Lights, Lasers and Illusions

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Recap:

Last time, we found out that LASER stands for…. Can you remember?

LASER

What does laser stand for?

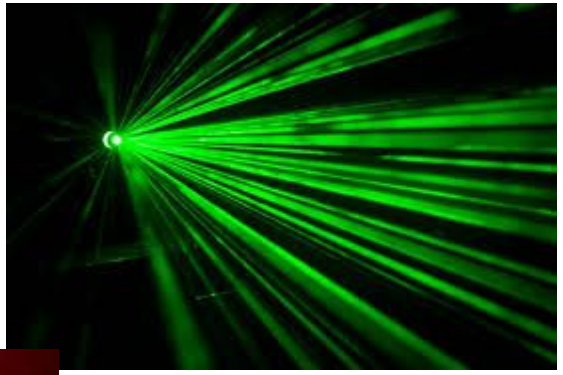
Light

Amplification by

Stimulated

Emission of

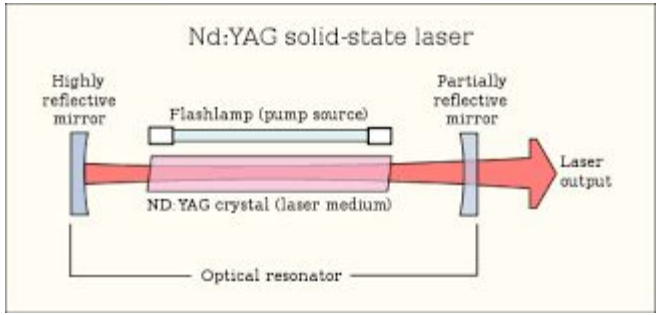
Radiation



More on Stimulated Emission

We also found out that inside a laser, there's a substance called a GAIN MEDIUM that amplifies light. It does this by Stimulated Emission. So that's where these words come from in LASER.

The atoms that make up the Gain Medium are hit by light energy from the energy source that powers the laser. Some of these atoms take in the energy and become excited. Excited atoms can give off energy as photons of light and that is exactly what some of them do. These photons then cause other excited atoms to release photons of light energy, and the process snowballs, so that more and more photons are released.

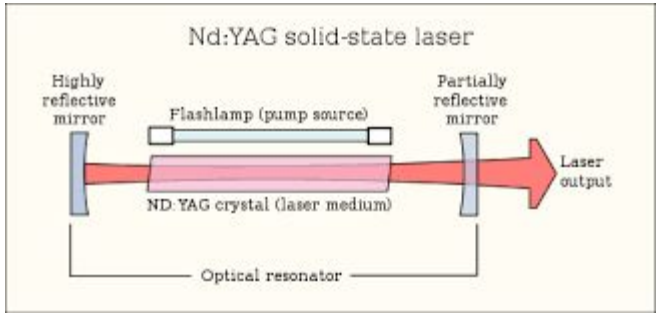


Stimulated Emission

Stimulated emission triggers a chain reaction so that loads of photons are produced in the gain medium.

These photons are reflected from mirrors in the laser, sending them back through the gain medium where they cause even more photons to be emitted.

Some of the light passes through a partial reflector on one end of the laser and comes out as a laser beam.



Uses of lasers

Lasers can be used in a myriad of ways.

Laser pointers can help teachers and lecturers point things out. These are very low powered but they can still hurt your eyes.

Laser light shows use higher powered lasers. These would definitely hurt your eyes if you looked at them directly

Compact Discs and Lasers

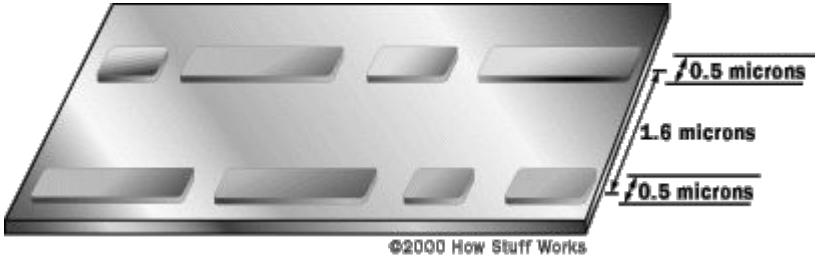
We used CDs to make rainbows. The real use of CDs is to store information.

A CD is made from a plastic disc with a long spiral track that starts in the centre.

The spiral track is made of a series of tiny bumps. It is covered in a thin layer of aluminium and with another layer of plastic (polycarbonate) to protect it.

