John Adams Institute for Accelerator Science

John Adams Institute for Accelerator Science Lecture Series

Thursday 21st February 2013 at 4:15pm
Fisher Room, Denys Wilkinson Building

Plasma Wakefield Acceleration and the AWAKE Project at CERN

The lecture will be delivered by

Dr. Patric Muggli,
Max Planck Institute for Physics

Abstract: Plasma wakefield acceleration has made remarkable progress in the last ten years. Experiments at SLAC have shown that an energy gain by trailing electrons of 42GeV in only 85cm of plasma is possible. This corresponds to an average accelerating gradient larger than 50GeV/m sustained along a meter-scale plasma. These results were possible only because ultra-relativistic, short (~100fs), high peak current (~10kA) electron bunches, focusable to ~10μm transverse size, are available at SLAC. However, these bunches only carry ~60J, thereby limiting the ultimate energy gain by a trailing bunch. Therefore this electron beam driven plasma wakefield scheme will have to resort to staging to reach the energy frontier (0.5-1TeV).

Proton bunches produced by the CERN SPS (450GeV, 10^{11} p^+) and LHC (7TeV) carry 7 to 110kJ. If used as plasma wakefield drivers they could take a few GeV incoming electron bunch to the energy frontier in a single plasma section as demonstrated in simulations in Caldwell et al., Nature Physics 5, 363 (2009). However, proton bunches available today are long, typically 10cm rms length in the CERN bunches case and would drive low amplitude wakefields in low density plasmas. We are planning on using a recently proposed self-modulation instability (SMI, N. Kumar et al., Phys. Rev. Lett. 104, 255003 (2010)) to demonstrate that proton bunches can drive GV/m wakefields in plasmas in the ten meter length range. In this scheme the incoming bunch first forms a train of bunches with the periodicity of the plasma wavelength (~1.2mm) with the occurrence of the SMI. The train can then resonantly drive wakefields to large amplitudes. The instability can be seeded to shorten its saturation length. A witness electron bunch can then be injected to witness the wakefields and be accelerated. The proposed experimental program is called AWAKE.

I will introduce the concept of plasma wakefield acceleration, briefly review the major experimental results obtained to date and introduce the AWAKE program.

For further details contact Glenn Christian at g.christian1@physics.ox.ac.uk