers aren't very efficient.

Physicist Hui Cao of Yale and colleagues tried something in between: an arrangement of holes that looks random from afar but has pockets of order up close. This is similar to the setup of air pockets in bird feathers. Their results are published May 6 in *Physical Review Letters*.



Certain brightly colored birds, like

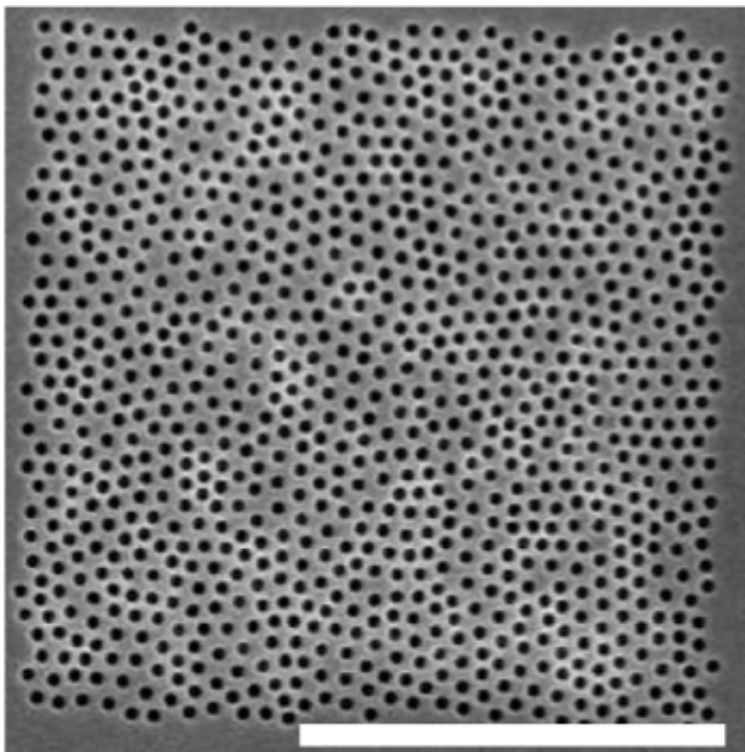
kingfishers or parrots, have feathers embedded with a not-quite-random arrangement of air pockets. Wavelengths of light that are related to the distance between the air pockets get scattered and built up more than others, giving the feathers their characteristic colors.

“After we learned this, we said, ‘Oh, that’s a smart idea!’” Cao said. “Can we use this to improve our lasers? Maybe we can use short-range order to enhance light confinement and make lasing more efficient.”

Cao’s team drilled holes in a 190-nanometer-thin sheet of gallium arsenide, a special sort of semiconductor that transmits light efficiently and is commonly used in optics. The holes were spaced between 235 and 275 nanometers apart. The material included a layer of equally spaced quantum dots, which emit lots of light when struck with one photon. When light entered the material, the physicists reasoned, it should bounce around between the holes long enough to make the quantum dots produce enough photons to start lasing.

When the researchers lit up the tiny wafer, it produced laser light with wavelengths of about 1,000 nanometers, in the near-infrared range of the electromagnetic spectrum. It was much more efficient than random lasers. The researchers also found that they could change the wavelength of the laser light by changing the spacing between the holes.

“Just like the birds, who can tune their short-range order to get different color from their feathers. We can do the same thing,” Cao said.



Cao doesn't have any particular applications in mind for this tunable, efficient laser. But she points out that by giving up on long-range order, her laser is much cheaper and easier to build than previous models.

"We can have control, and it doesn't have to be perfect," she said. "That's what we learned from nature."

Cao and colleagues are now trying to use actual bird feathers as a template. They hope to embed tiny semiconductors in the air holes and dissolve away the keratin that holds them together. This might be an easier way to make lasers with extremely short wavelengths, in the blue or ultraviolet range.

It might be even more interesting to figure out how the birds build their feathers in the first place, said biologist [Matt Shawkey](#) of the University of Akron in Ohio.

"Birds seem to do it very cheaply. They have thousands of these feathers," he said. "If you can get these things to build themselves, taking the painstaking process out, then you'd barely have to put any energy and time into it. It would be really cool to see which parameters the birds are changing to get these feathers to self-assemble."

Correction: Originally this article called gallium arsenide a plastic, when it is actually a semiconductor.

Images: 1. A kingfisher's bright colors come from light scattering off a not-quite-random arrangement of air pockets. (Pkhun/Wikipedia) 2. A scanning electron microscope image of the air pockets in a bird's feather. (Hui Cao) 3. The semirandom arrangement of holes in the laser mimics the arrangement in birds' feathers. (Hui Cao)

Citation:

"Control of Lasing in Biomimetic Structures with Short-Range Order." Heeso Noh, Jin-Kyu Yang, Seng Fatt Liew, Michael J. Rooks, Glenn S. Solomon and Hui Cao. Physical Review Letters, 106, 183901. May 6, 2011. DOI: 10.1103/PhysRevLett.106.183901.

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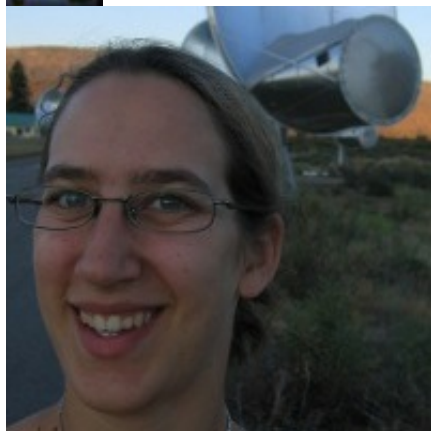
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C. Michael Greaves

GaAs is not a plastic, its a semiconductor.

