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Emulating magnetic skyrmions with light

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Magnetic skyrmions are topologically stable spin systems that cannot be smoothly deformed into any other spin configuration that differs topologically or possesses a different integer topological invariant, the Skyrme number. Their robustness has generated interest in using them as a resource for low power, information storage and computing. Recently topologically equivalent configurations have been generated in optical systems using structured light techniques. Here, we introduce an optical analogy to magnetic skyrmion dynamics subject to a magnetic field. Our optical skyrmions are engineered using superpositions of Bessel-Gaussian beams, with propagation dynamics mimicking the temporal evolution of their magnetic counterparts. We show that whilst the topology remains invariant, the texture of the optical configuration changes during propagation, exhibiting controllable periodic precession over a well-defined range, analogous to time varying spin precession in homogeneous magnetic fields. Furthermore, we discuss a general technique to control the on-axis optical spin to emulate any given magnetic spin subject to an arbitrary magnetic field. We believe this work offers new tools to study magnetic skyrmion dynamics subject to applied magnetic fields.

Apply to be considered for a student ; award (Yes / No)?

Yes

Level for award;(Hons, MSc, PhD, N/A)?

MSc

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