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Prototype MR unit offers fine spatial, temporal resolution -- sans magnet

By Shalmali Pal, AuntMinnie.com staff writer

August 28, 2006 -- Inexpensive, compact, and mobile are three words that are rarely associated with MRI. But researchers in California have designed an experimental MR system that uses optical atomic magnetometry instead of a superconducting magnet and cryogenics. In a clinical setting, this could one day lead to a portable MR unit as well as the ability to image in the presence of metal implants, they said.

Optical atomic magnetometry "is based on magneto-optical rotation in a 'sensor' vapor (making) it a viable alternative for detecting weak magnetic fields, eliminating the need for cryogenics and complicated electronics," wrote Alexander Pines, Ph.D., and colleagues in the *Proceedings of the National Academy of Sciences* (August 2, 2006).

Pines is a professor of chemistry at the University of California, Berkeley, and a senior scientist in the materials sciences division at the Lawrence Berkeley National Lab.

In their study, the authors "demonstrate the application of optical atomic magnetometry to low-field MRI, with time-resolved images of water flow obtained by using remote detection," they explained. For this research, MR imaging was done in the plane of flow direction and with phase encoding.

The resulting 2D images demonstrated the flow behavior, temporally and spatially resolved, of the encoded water. The experiment achieved a temporal resolution of 0.1 seconds and a spatial resolution of 1.6 mm across the flow, as well as 4.7 mm along the flow direction.

Pines' group noted several advantages of the technique over conventional MRI. First, it can directly measure the magnetic field as opposed to standard measurements in the transverse plane. Also, signals can be continuously monitored because no radiofrequency pulses are applied to the encoded sample.

"Low-field detection also opens up avenues of investigations of samples that contain high magnetic-susceptibility gradients, such as the study of porous material with paramagnetic impurities and medical imaging in the presence of metal implants," the researchers wrote. Also, it may prove easier to image samples that are too large to be introduced into the bore of a standard MR magnet. Of course, low-field magnets are available commercially, but they suffer from low sensitivity at fields much than 1 tesla, they noted.

For the near future, this scanner will be suitable for remote microfluid MRI, the group stated. This apparatus, which was built by the authors, can be designed to use a miniature, "vertical-cavity-surface-emitting laser" with consolidated optics and electronics for multiple channel detection. This will make the unit very compact and possibly even run on batteries.

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