The tiny bumps are the important part. When the disc is played, a laser follows the spiral track and reflects differently off the bumps or off the space between the bumps, changing where the reflected laser light goes.

A sensor picks up the reflections and depending where the light was reflected to, turns that information into, for example, music.


0.5 microns
1.6 microns
0.5 microns
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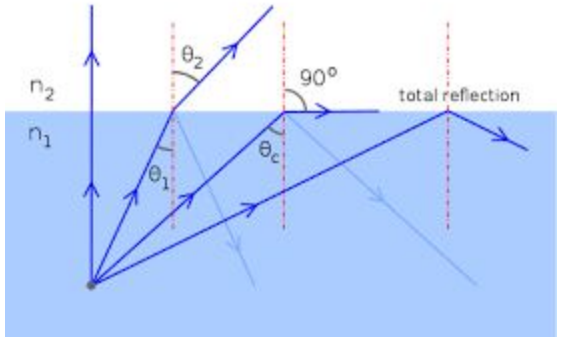
Lasers for measuring

Lasers can be used to measure the size of things. This can be handy if you want to measure something that's very high up or hard to get at. Lasers can be used when building skyscrapers to ensure the building is straight. A pulse of laser light is sent off. It gets reflected back. The time it takes for the journey multiplied by the speed of light gives the distance. (well twice the distance)

Lasers in communication

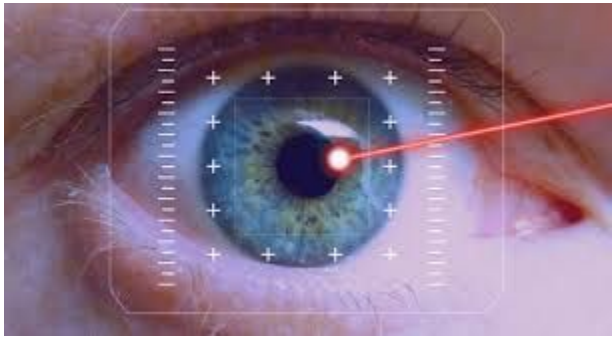
Lasers are used in fibre optic cables to send data over long distances, using total internal reflection.

But we know all about this already, don't we?!



Lasers for surgery

Higher powered lasers are used in surgery for cutting through tissue. They are often used in eye surgery. They can be used to reattach a retina that has become detached or to change the shape of the cornea so that glasses aren't needed anymore.



Lasers for cutting

Cutting through human tissue isn't that difficult though, it is quite soft.

Lasers can cut through much harder materials.

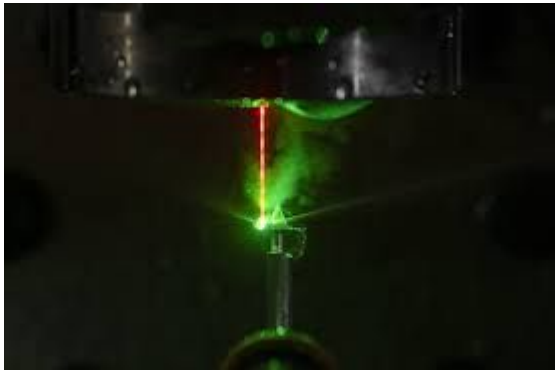
Lasers can be used to cut through metal.

Lasers for cutting

There are substances that are even harder to cut than metal.

Diamonds are extremely hard, so it is difficult to find something that can cut through them.

High powered lasers can cut through diamonds.



Lasers for making microchips

Micro lasers can drill tiny holes or shave tiny bits of material off. This is useful when making integrated circuits that are in phones, computers etc.

Lasers are used to make tiny integrated circuits.

Lasers in nanotechnology

Lasers can be used in nanotechnology to fabricate tiny nanomachines, to make nanoparticles etc.

