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Physicists Build World's First Antilaser

By Lisa Grossman
Email Author
February 17, 2011 |
3:00 pm |
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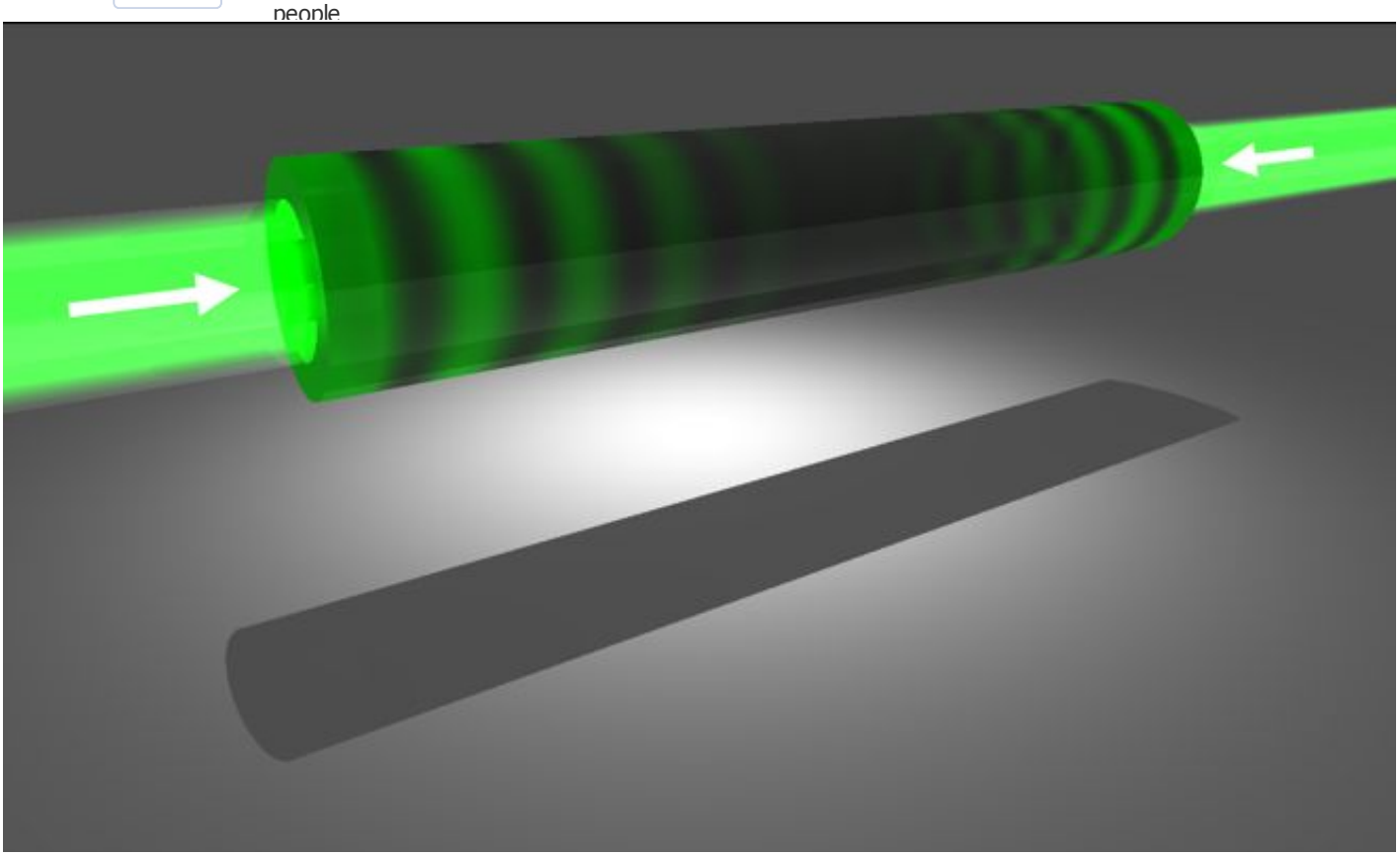


Less than a year after it was first suggested, the world's first antilaser is here. A team of physicists have built a contraption that, instead of flashing bright beams, utterly extinguishes specific wavelengths of light.

