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Particle Acceleration by Stimulated Emission of Radiation -- PASER for Short

Particle Acceleration by Stimulated Emission of Radiation (PASER for Short), a sort of particle analog of the laser process, has been demonstrated, for the first time, by a team of physicists from the Technion-Israel Institute of Technology using the accelerator facilities at the Brookhaven National Lab.

In a regular laser, photons traveling through an active medium (a body of excited atoms) will stimulate the atoms, through collisions, to surrender their energy in the form of additional emitted photons; this coherent process builds on itself until a large pulse of intense light exits the cavity in which the amplification takes place. In the new proof-of-principle PASER experiment, the active medium consists of a CO_2 vapor, and instead of surrendering their energy in the form of stimulated photons, the atoms transfer their energy to a beam of electrons.

The electrons stimulate the atoms into giving up their surplus energy through collisions. The electrons' energy is amplified in a coherent way; that is, the electrons are directly accelerated by a direct and coordinated quantum transfer of energy. Although millions of collisions are involved for each electron, no heat is generated. The transferred energy goes into an enhanced electron motion. One could say that here was a laser which produced no laser light, only a laser-like transfer of energy resulting in electron acceleration.

It should be said that the electrons began with an energy of 45 million electron volts (MeV) and absorbed only a modest energy of about 200 thousand electron volts (keV). The electrons, first accelerated in a conventional accelerator, were also exposed to a CO2 laser and also sent through a "wiggler" array of magnets; these actions served to carve a larger bunch of electrons into separate micro-bunches, which are timed and modulated in energy in order to more readily partake of the resonant PASER process in the CO_2-filled resonant cavity a little farther along (see figures at **Physics News Graphics**).

Being able to accelerate electrons with energy stored in individual atoms/molecules, a concept now demonstrated with the PASER, provides new opportunities since the accelerated electrons may prove to be significantly "cooler" (they are more collimated in velocity) than in some other prospective acceleration schemes, enabling in turn the secondary generation of high-quality X-rays, which are an essential tool in nano-science.

Banna, Berezovsky, Schachter, **Physical Review Letters**, upcoming article
Images at **Physics News Graphics**

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