Rotating light provides indirect look into the nucleus

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Nuclear magnetic resonance (NMR) is one of the best tools for gaining insight into the structure and dynamics of molecules because nuclei in atoms within molecules will behave differently in a variety of chemical environments. Nuclei can be thought of as tiny compasses that align when placed in the field of a strong magnet. Similar to magnetic resonance imaging (MRI), conventional NMR uses short pulses of radio waves to drive nuclei away from equilibrium and a 'signal' emerges as nuclei slowly realign with the field.

Results reported in The *Journal of Chemical Physics* introduce an alternative path to this information, by using light to observe nuclei indirectly via the orbiting electrons.

"We are not looking at a way to replace the conventional technique but there are a number of applications in which optical detection could provide complementary information," says author Carlos Meriles of the City University of New York.

The new technique is based on Optical Faraday Rotation (OFR), a phenomenon in which the plane of linearly polarized light rotates upon crossing a material immersed in a magnetic field. When nuclei are sufficiently polarized, the extra magnetic field they produce is 'felt' by the electrons in the sample thus leading to Faraday rotation of their own. Because the interaction between electrons and nuclei depends on the local molecular structure, OFR-detected NMR spectroscopy provides complementary information to conventional detection.

Another interesting facet of the technique is that, unlike conventional NMR, the signal response is proportional to the sample length, but not its volume. "Although we have not yet demonstrated it, our calculations show that we could magnify the signal by creating a very long optical path in a short, thin tube," Meriles says. This signal magnification would use mirrors at both ends of a channel in a microfluidics device to reflect laser light repeatedly through the sample, increasing the signal amplitude with each pass.

More information: The article, "Time-resolved, optically-detected NMR of fluids at high magnetic field" by Daniela Pagliero, Wei Dong, Dimitris Sakellariou, and Carlos A. Meriles appears in *The Journal of Chemical Physics*. See: link.aip.org/link/jcpsa6/v133/i15/p154505/s1

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