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News: Briefing

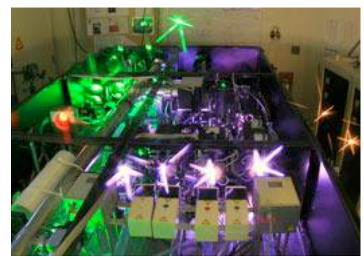
The most intense laser in the Universe

A record-breaking beam has been developed at the University of Michigan. *Nature News* finds out how powerful it is, and what it will be used for.

Katharine Sanderson (/news/author/Katharine+Sanderson/index.html)

Is this really the most intense laser in the Universe?

Yes, that's what scientists working on the HERCULES laser at the University of Michigan in Ann Arbor claim. "It is the highest-intensity laser that has been shown," says Karl Krushelnick, a member of the team running the experiment.



HERCULES: intense, but not so powerful.

Anatoly Maksimchuk/EECS

The intensity of a laser beam is the amount of energy it delivers per unit time per unit area. This record-breaking beam actually has very low energy — at just 20 joules, it is less than the 8,000 joules stored in a tic tac — but the energy is squeezed into a tiny spot (1.3 micrometres in diameter, about a hundred time thinner than a human hair) for a very short time, just 30 femtoseconds (10^{-15} seconds). So the beam has an intensity of 2×10^{22} watts per square centimetre: two orders of magnitude more intense than achieved before.

It can also pulse once every ten seconds. Other, more-powerful lasers can pulse, at best, once a minute, and aren't focused on such a small spot.

How did they achieve that?

They used a technique called chirped-pulse amplification. The laser beam is stretched out with an optical amplifier to make it last much longer than usual, then it is squeezed back into a shorter pulse. This boosted the HERCULES titanium–sapphire laser from a power of 50 terawatts to 300 terawatts, which was then focused on a tiny spot to give the record-busting beam.

Is this the most powerful beam ever?

No – petawatt (10^{15}) lasers exist. For example the Astra Gemini laser at Rutherford Appleton Laboratory in Harwell, UK, which opened in November 2007, has a 0.5 petawatt laser.

What will they do with this super-intense beam?

Such intense laser light is uncharted territory. The electrons in any material hit by the beam are accelerated to the point that they are almost travelling at the speed of light, transporting those electrons out of the classical world and into relativistic, quantum, territory. Theoretically it could be possible to make the electrons travel so quickly that their mass increases.

But for now, applications for the HERCULES high-intensity beam are likely to be in improving and adding to current laser technologies. For example, such an intense beam might make it possible to have a tool as powerful as the Diamond light source at Rutherford Appleton lab, but taking up a small lab space rather than five football pitches.

There's also a chance that the high-intensity beam could be investigated for its fusion power. At the moment, it is possible to trigger nuclear fusion with a high-energy laser. Krushelnick says that the upgraded HERCULES beam could be used to help understand the physics behind the process.

What if I get caught in the beam?

"You'd get a bad burn," says Krushelnick. But it wouldn't be horrific, he adds — remember that the pulse doesn't contain a huge amount of energy and lasts for only 30 femtoseconds. And you'll have ten seconds to move the 1.3 micrometres needed to get out of the way before the next pulse comes along.

References

1. Yanovsky, V. *et al. Opt. Express*, **16,** 2109 - 2114 (2008). | **Article** (http://dx.doi.org/10.1364/OE.16.002109) |

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KS writes " And youâ€™ll have ten seconds to move the 1.3 micrometres needed to get out of the way before the next pulse comes along." I'm not a physicist, and obviously this point is tongue-in-cheek, but if you move 1.3 microns you don't "get out of the way" you just move the burn to a new spot on your body.

Posted by: **David Beller** | 19 Feb, 2008

Unless of course you got hit 1.3 microns in...

Posted by: **Don Shaffer** | 19 Feb, 2008

There is a statement in this article which uses a form which is all too common in scientific writing (and many other types of writing) today. It is a misused verbal expression of a mathematical operation. The statement is: "about a hundred times thinner". It should be realized that it is impossible for anything to be to be more than one times thinner; one times thinner results in a size of zero. It should be obvious that it should have been worded ...times as thin. The literature is full of examples using similar expressions. I have found that, when the original numbers being compared are stated, it most often should say as large, as many, as great, etc. This misuse of language results in an uncertainty in what exact numbers it is supposed to represent. If one considers the mathematics being described, n times as great = (n-1) times greater. Note that using ntimes greater merely results in an uncertainty, while ntimes smaller results in an impossibility. I believe that much of the reason for the use of the greater/lesser form is the editorial preference for variety in forms of expression. The effect on precise meaning suffers when, as in this case, the real meaning is not considered. J H Crary

Posted by: **James Crary** | 19 Feb, 2008

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