Media Releases Nuclear Power without Radioactivity by Lasers

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Nuclear power without radioactivity

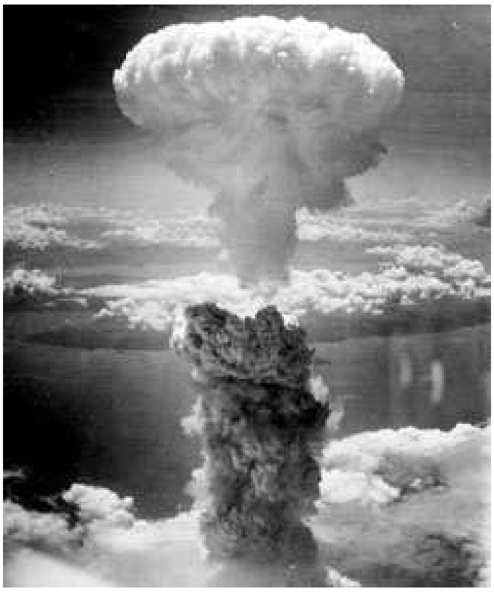
24 March 2010

Radiation-free nuclear fusion could be possible in the future claim a team of international scientists. This could lead to development of clean and sustainable electricity production.

Despite the myriad of solutions to the energy crisis being developed, nuclear fusion remains the ultimate goal as it has the potential to provide vast quantities of sustainable and clean electricity. But nuclear energy currently comes with a serious environmental and health hazard side effect - radiation. For fusion to gain widespread acceptance, it must be able to produce radiation-free energy but the key to this has so far remained elusive, explains Heinrich Hora at the University of New South Wales in Sydney, Australia.

Conventionally, the fusion process occurs with deuterium and tritium as fuel. The fuel is spherically compressed - meaning compression occurs from all directions - with laser irradiation to 1000 times its solid state density. This ignites the fuel, producing helium atoms, energy and neutrons which cause radiation. Fusion is also possible with hydrogen and boron-11, and this could produce cleaner energy as it does not release neutrons, explains Hora. But this fuel requires much greater amounts of energy to initiate and so has remained unpopular.

Now, a team led by Hora has carried out computational studies to demonstrate that new laser technology capable of producing short but high energy pulses could be used to ignite hydrogen/boron-11 fuel using side-on ignition. The high energy laser pulses can be used to create a plasma block that generates a high density ion beam, which ignites the fuel without it needing to be compressed, explains Hora. Without compression, much lower energy demands than previously thought are needed. 'It was a surprise when we used hydrogen-boron instead of deuterium-tritium. It was not 100 000 times more difficult, it was only ten times,' says Hora.



The power of nuclear fusion has yet to be tamed

'This has the potential to be the best route to fusion energy,' says Steve Haan, an expert in nuclear fusion at Lawrence Livermore National Laboratory in California. However, he also points out that it is still only potential at this point, 'there's a fair amount of work to do before this technology is at hand.'

Hora agrees that much more work is needed to fully understand this radical new approach. Its achievement will depend on continued advances in laser optics, target physics and power conversion technology, he concludes.

Yuandi Li
Editor, Royal Society of Chemistry, London.
Energy Environ. Sci. 2010, 3, 479-486

UNSW Faculty of Science DRAFT Media Release

New hope for ultimate clean energy: fusion power.

Imagine if you could generate electricity using nuclear power that emitted no radioactivity: it would be the answer to the world's dream of finding a clean, sustainable energy source.

That is the great hope raised by researchers who believe they have found a radical new path to the ultimate goal of solving the world's energy crisis through nuclear fusion power, as detailed in a paper published in the journal *Energy and Environmental Science*.

The international team of researchers - led by Emeritus Professor Heinrich Hora, of the UNSW Department of Theoretical Physics –has shown through computational studies that a special fuel ignited by brief but powerful pulses of energy from new high-energy lasers may be the key to a success that has long eluded physicists.

The intense laser beam would be used to ignite a fuel made of light hydrogen and boron-11. The resulting ignition would be largely free of radioactive emissions and would release more than enough energy to generate electricity.

The amount of radiation released would be even less than that emitted by current power stations that burn coal, which contains trace amounts of uranium. In another plus, the fuel source is plentiful and readily accessible and the waste product of ignition would be clean helium gas.

"This has the potential to be the best route to fusion energy," says Steve Haan, an expert in nuclear fusion at Lawrence Livermore National Laboratory in California, in a news report in the Royal Chemical Society's *Highlights in Chemical Technology*.

