Kitchen cosmology

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A laser, a wire, and hey presto-the heart of a galaxy

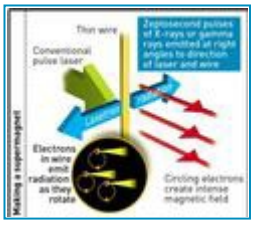
AT LAST, astrophysicists will be able to do something most scientists take for granted-experiments. They may be able to generate magnetic fields as intense as those in the hearts of galaxies, using only a laser and a thin wire.

Astrophysics deals with the behaviour of weird objects such as white dwarfs, collapsing stars and quasars, which have magnetic fields billions of times stronger than Earth's. But astrophysicists can't test their theories about the way matter in these fields behaves because the most powerful artificial magnetic fields are at least a thousand times weaker.

That could now change, because Alexander Kaplan at Johns Hopkins University in Baltimore and Peter Shkolnikov at the State University of New York at Stony Brook claim existing lasers could create huge magnetic fields, as well as ultrafast radiation pulses, simply by propelling electrons round in a circle.

Pulse lasers emit circularly polarised light, meaning that the electromagnetic field of the light rotates. Any electron within the field is pushed round in a circle as well, causing it to send a narrow beam of X-rays or gamma rays out in front of it like a revolving lighthouse beam.

Kaplan and Shkolnikov say that if the laser were fired at a thin wire, the electrons in the wire would rotate in synchrony, making the wire radiate like an antenna (see Graphic). Interference would destroy the radiation in all directions but two, leaving two pulsing beams at right angles to the direction of the laser and the wire.



Making a supermagnet

The researchers call their antenna a "lasetron". The radiation pulses it gives out would be millions of times briefer than those of the laser powering it. Top-of-the-range lasers that pulse every picosecond-10^{-12} of a second-could produce radiation bursts just zeptoseconds long-10^{-21} of a second. That's swift enough to image even fast-moving atomic nuclei.

But the most obvious application of the lasetron is to use the huge magnetic field produced by so many electrons circling in synchrony. Shkolnikov says that with today's lasers, the technique could generate a field of 1 million teslas-at least as strong

as that around a white dwarf star. If you powered the lasetron with laser radiation of centimetre wavelengths, the magnetic field formed around the wire would be stable for several centimetres around the wire-enough to do experiments within it.

The lasetron would allow astrophysicists to test their ideas about what happens to matter in such powerful magnetic fields. Atoms should become elongated as the field stretches their orbiting electrons, but no one yet knows how this would affect molecular reactions. "This is a way to do astrophysics on a tabletop," says Shkolnikov.

Further reading:

- ***More at:*** *Physical Review Letters* (vol 88, p 748011)

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