MIT Technology Review

COMPUTING NEWS

Cheap, Portable MRI

A new device uses inexpensive, low-power magnets and lasers to create images for materials and biomedical applications.

By Courtney Humphries on September 14, 2006

Researchers have come up with a new technique for magnetic resonance imaging (MRI) that's much cheaper and more portable than current technology. Although it's not feasible for many traditional medical applications, the device could be useful, they say, in the fields of biotechnology, geology, and industry, where high-power magnets are too expensive or samples contain magnetic properties that interfere with high magnetic fields.

MRI scanners create images of the inner structures of living tissues, the flow of fluids through pipes, or the structure of objects such as rocks and fossils. The main drawback of MRI is that it requires powerful magnetic fields generated by superconductive magnets to produce detectable signals, which makes it an expensive and unwieldy technology.

A new and radically different MRI device, developed in the labs of Alexander Pines and Dmitry Budker at the University of California, Berkeley, could solve those problems. It relies on low-power magnets and costs only a few thousand dollars. The team eventually hopes to minimize the current setup and thereby create a handheld, battery-powered device that can be used anywhere.

“Both this group and other people are looking around and saying, let's forget about the typical way we do magnetic resonance,” says Andrew Webb, an MRI specialist at Penn State University. This approach offers “a completely different way of detecting this MRI signal,” he says.

In traditional MRI scanners, a strong, uniform magnetic field forces some of the hydrogen atoms inside a patient or sample to “spin” in the same direction. A radio-frequency pulse then makes the aligned hydrogen atoms shift direction and enter a high-energy state. When the pulse ends, these atoms gradually realign while giving off energy. A magnetic coil in the MRI machine can detect this energy, which is used to create the image.

The new device, called an optical atomic magnetometer, is designed to image fluids like gasses and water. The sample material is first polarized with a magnet. Then it's exposed to a varying magnetic field, in which each atom in the sample receives a different level of magnetism, giving it a different spin.

The sample then moves into a detection chamber. Unlike traditional MRI, though, where the structural information is detected using a magnetic coil, Budker's lab developed a way to detect the MRI signal using light. A glass cell near the chamber is filled with rubidium atoms, which are highly sensitive to changes in magnetic fields and can detect magnetic signals from the sample. When a laser light probes the rubidium atoms, they change the polarization of the laser light according to the strength of magnetic fields they sense. The signals can then be reconstructed into an image. (A description of the device and preliminary results were published last month in the *Proceedings of the National Academy of Sciences.*)

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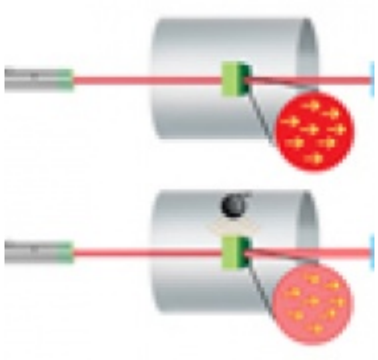

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“The most interesting aspect of the study is it combines two technologies that are both young and could be improved further,” says Michael Romalis, a physicist at Princeton University who’s developing similar MRI techniques. With these two technologies, ”you can make a pretty simple and inexpensive system,” he says.

Although it provides a creative solution to some imaging problems, the method is probably not suitable for widespread medical use at the moment. Because it relies on accessing the fluids that are imaged, the most feasible medical application would be imaging the lungs using a polarized gas, says Shoujun Xu, a member of Pines’ lab.

Instead, geologists could use it in the lab to study fluid-filled porous rock samples, which often contain magnetic impurities that interfere with high-power magnets. And with further improvements it might someday be used by the petroleum industry to study porous materials like oil fields and reservoir rocks, which also have magnetic impurities.

The researchers also anticipate applying the technique in microfluidics, which uses small-scale “lab-on-a-chip” technologies to study biological processes, screen for new drugs, and test toxicity levels in water. Currently, chips must be specially manufactured for use in high-powered magnetic fields in order to monitor fluids and chemical reactions with MRI.

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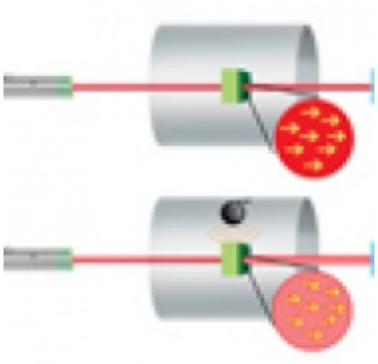

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