The 'Spaser' heats up laser technology

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Lasers have revolutionized the communications and medical industries. They focus light to zap tumors and send digital TV signals and telephone communications around the world.

But the physical length of an ordinary laser cannot be less than one half of the wavelength of its light, which limits its application in many industries. Now the Spaser, a new invention developed in part by Tel Aviv University, can be as small as needed to fuel nano-technologies of the future.

Prof. David Bergman of Tel Aviv University's Department of Physics and Astronomy developed and patented the theory behind the Spaser

device in 2003 with Prof. Mark Stockman of Georgia State University in Atlanta. It is now being developed into a practical tool by research teams in the United States and around the world.

"Spaser" is an acronym for "surface plasmon amplification by stimulated emission of radiation" — and despite its mouthfilling definition, it's a number one buzzword in the nanotechnologies industry. The Spaser has been presented at recent meetings and symposia around the world, including a recent European Optical Society Annual Meeting.

Seeing your DNA up close

Spasers are considered a critical component for future technologies based on nanophotonics —technologies that could lead to radical innovations in medicine and science, such as a sensor and microscope 10 times more powerful than anything used today. A Spaser-based microscope might be so sensitive that it could see genetic base pairs in DNA.

It could also lead to computers and electronics that operate at speeds 100 times greater than today's devices, using light instead of electrons to communicate and compute. More efficient solar energy collectors in renewable energy are another proposed application.

"It rhymes with laser, but our Spaser is different," says Prof. Bergman, who owns the Spaser patent with his American partner. "Based on pure physics, it's like a laser, but much, much, much smaller." The Spaser uses surface plasma waves, whose wavelength can be much smaller than that of the light it produces. That's why a Spaser can be less than 100 nanometers, or one-tenth of a micron, long. This is much less than the wavelength of visible light, explains Prof. Bergman.

Fuelling the buzz

In the next year, the research team expects even more buzz to be created around their invention. In 2009, a team from Norfolk State University, Purdue University, and Cornell University managed to create a practical prototype.

The Spaser will extend the range of what's possible in modern electronics and optical devices, well beyond today's computer chips and memories, Prof. Bergman believes. The physical limitations of current materials are overcome in the Spaser because it uses plasmons, and not photons. With the development of surface plasma waves — electromagnetic waves combined with an electron fluid wave in a metal — future nano-devices will operate photonic circuitry on the surface of a metal. But a source of those waves will be needed. That's where the Spaser comes in.

Smaller than the wavelength of light, nano-sized plasmonic devices will be fast and small. Currently the research team is working on commercializing their invention, which they suggest could represent a quantum leap in the development of nano-sized devices.

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