Research project could help create computers that run on light

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A new research project begins soon which could be an important step in bringing the dream of photonic computers – devices run using light rather than electronics – onto the desktop. Physicists at the University of Bath will be looking at developing attosecond technology – the ability to send out light in a continuous series of pulses that last only an attosecond, one billion-billionth of a second.

The research could not only develop the important technology of photonics, but could give physicists that chance to look at the world of atomic structure very closely for the first time.

In June Dr Fetah Benabid, of the Department of Physics at Bath, will lead a team of researchers to develop a new technique which would enable them to synthesise 'waveforms' using light photons with the same accuracy as electrons are used in electronics. Waveform synthesis is the ability to control very precisely the way that electric fields vary their energy.

Ordinarily, electric fields rise and fall in energy in a regular pattern similar to the troughs and crests of waves on the ocean, but modern electronics allows a close control over the shape of the 'wave' – in effect creating waves that are square or triangular or other shapes rather than curved.

It is this control of the variation of the electric field that allows electronic devices such as computers to function in the precise way needed.

But electronics has its limitations, and the development of ever smaller silicon chips which has allowed computers to double in memory size every 18 months or so will come to an end in the next few years because the laws of physics do not permit chips smaller than a certain size.

Instead, engineers are looking to the science of photonics, which uses light to convey information, as a much more powerful alternative. But so far photonics can use light whose waveform is in one shape only – a curve known as a sine wave – and this has limited value for the communications needed to run a computer, for example.

The Bath researchers want to allow photonics to create waveforms in a variety of different patterns. To do this, they are using the new photonic crystal fibres which are a great step forward in photonics because, unlike conventional optical fibres, they can channel light without losing much of its energy.

In the research, light of one wavelength will be passed down a photonic crystal fibre which then branches off in a tree-like arrangement of fibres, each with a slightly separate wavelength, creating a broad 'comb-like' spectrum of light from ultra-violet to the middle of the infra-red range.

This broad spectrum would allow close control over the electric field, which is the basis of conveying enormous amounts of information that modern devices like computers need. They are funded by a grant from the Engineering and Physical Sciences Research Council.

"Harnessing optical waves would represent a huge step, perhaps the definitive one, in establishing the photonics era," said Dr Benabid.

“Since the development of the laser, a major goal in science and technology has been to emulate the breakthroughs of electronics by using optical waves. We feel this project could be a big step in this.

“If successful, the research will be the basis for a revolution in computer power as dramatic as that over the past 50 years."

Dr Benabid said that the technology that could be built if his research was successful could, for instance, make lasers that operate at wavelengths that current technology cannot now create, which would be important for surgery.

The continual series of short bursts of light will not only dramatically affect technology - it will also advance physics by giving researchers the chance to look inside the atom.

Although atoms can now be “seen” using devices such as electron microscopes, it has not been possible to examine their fast dynamics.

By sending the light in short bursts into an atom, they will be able to work out the movements of electrons, the tiny negatively charged particles that orbit the atom’s nucleus.

This may throw light, literally, upon the strange quantum world of sub-atomic particles, which have no definite position, but are only ‘probably’ in one place until observed.

Source: University of Bath

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