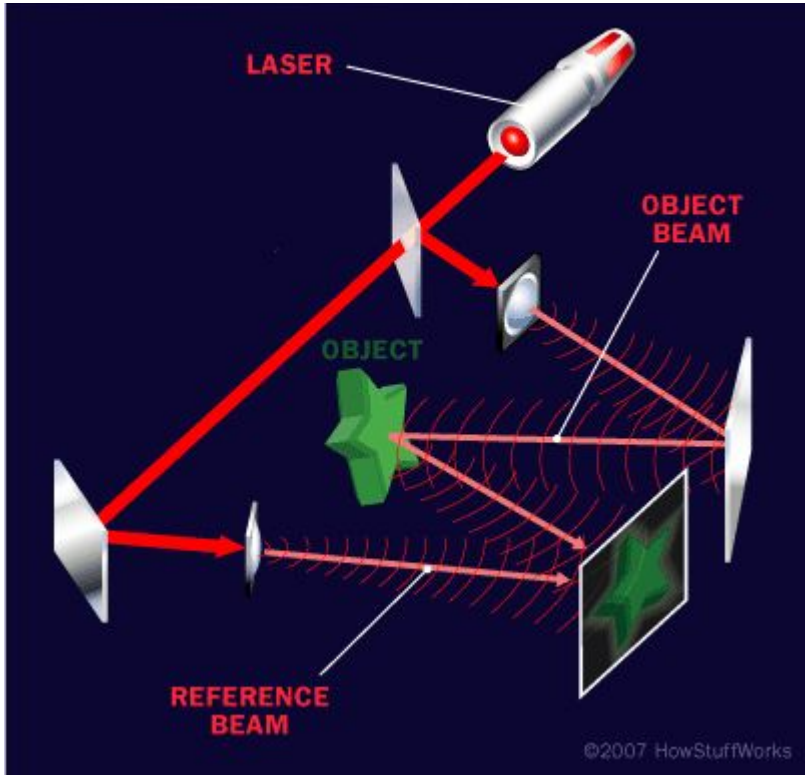
Nanotechnology deals with things that are of the order of size of 0.000000001m. This is a thousandth of a micrometre which is a thousandth of millimetre. So, quite small!

Lasers can be focussed so finely that they can even be used at these small sizes.

Holograms

Holograms are 2D pictures that look like they are 3D. As you move around and look at a hologram, it seems to have depth as well as length and height. Holograms are made by laser light.

There are two different types of hologram: transmission and reflection. Here's how a reflection hologram is made:



Holograms

There are more holograms around than you'd imagine. There are holograms on passport, drivers licences and on euro notes. If you move a hologram around, the picture and colours change in it.

In the 10 euro note, there's a hologram of a 10 which changes to a euro sign when you tilt it.

Laser maze

What you need:

Mirrors

A laser or a torch with black paper over it and a pinhole in the black paper

Blue tack

Piece of paper

What you do:

1. We know that the angle of incidence equals the angle of reflection so set up your mirrors so that they reflect light from mirror to mirror. When you're happy with your positioning, secure the mirrors in place with bluetack
2. Shine your laser at the right angle into the first mirror.
3. Hold your paper up where the light should be reflected from the last mirror. Did it work?