Both Haan and Hora caution that the study only demonstrates the potential of the new process and that much work would need to be done to demonstrate it in practice.

The conventional fusion process uses highly compressed spheres of deuterium and tritium as fuel. Hora says the proposed new process overcomes previous objections to hydrogen-boron11 fuel because it would not have to be compressed and therefore need much less energy than previously thought to start the ignition.

"It was a surprise when we used hydrogen-boron instead of deuterium-tritium," says Hora. "It was not 100,000 times more difficult to ignite, as it would be under the usual compression process. It would be only 10 times more difficult, using the latest generation of lasers."

As it happens, a unique new laser capable of producing the required amount of ignition energy is in its early stages of testing in the US at the Los Alamos National Laboratory.

Another extraordinarily powerful US laser known as the National Ignition Facility has been built at Lawrence Livermore National Laboratory: "It is the largest laser on earth and has cost about US$ 4 billion," he says. "The laser pulse of about few billionths of a second duration produces 500 times more power than all US power stations."

Professor Hora, who founded the UNSW Department of Theoretical Physics in 1975 and has been an Emeritus Professor since 1992, is known for his work on the theory of fusion energy with lasers.

The new paper is here: Enery and Environmental Science, **3** (2010) 479-486. It builds on previous publications in the journal *Optics Communications*, Vol. 282 (2009) p4124, and in *Laser and Particle Beams* Vol. 27 (2009) p495.

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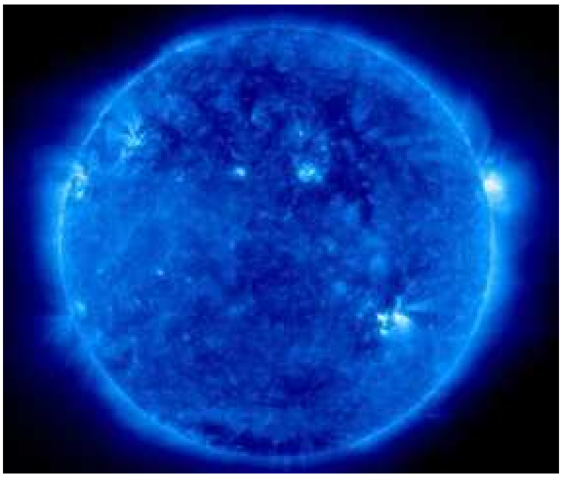
Lasers could spark clean nuclear power

Tuesday, 6 April 2010 Stuart Gary
ABC



Researchers hope to one day recreate the nuclear process that drives the Sun, using lasers instead of heat and pressure to fuse atoms together *(Source: SOHO/ESA/NASA)*

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An international team of scientists are looking at a new way of creating energy from nuclear fusion.

The process could result in no radioactivity, produce little pollution and provide a cheap abundant source of electricity.

The Australian-led team of scientists have used computer models to simulate nuclear fusion without the extreme temperatures currently needed for other fusion methods. Their findings appear in the journal *Energy and Environmental Science*.

Emeritus Professor Heinrich Hora of the Department of Theoretical Physics at the University of New South Wales, who is leading the research effort, says the process would rely on a new generation of extremely powerful and very fast lasers now being developed.

Short, sharp laser

"The key is a very carefully controlled extremely short laser pulse essential for ignition. The pulse would ignite a fuel made of ordinary hydrogen and boron-11," says Hora.

"The idea of a hydrogen and boron fusion reaction is interesting because it wouldn't cause neutron production. Neutrons are a problem because they generate radioactivity."

Hora says his team were originally developing computer models using next generation lasers to duplicate the work being done at the new US$4 billion (A$4.34 billion) National Ignition Facility at Lawrence Livermore National Laboratory in the United States.

The US scientists are developing what is currently the world's largest laser to ignite highly compressed spheres of deuterium-tritium fuel in a nuclear fusion reaction.

The laser can produce a pulse of a few billionths of a second duration, which produces 500 times more power than all US power stations combined.

Hora's team originally rejected the idea of a hydrogen-boron fuel for their simulations "because the higher temperatures and compression needed, made it a hundred thousand times more difficult than the Lawrence Livermore approach, making it just about impossible".

"But when we ran computer simulations using these next generation petawatt (quadrillion watt) strength lasers with a hydrogen-boron fuel, we were shocked to find that it's only ten times more difficult than deuterium-tritium," he says.

"It makes this all within the reach of current technology in a relatively short time. In fact these types of lasers are already in early testing at Los Alamos National Laboratory."

