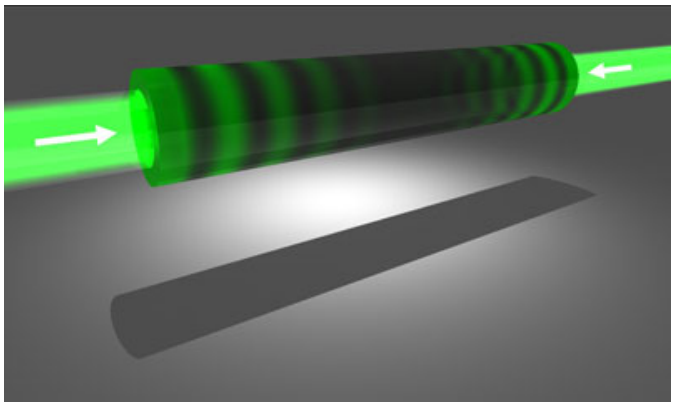
Physicists create 'anti-laser'

Feb 17, 2011 11 comments



A time-reverse laser made from silicon

In a fascinating case of physics being turned on its head, a group of researchers at Yale University in the US has created an "anti-laser" that almost perfectly absorbs incoming beams of coherent light. The invention is based on a theoretical study reported last summer in which Douglas Stone and his Yale colleagues claimed that such a system could be possible in a device that they call a coherent perfect absorber (CPA). Instead of generating coherent light beams with a laser, the devices absorb incoming coherent light and convert it into either heat or electricity.

Now, having teamed up with experimental physicists at Yale, Stone has built a version of the device by creating an "interference trap" inside a silicon wafer. Two laser beams – originally split from a single beam – are directed onto opposite sides of the wafer and their wavelengths are fixed so that an interference pattern is established. In this way, the light waves get stalled indefinitely, bouncing back and forth within the wafer, with 99.4% of both beams being transformed into heat.

The group argues that there is no theoretical reason why 100% of the light could not be absorbed using the technique. The researchers are also confident that the current size of the device, 1 cm in diameter, can be reduced to just 6 μm. "It is surprising that the possibility of the 'time-reversed' process of laser emission has not been seriously discussed or studied previously," says Stone.

Focus on applications

Stone's group believes that its "anti-laser" could prove to have many exciting applications. These might include filters for laser-based sensors at terahertz frequencies for sniffing out biological agents or pollutants, which requires detecting a small backscattered laser signal against a large background of thermal noise.

Another idea is to use the device as a type of shield in medical applications to enable surgeons to fire laser beams at unwanted biological tissue, such as tumours, with greater accuracy. "With our technique an appropriately engineered incident set of light waves could penetrate deeply into such a medium and be absorbed only at the centre, enabling delivery of energy to a specified region," explains Stone.

The group also speculates that by adding another "control" beam it could control the device to toggle between near complete absorption and 1% absorption. This property could enable the

devices to function as optical switches, modulators and detectors in semiconductor integrated optical circuits.

One limitation of all such devices, however, is that they will only work at specific wavelengths, meaning that the technology will not be particularly useful in photovoltaic cells or cloaking devices.

The findings are reported today in *Science*.

About the author

James Dacey is a reporter for *physicsworld.com*

11 comments

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1 **Jarek Duda**
Feb 18, 2011 8:32 AM
Cracow , Poland

What cause CPT analogue of laser?

If standard laser stimulate photons to be emitted and so absorbed by the target, shouldn't such 'antilaser' (lasar?) stimulate photons to be absorbed and so emitted by the target?
So if we constantly excite a sample which is surrounded by detectors in all directions but the one to the antilaser, shouldn't turning it on cause that detectors caught smaller amount of light ... earlier?
Another configuration - laser hits half-silvered mirror behind which there is near detector on one optical path and far such antilaser on the second - does turning it on make that detector gets less amount of light ... earlier?
I thought about something similar, but conceptually simpler - imagine CPT transformation of free electron laser...

Edited by Jarek Duda on Feb 18, 2011 8:47 AM. Reason: simpler configuration

2 **amarov**
Feb 18, 2011 9:35 AM

What about wireless power transfer?

An interesting question is whether it is feasible to convert the absorbed light energy to electrical or chemical one. If it can be done with the same efficiency as converting it to heat, wow, this could be the best invention of the century.

3 **jezturner**
Feb 19, 2011 1:44 PM

Shielding

Could this technology be used as an EM shield on manned spacecraft shielding them from cosmic rays. We know the wavelength of the most energetic rays so the device could be 'tuned' to that particular frequency or have a range of devices covering a range of frequencies. This energy may be able to be emitted at different wavelengths depending on the materials used and their energy levels. Maybe doping the silicon used may help?

4 **cmhintl**
Feb 21, 2011 2:05 PM
--, Spain

Really cool

Quote:

> *Originally posted by* ***amarov***
> An interesting question is whether it is feasible to convert the absorbed light energy to electrical or chemical one. If it can be done with the same efficiency as converting it to heat, wow, this could be the

> best invention of the century.

Sure it would be a fantastic idea! However, depending on the transferred power we should take care to not walk across the beam! :D

5 **hehe93**
Feb 21, 2011 4:01 PM

Quote:

> *Originally posted by* ***cmhintl***
> Quote:
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> Sure it would be a fantastic idea! However, depending on the transferred power we should take care to not walk across the beam! :D

6 **ChipD**
Feb 21, 2011 10:00 PM

recharge

This could be an interesting way to recharge batteries on spacecraft or rovers. Imagine being able to recharge a telescope on the moon from earth. Cheaper than a shuttle mission.

7 **kinslerp**
Feb 22, 2011 5:30 PM

I do not believe this will work -

at least in any useful sense. This is because you need to know everything about the incoming beam before it gets to you; so either you have to have a conspiracy or have to violate causality:

See:
"Active drains and causality", Phys. Rev. A82, 055804 (2010),
or
arxiv.org…1008.2088

8 **martinharnevie**
Feb 25, 2011 2:47 AM

Well if it can be done in the 8-12 um band, FIR, it could potentially be used to transmit energy from satellite solar power screens down to earth....

9 **Tom Sullivan**
Feb 25, 2011 7:45 PM

I would not count out it's use in photovoltaic's

I would not count out it's use in photovoltaic cells!

10 **mikki**
Feb 26, 2011 3:30 PM

If it is shown that "the light waves get stalled indefinitely, bouncing back and forth within the wafer, with 99.4% of both beams being transformed into heat"- what does that mean?

(1) Light is heat or radiation is light...
(2) Photon that carries heat is a particle and shines displaying light... And,
(3) Experiments on light at Harvard U show when light is cooled to K~0, light turns into mass; and that mass turns back into light when heat is introduced... that means Photon has a mass.
(4) So, Photon is a -param: correct?

That is a piece of evidence to prove- Vacuum is NOT an empty space, but filled with params (or dark matter) including +params and dark-Objects (not BHs) as I showed in my work..

Any comments?

11 **Tom Sullivan**
Mar 9, 2011 11:19 PM

I would not count out it's use in solar energy!

A prism could be used to separate sun light into it's individual frequencies, each of those frequencies could be split into two beams and directed back at each other within a wafer by fiber optics. Even if only the frequencies with the most energy are used an array of wafers utilizing 50% to 75% sunlight's energy to produce heat would produce a massive amount of energy. Tom Sullivan