Spinning Gas Rotates Polarization of Light

Experiments confirm that a light beam's polarization rotates when it travels through a gas of spinning molecules, a phenomenon previously observed only in rotating solids.

By Sophia Chen

In 1923, Enrico Fermi made a prediction about the propagation of light in a rotating medium. He conjectured that when linearly polarized light traveled through a rotating dielectric material, the angle of the light's polarization would rotate, a phenomenon he named polarization drag. Previously, researchers had observed polarization drag in light traveling through a rotating solid. Now, Valery Milner of the University of British Columbia in Canada and colleagues have experimentally observed this phenomenon with a gas [**1**]. Polarization drag is predicted to occur in astrophysical systems such as pulsars, affecting the polarization of their emitted light.

In their experiments, the team used gases made up of either nitrogen, oxygen, carbon dioxide, or air. To make the molecules in the gas spin, they applied to the gas a laser field known as an optical centrifuge, whose linear polarization rotates at an accelerating rate. When each molecule interacted with the centrifuge, it was excited to an extremely high rotational state, such that it spun at a few THz. Next, the team beamed a picosecond pulsed laser at the spinning-molecule gas. They then turned off the centrifuge beam and monitored the polarization of the pulsed laser.

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Their measurements show that, over a distance of about 1 mm, the polarization angle of the laser rotated by about 0.2 milliradians for molecules spinning at 6 THz. The team showed that they could adjust this angle by changing the frequency of the centrifuge. The observations agree with theoretical predictions. The polarization rotation only occured within a few nanoseconds of turning off the centrifuge, as the effect decays quickly because of molecule collisions.

Correction (8/12/2021): The teaser has been updated to correct an inaccuracy about Fermi's original prediction, which was formulated for solids, and not, as the initial version implied, for gases.

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REFERENCES

1. A. A. Milner *et al.*, "Observation of mechanical Faraday effect in gaseous media," Phys. Rev. Lett. 127, 073901 (2021).