THE ‘ANTI-LASER’

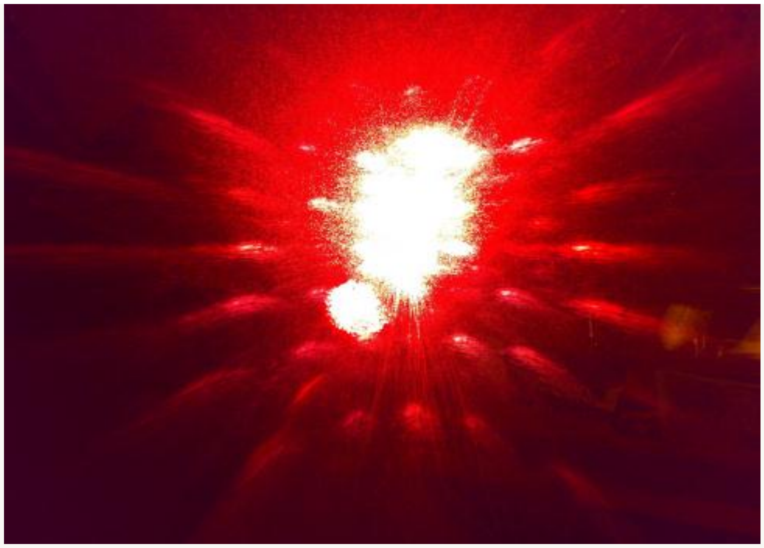

Photo by piglicker via flickr.

I don’t have much time this week and next to blog, but yesterday *Science* published an interesting paper by Hui Cao and colleagues at Yale that is hard to ignore. It is the ‘anti-laser’.

In short, this anti-laser does exactly the same what a laser does, just with time reversed. You can do that because the physics involved in the laser doesn’t change when you reverse the time. It is as if you play a laser backwards.

A laser requires at least two energy states that are placed between two mirrors. An electron in an upper energy state relaxes to the lower one and emits light. If the electrons are continuously pumped into the upper state, the light that bounces between the mirrors becomes increasingly intensive and at some point lasing kicks in. One of the two mirrors is semi-transparent, so the laser light can get out of the device.

In the anti-laser, coherent light of a specific wavelength (that is, laser light) is directed towards such an optical resonator. It then bounces back and forth between the mirrors, until it gets absorbed by the electrons. This time, the electrons are excited into the higher state and absorb light.

What strikes me as interesting in this paper is an issue that the news reports don’t delve into. The anti-laser in the *Science* paper uses silicon. Now, silicon is known to absorb light very well and is used a lot for solar cells. But it is a terrible light emitter. In fact, this is a real tragedy, as otherwise it would be really easy to integrate optical devices with silicon electronics.

So, given than silicon is a terrible light emitter but good absorber, the realisation of such an anti-laser seems the perfect thing to do. But I wonder whether such a scheme would also work as efficiently with semiconductors that are good light emitters. For these to achieve a net absorption of light could be more difficult.

Either way, the demonstration of this anti-laser is an intriguing realisation of the time reversal principle. Its realisation on silicon suggests use as an absorber or detector, and is an important step towards integrating more optical functionality on silicon chips.

From a more fundamental point of view, I very much agree with the comment by Marin Soljačić in the news report by my colleagues from Nature News: “It is surprising to have something so new and quite fundamental discovered in such a mature field.”

Update: I got asked on twitter by Geoff Brumfiel, who wrote the Nature News article I mentioned above, whether ‘anti-laser’ is really the right name for this device. And I agree, it is not a good name as far as fundamental physics is concerned. That’s why I used it in inverted commas in the title of this blog post. It has nothing to do with the anti-particles of particle physics. Nor is it really a 100% the reverse of laser action. Of course, in case of silicon used here, light-emission is very difficult, so it doesn’t compare to a laser. But even if one would use the perfect laser material, the ‘anti-laser’ wouldn’t be the reverse of a laser. The dynamics along of light absorption and emission are completely different. And often the electron energy bands are different too – emission occurs at a slightly different energy than absorption. So to be precise one shouldn’t call such a device a laser at all, but an absorber of some sort. But ‘anti-laser’ is such a catchy name for it, my feeling is that it might stick for this device.

Source: http://allthatmatters.heber.org/2011/02/18/the-anti-laser/