05/06/2011 05:35 PM 7 Likes

Like



lisagrossman

Thanks--I added a correction.

05/09/2011 11:00 AM in reply to C. Michael Greaves

Like

**john long****Charles Frith**

Why? you say??

dude, L I G H T S A B E R S...

05/07/2011 03:36 AM 4 Likes

Like

**Charles Frith**, www.charlesfrith.com +66 47 33 47 69

Do we need a new laser? When is science going to take on wall street, food prices or war. Important issues.

05/06/2011 06:39 PM 3 Likes

Like

**MediocreScientist**

We can use laser to kill people from wall street and in wars. And, we can attach the fricking lasers to fricking sharks and they will hunt food for you.

05/06/2011 07:08 PM in reply to Charles Frith 18 Likes

Like

**Daniel Roberts**

You are seriously worried that one fundamental science project is going to effect three of the best funded areas of science? Just think if someone like you had decided that money was wasted on investigating fungi, we wouldn't have anti-biotics.

05/08/2011 06:22 AM in reply to Charles Frith 7 Likes

Like

**acslatero17**

Those are important issues, but you're kidding yourself if you think science hasn't caused massive revolutions in economics, agriculture, and war...

Actually if I had to pick 3 areas of study, I'd say those are the top 3 areas where science has impacted society.

05/07/2011 12:59 AM in reply to Charles Frith 6 Likes

Like

**Charles Frith**, www.charlesfrith.com +66 47 33 47 69

You need to get out more. You're ill informed and displaying it publicly.

05/07/2011 05:37 AM in reply to acslater017 1 Like

Like

**acslater017**

Instead of labels and the cliché "get a life" burn, how about addressing my points? I think the Industrial Revolution, Green Revolution (rise of high-yield crops) as exemplified in India, and pretty much any war since the Civil War have brought about enormous changes to society.

Please tell me how I'm ill-informed.

05/07/2011 08:55 AM in reply to Charles Frith 7 Likes

Like

**Daniel Roberts**

Dude look at his blog. He is into magic and pseudoscience shit. Calls other people 'zombies' for not taking it seriously. I'm not sure why wired science attracts so many people who are distinctly ant-science in general.

05/08/2011 06:31 AM in reply to acslater017 4 Likes

Like

**Charles Frith**, www.charlesfrith.com +66 47 33 47 69**acslater017**

I take back my comment. It was ruder than necessary. Sorry about that. I still disagree with you though. Saying that all war since the civil war is a good thing is both untrue and an example of the myopia that I assert you are afflicted by. For example; civil war for me, off the top of my head is Rwanda, Cambodia and Libya. The only reason you don't mention which one specifically is because like that scientific materialism you idolise, it's culturally framed and biased through programming. If you stopped to think about it you'd have a view of your own.

05/09/2011 01:41 AM in reply to acslater017

Like

**horsey_horse**

You stopped short of saying, "Wake up and see the big picture, sheeple!"

I am disappointed.

05/09/2011 05:36 AM in reply to Charles Frith

Like

**Kilo Byte**

So much for "creative thinker" with that tired old line. To say science isn't taking on economics, war, and food prices is ludicrous and dimwitted.

05/08/2011 01:07 AM in reply to Charles Frith 5 Likes

Like

**Jonathon Finney**

So what areas has science impacted society more than agriculture, war and economics? Maybe communication. Please inform us.

05/07/2011 07:47 AM in reply to Charles Frith 3 Likes

Like

**Chuckiechan**

We'll be needing better lasers to read your thoughts...

05/07/2011 08:28 AM in reply to Charles Frith

Like

**lionstorm**, Reason isn't sufficient for all, but it's necessary for pretty much everyt...

Or maybe use the laser to stimulate more creative thinking. Scratch that-- make it SOME creative thinking.

05/08/2011 07:17 PM in reply to Chuckiechan

Like

Roberto Oscuro



Does this mean LASER Televisions with multiple layers of reflexive wafers with holes that will tune the light waves to create sharper color? If so I want in on the R&D department.

05/07/2011 11:04 PM 2 Likes

Like



frantik

SHOOP DA WHOOP

05/08/2011 10:19 PM 1 Like

Like



Anakaris

I'd like to point out an error in this article: "The plastic included a layer of equally spaced quantum dots, which emit lots of light when struck with one photon."

Quantum dots don't emit lots of light when struck with a single photon. QDs generally emit a single photon out for each photon which excites the material which is why QDs have such high quantum efficiency.

05/08/2011 03:56 PM 1 Like

Like



Myo wint wint

That very interesting..I will try on my pets cat names, Liz Kate, the mice name snow white and termites queen name killer..It work on the cat, mice and termite before..The cat body expand out from the cat every length you want with the laser that I using..The cat, mice, and termite were more easy to used for this laser project than the birds for me..

05/06/2011 05:03 PM 1 Like

Like



Frugally Savvy

This is an interesting study on how bird feathers could influence laser technology

05/09/2011 10:29 AM

Like

Truly Wizard, I like orange. And cats.



Cute bird.

05/09/2011 09:39 AM

Like



William Collins

Does this mean we are going to test out these lasers on this bird?

05/08/2011 01:49 PM

Like



Dianabol

pretty birds not sure how they inspire lasers though.
[steroids blog](#)

05/07/2011 06:50 AM

Like



sim onfilm

Perhaps we will see a new gen of color e-books .

05/07/2011 01:16 AM

Like



Mark Jones

I saw the magnified area of picture #2 and Roger Penrose immediately came to mind.

05/06/2011 04:39 PM

Like



Kn

Yeah. "Microtubulez!"

05/08/2011 11:54 AM in reply to Mark Jones

Like

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