Bending light: total internal reflection in water

What you need

A water bottle

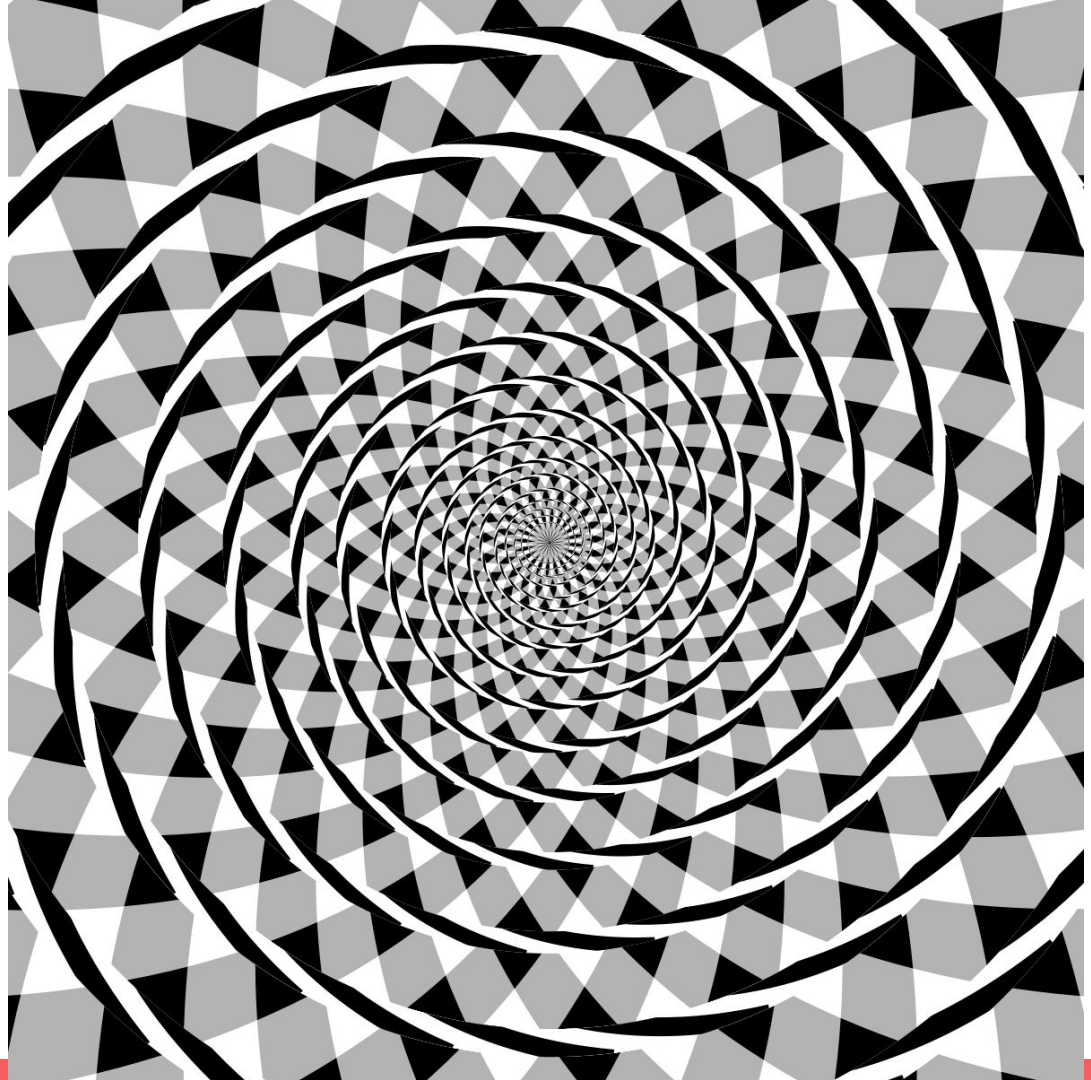
A sharp knife (or fork) - something to poke a small hole in your bottle

