LASER PLASMA WAKEFIELD ACCELERATION

SILIS Group, Plasma Division, Department of Physics

constantin.aniculaesei@strath.at.uk

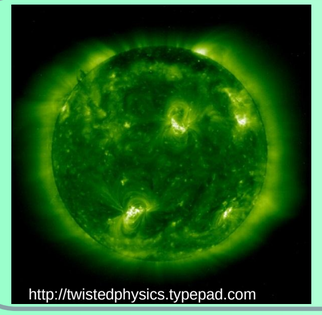
Overview

Particle accelerators are the main tools for a particle physicist. Such accelerators can take a particle like an electron, and using a strong electric field accelerate it to speeds near that of light, and then collide it with another particle (atom, electron etc.), to discover its internal structure. The cost and size of the accelerators required to do this has increased dramatically as we have generated higher energy particles, making it almost impossible to build an accelerator such as the Large Hadron Collider (LHC), without international financial co-operation. That is why, here at University of Strathclyde, using the latest discoveries in laser-plasma physics we are developing the next generation of particle accelerators. These accelerators will not only be cheaper than classical accelerators but will also be reduced in size dramatically – fitting on a laboratory bench-top!

LASER

- LASER – Light Amplification by Stimulated Emission of Radiation – is a source of intense, monochromatic and coherent light
- In our experiments we are using a very high intensity femtosecond laser
- Laser intensity =1,000,000,000,000,000,000 W/cm^2
- 1 fs = 0.000,000,000,000,001 s

PLASMA

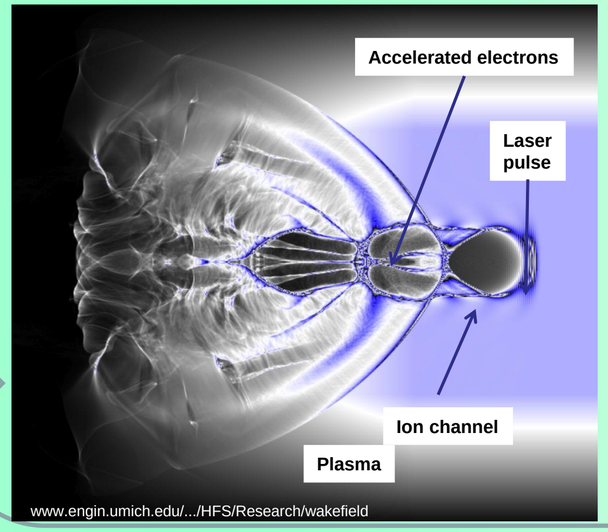


- PLASMA - is partially or fully ionized gas comprising of atoms, ions, and electrons.
- It is said that 99% of the visible matter in the Universe is plasma.
- Example of plasma: sun, lightning, Aurora Borealis, electrical discharges

WAKEFIELD ACCELERATION

- In this image you can see waves generated by a boat as it moves across the surface of water. We call these waves WAKEFIELDS
- If a surfer is in the right place and in the right moment he will “catch the wave”, which means that he will start to accelerate and move across the surface, too ”riding the wave”
- The important thing to remember is that if the boat travels at higher speeds, so do the waves in the wakefield - and so can the surfer

LASER PLASMA WAKEFIELD ACCELERATION



- Using the analogy with the boat imagine that instead of water we have plasma , instead of the boat we have high intensity laser pulse and instead of surfers we have electrons.
- The wave is created through the passage of a very short laser pulse in plasma , a technique known as **laser plasma wakefield acceleration**
- If we inject electrons in the right place and in the right phase they will be accelerated: their final speed being equal to the speed of plasma waves
- Using this technique, In a few centimetres of plasma we can accelerate electrons close to the speed of light.
- To obtain electrons with the same energy, several meters long conventional accelerators several km long are required..
- My PhD focuses on making these accelerated electrons a stable and reliable source of accelerated electrons for the particle accelerators of the future…

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