Conventional lasers create intense beams of light by stimulating atoms to spit out a coherent

beam of light in which all the light waves march in lockstep. The crests of one wave match the crests of all the others, and troughs match up with troughs.

The antilaser does the reverse: Two perfect beams of laser light go in, and are completely absorbed.

"There will be nothing coming out again," said experimental physicist Hui Cao of Yale University, whose research group built the new device.

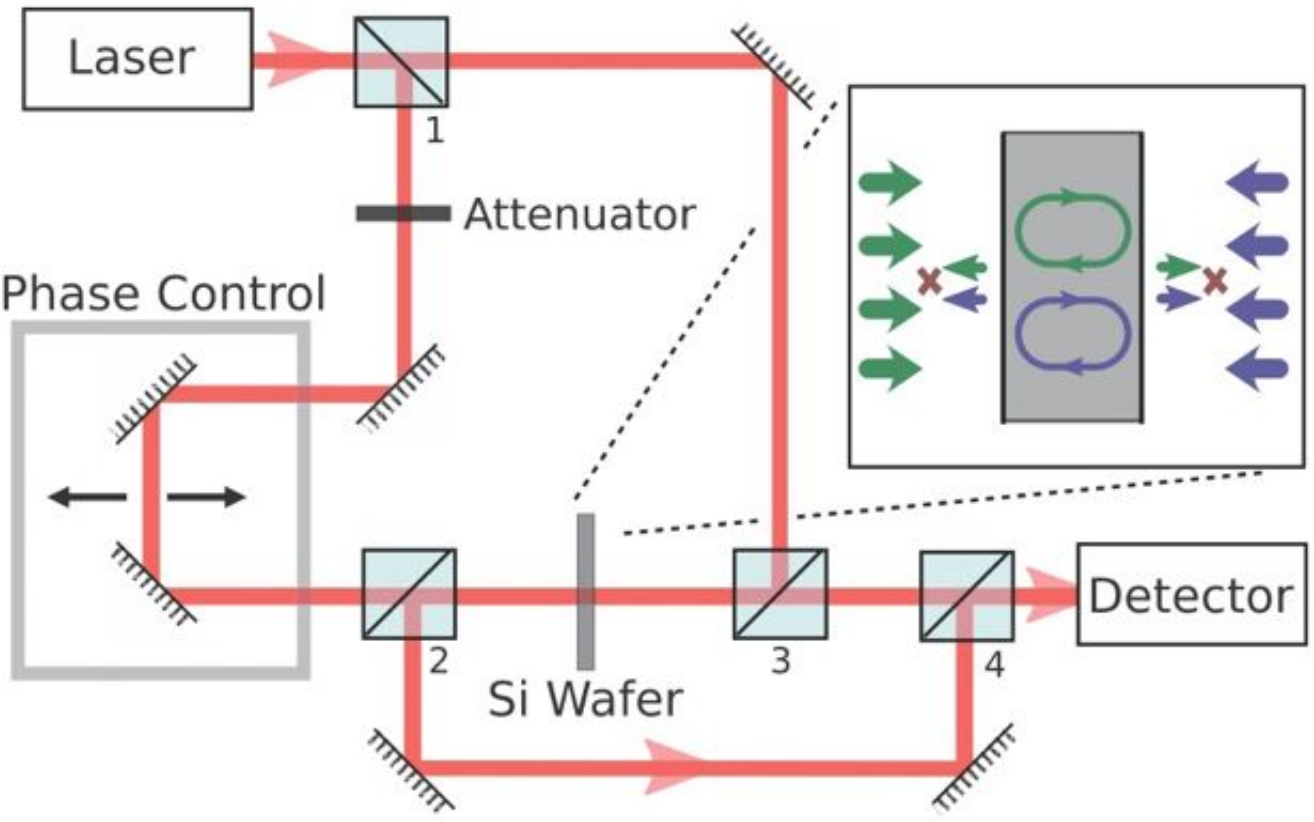
The device could find uses in fields from computing to medical imaging, the researchers report in the Feb. 18 issue of *Science*.