Hora says the key is to ensure the laser pulse is "extremely clean", lasting no more than a millionth of a millionth of a second.

"This allows conversion of optical energy to mechanical energy without heating," he says.

Better fuel source

Hora says the hydrogen-boron fuel has a numberof advantages over deuterium-tritium.

"It would be largely free of radioactive emissions producing less radiation than that emitted by current power stations that burn coal, which contains trace amounts of uranium," he says.

According to Hora, hydrogen and boron are plentiful and readily accessible, and the waste product of ignition would be clean helium gas.

"The hydrogen-boron fuel would not have to be compressed. This means it needs far less energy to start the ignition."

But Hora warns the study only demonstrates the potential of the new process and much work needs to be done to demonstrate it in practice.

Laser 'punch' could bump up fusion power

- 18:09 01 April 2010 by **Colin Barras**

How do you create efficient fusion power with fewer radioactive by-products? Use a laser to send the equivalent of a seismic wave through the fuel.

Nuclear fusion – creating energy by fusing together light atomic nuclei, such as hydrogen – could begin at the National Ignition Facility (NIF) in California this year.

To kick-start the reaction, the plan is to focus 192 high-power laser beams onto a tiny hollow metal cylinder that contains a small spherical fuel pellet of deuterium and tritium. The lasers would heat the cylinder to several million degrees, encouraging it to emit high-power X-rays into the pellet.

The X-rays would compress the fuel to 1/1000th of its original volume, raising its temperature and kick-starting a fusion reaction that spews out helium-4 and neutrons. The hope is that the reaction would release more energy than was injected into the system.

Yet some of the neutrons from this reaction will produce radioactive isotopes by interacting with the walls of the reactor. "NIF also has to handle radioactive tritium, and this must not leak from the reactor," says Heinrich Hora at the University of New South Wales in Sydney, Australia.

Laser punch

Now Hora and his colleagues propose using the mechanical punch of a laser to trigger fusion instead. They suggest using a "flat-faced" laser pulse; ordinary pulses are pointed. The pulse would strike the surface of the fuel rather than penetrating it, as normally happens.

As the pulse hits the fuel, a layer of plasma would be created from ionised gas. This would generate a thermonuclear shock wave that ripples through the fuel, promoting compression.

The process relies directly on the mechanical force of the laser to trigger fusion, rather than converting the laser's energy first into heat and then X-rays, which means electricity generation is more efficient, says Hora.

What's more, fewer radioactive isotopes would form. This is because the method may eventually allow us to use a different fuel – hydrogen and boron-11 – that has fewer by-products. Compressing this fuel with the array of lasers at NIF would be very difficult;; it would require laser pulses 100 times more powerful, says Hora.

Powerful laser

The team's initial calculations suggest that a 60-petawatt laser would be enough for their method. It will be a while before this fuel can be used, though; the most powerful laser today is 10 petawatts, which is more powerful than those used at NIF.

Steve Haan at Lawrence Livermore National Laboratory in California, where the NIF is sited, thinks the idea has potential. The process would allow "more options for capturing [fusion] energy and turning it into electricity", he says, but adds that further experiments are needed to test the practicality of the theory.

Journal reference: *Energy & Environmental Science*

Short note in NEW SCEINTIST 10 April 2010, p.14

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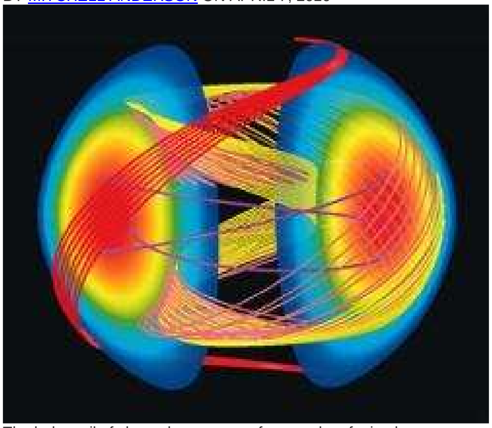
CLEAN FUSION BREAKTHROUGH?

BY MITCHELL ANDERSON ON APRIL 7, 2010



The holy grail of clean cheap energy from nuclear fusion has seen many false starts.

The cold fusion fiasco of twenty years ago sent scientists and potential investors fleeing towards the door. Even the "conventional" approaches to fusion energy will require enormous amounts of energy, and if they work, still produce large amounts of dangerous radiation.

