PCPDTBT as a hole transport material[17], which may have improved the collected photocurrent of the device.

As research into promising candidate Goldilocks compounds continues, the latest performance improvements in a non-cubic material are promising. Future research will be needed to understand and generalize the role of crystallography in carrier transport across a broad class of materials, including $Sb_2Se_3$, $Sb_2S_3$ and SnS. The next obvious research challenge is to demonstrate solar cell efficiency enhancements greater than 10% for these materials, to engage a broader academic community, and ultimately attract commercial interest. We note that First Solar's current commercial CdTe modules have an average production efficiency of 14.5% in the first quarter of 2015, with a roadmap to reach 17% by 2017. An outstanding question is whether the community can accelerate the rate of learning in novel inorganic PV materials, to reach commercially relevant device efficiencies within a timeframe commensurate with trends in PV funding and deployment, while CdTe and crystalline silicon continue to improve. ❐

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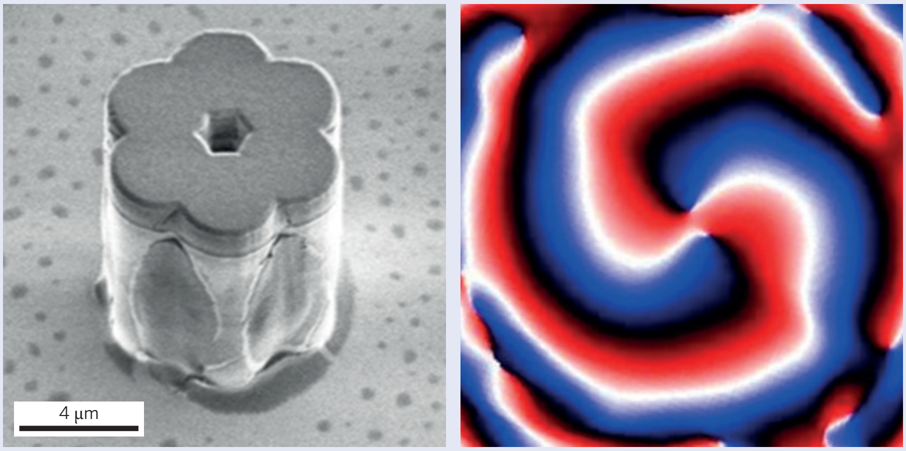
SPIN–ORBIT COUPLING

# A polaritonic molecule

It is well known that spin–orbit (SO) coupling — an interplay between the orbital motion and spin of a particle, commonly an electron — induces a number of exciting phenomena like the spin Hall effect, the persistent spin helix, or topological insulation in the absence of any external magnetic field. The analogue of SO coupling for light is also a topic of much current research. V. G. Sala and co-workers from France and Italy propose the design of a photonic molecule — consisting of a number of coupled semiconductor micropillar cavities arranged in a hexagonal-shaped ring (pictured) — that supports SO coupling for polaritons and provides a platform for exploring fundamental physics. In particular, the team has shown that it is possible to induce condensation of polaritons into states with complex spin textures (*Phys. Rev. X* **5**, 011034; 2015).

The photonic molecule is composed of six GaAlAs-based micropillar cavities. Each micropillar, with a diameter of 3 µm, contains three sets of four GaAs quantum wells and Bragg mirrors on the top and the bottom, resulting in photon–exciton strong coupling with a Rabi splitting of 15 meV. The centre-to-centre distance between the micropillars is 2.4 µm. The arrangement gives rise to a tunnelling-coupling of polaritons, through their photonic component, between neighbouring micropillars.



APS

The team pumped the hexagonal photonic molecule with Ti:Sapphire laser light and measured the resulting photoluminescence at a temperature of 10 K. At a low excitation power of 7 mW, interferometric measurements indicate that the phase structures of the polariton eigenmodes reflect the structural symmetry of the hexagonal ring of pillars. However, at a higher pump intensity of 84 mW, polariton condensation takes place and an underlying helical orbital structure consisting of a linear superposition of two states with opposite orbital vorticity and opposite spins (polarizations) was observed.

A two-dimensional finite-element mode calculation using Maxwell's equations for the hexagonal photonic molecule confirmed that the observation of eigenstates with the radial or azimuthal polarization patterns was clear evidence for the presence of the SO coupling. The SO coupling demonstrated here for polaritons originated in the polarization dependence of the photonic confinement and photon tunnelling amplitude, which could both be engineered with a suitable design of the structure.

"Our system provides a photonic workbench for the quantum simulation of the interplay between interactions and spin–orbit effects, particularly when extended to two-dimensional lattices," Sala said.

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