Yale physicist A. Douglas Stone, a co-author of the paper, first suggested the antilaser in a theoretical paper last July. Stone and colleagues had noticed that several other researchers had hinted at the idea of a laser that runs backward, and some problems in engineering called for a way to completely snuff out light. But no one had ever put the two ideas together.

"Others discovered independently that there's an optimal condition where they can have the best absorption," Cao said. "But they didn't realize this was a time-reversed laser. They didn't know they can get in principle perfect absorption."

To build the antilaser, which Cao and colleagues call a "coherent perfect absorber," the researchers split a beam from a titanium-sapphire laser in two. The laser emitted light in the infrared part of the electromagnetic spectrum, with longer wavelengths than the human eye can see.

Some of the light continued forward through the beam splitter, and the rest was forced into a sharp right turn. The physicists guided the light beams into a cavity containing a silicon wafer one micrometer thick. One beam entered from the left and one from the right. The distance each beam traveled determined the way the crests and troughs of the light waves aligned when they met in the wafer.



When the alignment was right, the light waves canceled each other out. The silicon absorbed the light and converted it to another form of energy, like heat or electrical current.

"It is a simple experiment," Cao said. "But it shows a very powerful way to control absorption."

The device can only absorb one wavelength of light at a time, but that wavelength can be adjusted by changing the thickness of the wafer.

Surprisingly, the antilaser switched from absorbent to reflective when the researchers changed the way the waves met in the wafer. Under certain conditions, the silicon crystal actually helped light escape.

"That is a little surprising," Cao said. "We can turn it on and off."

Theoretically, 99.999 percent of the light can be extinguished. Because of the physical limitations of the laser and the silicon wafer, the antilaser only absorbed 99.4 percent of the light.

That may be good enough, Cao said.

"For many applications, if you already have less than 1 percent coming out, you're already okay," she said. "I'm sure people in the community who have better lasers than us, I'm sure they will achieve much more impressive results. This is only the first demonstration of the principle."

The device may find uses in optical switches for future superfast computer boards that use light instead of electrons. It may also have medical applications, such as imaging a tumor through normally opaque human tissue.

The most exciting applications will no doubt be those no one has thought of yet. The laser itself was called "a solution without a problem" when it first showed up.

"It is quite novel and indeed surprising that in such a mature field one can come up with something fundamentally new," said physicist Marin Soljačić of MIT, who was not involved in the new work. "I think it opens a few exciting venues."

Image: Science/AAAS

"Time-Reversed Lasing and Interferometric Control of Absorption." Wenjie Wan, Yidong Chong, Li Ge, Heeso Noh, A. Douglas Stone, Hui Cao. Science, Vol 331, Feb. 18, 2011. DOI: 10.1126/science.1200735.

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Hunter

Any body else think we might have been able to save Alderaan if we'd had this a little sooner?

02/17/2011 02:25 PM 52 Likes Like

CityZen, Oh, I'm picking out a thermos for you! Not an ordinary thermos, for you! But the...

Alderaan just needed a giant retroreflector. Would've solved two problems at the same time!

02/17/2011 07:34 PM in reply to Hunter 7 Likes Like

hammondhank

But we can still save Tattooine, and Austin from Dr. Evil.

02/19/2011 01:25 AM in reply to Hunter 1 Like Like

hamb

I knew it! I have long thought that flashlights did not make light, they sucked in dark. I have taken the batteries out of flashlights and opened them up, finding them full of black stuff. This invention is terrific, it will have the ability to suck in unlimited amounts of light.