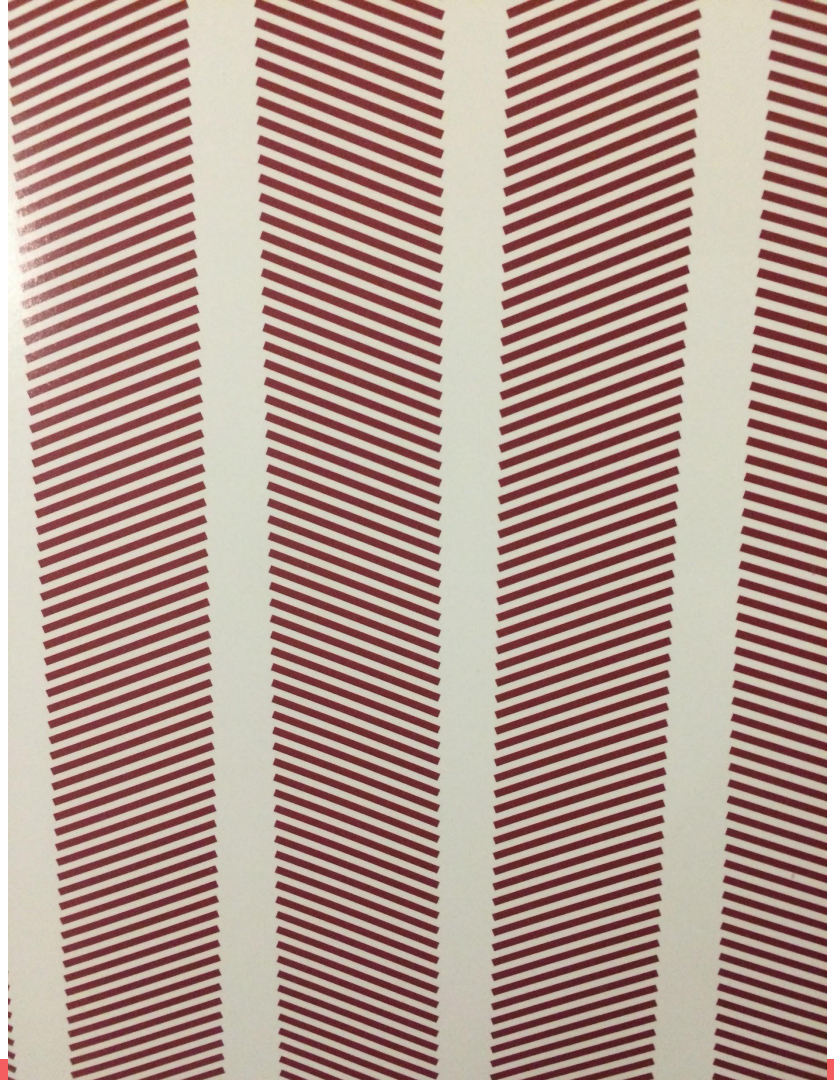
Water

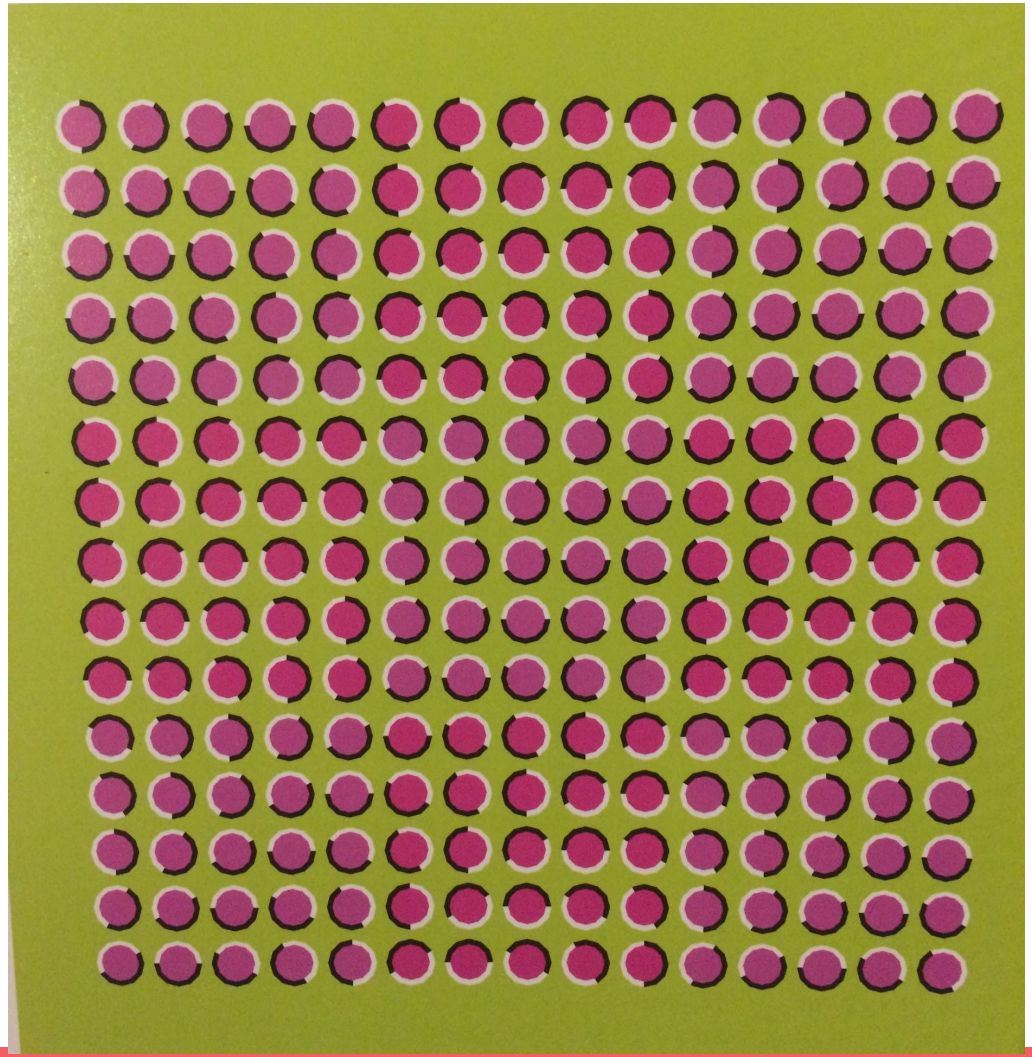
A large flat bottomed dish

A laser

1. Poke one small hole in your water bottle about a third of the way up from the bottom of the bottle. Be careful doing this.
2. Fill the bottle with water and put it into the flat bottomed dish. The water will be shooting out of the small hole so be careful not to splash yourself (or your kitchen)
3. In the dark, shine the laser light through the bottle and out through the hole you made. This will take some time! The laser light should travel down the stream of water due to total internal reflection and the stream should light up.







Quiz Time!