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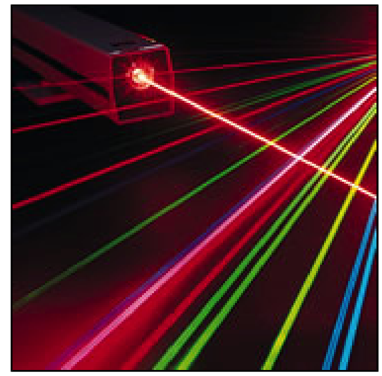
Lasers trigger cleaner fusion

Neutron-free reaction makes less radioactive waste.

Mark Peplow

Russian scientists have managed to use lasers to create a billion-degree nuclear fireball. The resulting fusion reaction is far cleaner than the kind currently being investigated to generate nuclear power.

Sadly, the team's efforts are no good for power generation at the moment as the laser takes so much energy to run. But achieving this kind of laser-driven fusion in the lab will give scientists a better way to investigate the phenomenon, which could one day be used to create cleaner energy.



Some like it hot: lasers can trigger billion-degree reactions.

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Currently, the main contender for generating fusion power uses strong magnetic fields to confine a fiery plasma of atomic nuclei: fusion experts hope that the International Thermonuclear Experimental Reactor (ITER), to be built in Cadarache, France, will fuse deuterium and tritium nuclei together in this way to create energy.

But this reaction also produces copious amounts of neutrons. When these neutrons hit the reactor walls they generate radioactive isotopes that will eventually have to be disposed of. And although this radioactive waste is cleaner than the by-products created by fission, the reaction used by today's nuclear power plants, it isn't perfect.

Turning up the heat

So some physicists have suggested using a different fusion process instead, which forces protons and boron nuclei together in a reaction that generates virtually no neutrons[1].

Although this sounds safer, kick-starting proton-boron fusion requires temperatures of a billion degrees, more than ten times the heat needed by the deuterium-tritium reaction. "Deuterium-tritium fusion is the reaction of choice simply because it's easier to achieve," explains Gennady Shvets, a physicist at the University of Texas at Austin.

Now a team of Russian scientists have topped the billion-degree mark in a system that does not need huge magnets to confine the reaction. "We have achieved a neutronless proton-boron reaction for the first time using a laser," says Vadim Belyaev, a physicist from the Central Research Institute of Machine Building, Koralev, Russia.

The team blasted polythene pellets containing boron atoms with laser pulses that last for just over a trillionth of a second (10^{-12} seconds). This creates an intensely hot plasma where protons from the polythene merge into boron atoms, which then fall apart to release a stream of helium nuclei, also known as alpha particles.

Lumbering alpha particles tend to stay within the reaction mixture rather than escaping to make surrounding equipment radioactive. Crucially, the team detected no neutrons coming from the reaction at all.

Cleaner energy

The success opens the door to "an ecologically pure technology of nuclear energy production", says Belyaev, whose team reports its research in the journal *Physical Review E*[2].

An added advantage to the system is that the charged alpha particles could be directly tapped as a source of electric current. A power plant based on ITER would simply use the heat from fusion to turn electrical turbines, much as coal-fired power stations do today.

And laser-driven fusion might be easier to sustain than the reaction inside magnetic bottles used by projects such as ITER. In theory, once the reaction is going, all one would have to do is keep dropping fuel pellets into the beam. In contrast, ITER will use giant magnets to keep a turbulent, burning ball of plasma confined. "Unfortunately [confinement] is the least understood process in fusion," says Schvets.

Other labs, including the National Ignition Facility at Lawrence Livermore National Laboratory in California, similarly use lasers to investigate fusion, but of the dirtier deuterium-tritium type. Belyaev now hopes to see a wider international project to investigate the proton-boron reaction.

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References

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