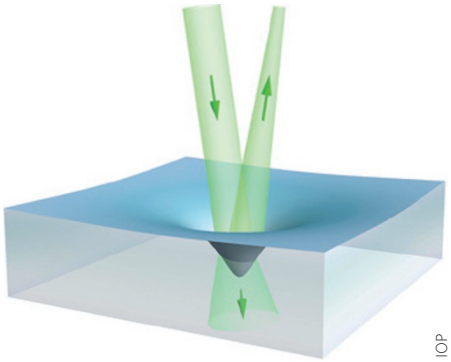
FUNDAMENTAL OPTICS

Momentum debate

New J. Phys. **17,** 053035 (2015)



IOP

One of the oldest remaining debates in fundamental physics concerns the momentum of photons in a medium. In the early part of the twentieth century, two scientists — Minkowski in 1908 and Abraham in 1909 — presented apparently contrary views and there is no definitive answer so far as to which is right, or whether both are correct under appropriate interpretations or conditions. Several experiments support the Minkowski result yet nothing is definitive. Now Li Zhang, Weilong She and co-workers from Sun Yat-Sen University in Guangzhou, China, and the Weizmann Institute of Science, Israel, report experimental results that support Abraham's viewpoint. One of the ways of testing the theories is to illuminate a liquid interface and observe whether the liquid rises (is pulled, forming a convex defocusing surface for reflection) or falls (is pushed, forming a concave focusing surface). In their experiment, the team illuminate either mineral oil or water with a Gaussian green laser beam (wavelength 532 nm) at a 3° angle of incidence. Analysis suggests that a focusing effect in the reflected beam is taking place, consistent with Abraham's idea. For the 1-mm-wide beam, the surface of the water was reported to deform by about 10 nm. *DP*

EXCITONICS

Polariton combs

Phys. Rev. Lett. **114,** 193901 (2015)

Exciton–polaritons in microcavities are a candidate system for the realization of low-threshold coherent light sources and efficient switches. Inhomogeneity of the sample (introduced deliberately or otherwise) can result in more than one exciton–polariton centre. Kristian Rayanov and colleagues from New Zealand, the USA, Mexico and Korea, have theoretically proposed that interaction between just two exciton–polariton centres in the weak lasing regime can exhibit dynamics much more complex than well-known bifurcations. In particular, self-induced oscillations in the two-centre system may result in the emission of a frequency comb spectrum of coherent radiation. The frequency offset and line spacing of the combs are tunable. They suggest that filtering the high-frequency components of the emission might result in a new type of coherent THz emitter. The team also considered the effect of noise on the system, and showed that peaks can be broadened to the point that merging can occur if spacing is insufficient. *DP*

MATERIALS SCIENCE

Geometry and bandgaps

Proc. Natl Acad. Sci. USA **112,** 5888–5892 (2015)

Phosphorene — an allotrope of phosphorus — is a new 2D material. Unlike graphene, phosphorene exhibits either semiconductor or metallic features depending on its structure. Recently it was found that the semiconducting gap was tunable by the number of layers, and by in-plane strain. Mehrshad Mehboudi and co-workers from the USA and Colombia have now further explored the tunability of the semiconducting gap for both phases — black phosphorene (black P) and blue phosphorene (blue P). The scientists theoretically investigated a semiconducting gap of finite-size conical black P and blue P monolayers. The phosphorene cones considered here were made by removing an angular segment from the planar structure and joining the cleaved edges. The gap energies were then calculated by density-function theory. With respect to the fully periodic planar 2D structure, the team found that the gap drastically changed for the conical structure; from 0.8 eV (2.0 eV) to 0.84 eV (1.7 eV) for black P (blue P). According to the authors, this geometrical effect could provide a unique optical vehicle to single out local structural defects on this 2D material. *NH*

FLUORESCENCE IMAGING

Scattering lens power

Optica **2,** 424–429 (2015)

The ability to resolve objects below the diffraction limit of light is appealing for many applications in nanoscience and biological sciences. Using a high-index scattering medium as an imaging lens, Hasan Yilmaz and colleagues from the Netherlands and the UK have realized a fluorescence imaging method with a resolution of 116 nm. Compared with existing superresolution imaging techniques, their method stands out as its resolution does not depend on the numerical aperture of the imaging lens and has a wide field of view (10 μm × 10 μm). The main element is a scattering lens comprising a 400-μm-thick GaP substrate with a refractive index of 3.42, of which one surface has a 2-μm-thick scattering layer and the other is polished. A beam of coherent light with a diameter of 0.8 mm and wavelength of 561 nm is incident onto the scattering surface of the substrate, generating a speckled intensity pattern that illuminates a fluorescent object. The team collected 2D fluorescence images of a collection of 100-nm-diameter dye-doped nanospheres and reconstructed the image using a new Gerchberg–Saxton image reconstruction algorithm that they developed. The team demonstrate that their method is suitable for imaging under ambient conditions because of its robustness, and suggest that the resolution of 116 nm can be further improved. *RW*

MAGNETIC MATERIALS

Optical control

Nature Phys. **11,** 487-491 (2015)

Reconfigurable one- and two-dimensional magnonic crystals — artificial periodic magnetic lattices — have been produced by using patterns of light to induce thermal gradients in magnetic media. Marc Vogel and co-workers from the University of Kaiserslautern and the Fraunhofer Institute for Physical Measurement Techniques in Germany sent spatial intensity patterns of laser light formed by a spatial light modulator into a 5-μm-thick ferromagnetic yttrium–iron–garnet (YIG) waveguide grown on a 500-μm-thick gadolinium–gallium–garnet substrate. To increase the efficiency of the laser-induced heating, a black coating was deposited on top of the YIG. The resulting heat landscape locally changes the saturation magnetization of the YIG and thus alters spin-wave propagation and behaviour. The researchers use the approach to fabricate structured magnonic crystals and suggest that the approach could prove useful for ultrafast spintronic control if femtosecond laser pulses and nanometre-thick magnetic layers are used. *OG*

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