But a recent paper in the journal, "Energy and Environmental Science" indicates that radiation-free fusion energy might be closer than we thought. The secret? A little bit of boron, and a very large laser.

Emeritus Prof. Heinrich Hora of the Department of Theoretical Physics at the University of New South Wales hopes to utilize the new generation of enormously powerful lasers now under development at the Lawrence Livermore National Laboratory. These can generate an extremely short pulse of light that equals 1,000 times the generating capacity of the Unites States.

These massive lasers are being investigated as a way to ignite a hydrogen target to kick off the fusion reaction in a technique called "inertial confinement fusions" (ICF).

First proposed back in the 1960's, ICF has been considered a long-shot in comparison to other strategies that employ massive magnets to achieve fusion, such as the €10 billion ITER project in France that is planned to be switched on by 2018.

The problem with all these methods (besides the astronomical cost) is that "clean" fusion isn't all that clean. Re-creating conditions at the centre of our sun is not only a daunting task – it would result in a chain reaction producing dangerous neutron radiation.

That's where the work Dr. Hora comes in. He investigated whether the massive lasers now under development in the US could instead ignite a hydrogen target that also included boron, which would virtually eliminate all radiation from the reaction.

To his surprise, his computer models showed that this process was not nearly as hard as everyone thought it was.

According to the CBC:

Hora's team originally rejected the idea of a hydrogen-boron fuel for their simulations "because the higher temperatures and compression needed made it a hundred thousand times more difficult than the Lawrence Livermore approach, making it just about impossible."

"But when we ran computer simulations using these next generation petawatt (quadrillion watt) strength lasers with a hydrogen-boron fuel, we were shocked to find that it's only 10 times more difficult than deuterium-tritium," he said.

"It makes this all within the reach of current technology in a relatively short time. In fact these types of lasers are already in early testing at Los Alamos National Laboratory," he said.

This technique might open the door for clean cheap and unlimited power that would actually have less radiation emissions than many plants that burn coal, “which contains trace amounts of uranium," said Hora.

It would also reduce the effort needed to prepare the fuel source. "The hydrogen-boron fuel would not have to be compressed. This means it needs far less energy to start the ignition," he said.

According to Hora’s recent paper,

This provides an exciting vision of a very attractive sustainable future power plant for worldwide use. Its achievement will depend on continued advances in laser optics, target physics and power conversion technology. However, the studies reported here show that such a system is rather close at hand—something not realized before, since [boron] ignition had always been viewed as virtually impossible.

How close are we now to realizing controlled fusion? Researchers at Lawrence Livermore hope to power up their laser-powered plasma reactor as early as this summer. The research by Hora and his team may open the door for this technique to lead to commercially available clean fusion faster than anyone thought.

Don’t sell your solar stocks any time soon but this promising new development could be a game-changer a decade or two down the road.

TAGS: Yes, CBC, Lawrence Livermore National Laboratory, Los Alamos National Laboratory, France, cold fusion, emerging energy source, Energy and Environmental Science, France, Fusion, Heinrich Hora, ITER project, Lawrence Livermore National Laboratory, University of New South Wales, “inertial confinement fusions, energy, Finance, Heinrich Hora, laser, lasers, New South Wales, Radiation, University of New South Wales

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From Phys.org/news

New hope for ultimate clean energy: fusion power

April 12, 2010 By Bob Beale

(PhysOrg.com) -- Imagine if you could generate electricity using nuclear power that emitted no radioactivity: it would be the answer to the world's dream of finding a clean, sustainable energy source.

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The international team of researchers - led by Emeritus Professor Heinrich Hora, of the University of New South Wales Department of Theoretical Physics -has shown through computational studies that a special fuel ignited by brief but powerful pulses of energy from new high-energy lasers may be the key to a success that has long eluded physicists.
The intense laser beam would be used to ignite a fuel made of light hydrogen and boron-11. The resulting ignition would be largely free of radioactive emissions and would release more than enough energy to generate electricity.
The amount of radiation released would be even less than that emitted by current power stations that burn coal, which contains trace amounts of uranium. In another plus, the fuel source is plentiful and readily accessible and the waste product of ignition would be clean helium gas.
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Professor Hora, who founded the UNSW Department of Theoretical Physics in 1975 and has been an Emeritus Professor since 1992, is known for his work on the theory of fusion energy with lasers.

More information: The new paper is here: http://www.rsc.org/Publishing/Journals/EE/article.asp?doi=b904609g (reference Energy and Environmental Science, Vol. 3, (2010) 479-486).

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Provided by University of New South Wales (news : web)