02/17/2011 03:06 PM 14 Likes Like

Angus

"Mini Me... Stop humping the ANTI laser."

Doesn't have the same ring to it. :-(

02/17/2011 12:48 PM 12 Likes Like

brixabrax

I'm confused. How does this differ from... say... a brick? My house is built from anti-lasers.

02/18/2011 01:33 PM 4 Likes Like

AlfLup

So you're saying we can farm light for energy. I wonder how efficient it can be.

02/17/2011 02:36 PM 3 Likes Like

MrBeachBum

The article says it can convert the laser light into heat or electrical current. So lasers could replace power cords!! I know, inefficient as hell, but cool!!

02/17/2011 01:06 PM 2 Likes Like

Asher Schweigart

would possibly be useful though for beaming solar energy collected by a satellite back down to earth.

02/17/2011 04:05 PM in reply to MrBeachBum 5 Likes Like

Xenobio

I'm not a physics or engineering person so correct me if I'm wrong: I assume you would have to convert solar light -> electricity -> lasers light at the satellite first before beaming it down to Earth. Wouldn't that be more inefficient than just reflecting the light from a big mirror on the satellite?

02/18/2011 01:00 AM in reply to Asher Schweigart 1 Like Like

omems

er, what do the lasers run on?

02/17/2011 03:33 PM in reply to MrBeachBum 4 Likes Like

gwerno

> The device may find uses in optical switches for future super-fast computer boards that use light instead of electrons.

That makes sense. If you are using ultra-miniaturized ultra-fast optical switches, and you suddenly need to get rid of some light packets, you can't just let it spill out and bounce around willy-nilly.

02/17/2011 12:58 PM 2 Likes Like

p

you don't have a light bucket? or photon absorption grid? we had those years ago!

02/18/2011 11:22 AM in reply to gwerno Like

hammondhank

Can I get one of these to put on my anti-sharks' frickin' heads?!

02/19/2011 01:23 AM 1 Like Like

AussieinHK

I'm surprised no one thought of this before. After all, it's long been known you can cancel sound waves, why not light waves?

02/18/2011 02:19 PM 1 Like Like

m3kw

If they can split lasers, they can combine lasers, like the Death Star.

02/18/2011 08:53 AM 1 Like Like

CNASchool

Great information! I've been looking for something like this for a while now. Thanks!
http://www.cnaon.com/cna-salar...

02/18/2011 03:24 AM 1 Like Like

stoffer

I wonder if this can be used to make better photodetectors. It seems that the paper is worth reading :).

02/17/2011 12:47 PM 1 Like Like

Kishore

I see it as an interferometer. Well aligned interferometer which produces darkness if the path difference between the waves is exactly half a wavelength. Or am I missing something here ?

03/07/2011 08:13 AM Like

Guest

So is the first law of thermodynamics still true or not? :) It doesn't even sound like wave cancellation. It sounds like just a piece of wafer absorbing two phase shifted beams of light. How is that special? :)

02/18/2011 02:52 PM Like

Jason

"The silicon absorbed the light and converted it to another form of energy, like heat or electrical current."
-Ummm, heat isn't "another form of energy," IT IS light- infrared light. So, then, what this article is saying is that the laser was split into infrared light, was absorbed, then re-emitted as heat (infrared light). How is this "perfect absorption? Or is this just a typo?

02/18/2011 02:47 PM Like

rrjhrrurru

Jason,

You are correct in principle, hot matter emits IR radiatation and looses stored energy in the process but the absorbed electromagnetic energy from the photons is converted to an increase in vibration of absorbing material which is the underlying princple off heat .

02/20/2011 12:45 AM in reply to Jason Like

Elijahs Fury

GET THE ANTI-LASERS UP, SCOTTY! I NEED EMERGENCY POWER TO THE FORWARD ANTI-LASERS!mmm...sorry..doesnt work for sci-fi flicks..

02/18/2011 02:18 PM Like

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