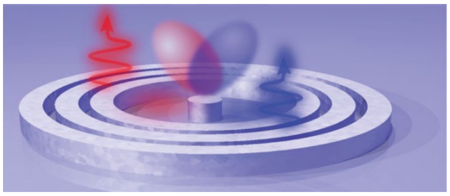
NANOPHOTONICS

Steering second-harmonics

Nano Lett. **18**, 6750–6755 (2018)



Credit: American Chemical Society

The phase control and shaping of the second-harmonic radiation generated from an AlGaAs nanodisk antenna has now been accomplished by a team of researchers from Italy, France and Australia. Lavinia Ghirardini and co-workers used electron-beam lithography to fabricate a pair of gratings located either side of a nonlinear nanoantenna. Phase engineering then made it possible to redirect and control the emission angle of second-harmonic light generated from the optically pumped structure. The precise angle of emission can be engineered by employing gratings with different symmetry, or by varying the polarization of the optical pump beam. The control of the emission direction is important because it means that two orders of magnitude more power can be collected out of the antenna plane and arbitrary emission angles could be useful for certain applications. Another key point is that the AlGaAs structures can exhibit lower losses than metallic nanoantennas, which aid efficiency. Such efficient shaping of the nonlinear beams may have applications to, for example, single-photon sources and nonlinear imaging. *DFPP*

https://doi.org/10.1038/s41566-018-0318-x

OPTICAL MANIPULATION

Virtual potential

Appl. Phys. Lett. **113**, 183702 (2018)

Optical tweezers are a popular tool for manipulating and sorting individual nanoparticles. Now, Avinash Kumar and John Bechhoefer from Simon Fraser University, Canada have shown that when equipped with a suitable feedback scheme tweezers can be used to create a more complicated force field, such as single- or double-well harmonic potentials, for controlling particle dynamics. In the experiments, a polarized 532-nm laser was used for trapping and detection. The polarization of the detection beam was rotated by 90° with a half-wave plate so that a polarized beam splitter could separate the detection beam from backscattered light arising from the trapping laser. Quadrant photodiodes were used to detect the particle's fluctuation and dynamics. Two feedback loops continuously regulated a pair of acousto-optic deflectors to compensate for any fluctuation in the total intensity. The shape of the double-well potential was reconstructed from the Boltzmann distribution of the position measurements. The well separation was 10.6 nm, which is far below the diffraction limit (≈220 nm). The ability to create and control energy landscapes at scales comparable to the size of proteins offers intriguing possibilities for biophysical applications. *NH*

https://doi.org/10.1038/s41566-018-0319-9

IMAGING

Localization errors

Nat. Phys. https://doi.org/cwz4 (2018)

Localization calculations for determining the position of light emitters or scatterers that are not linearly polarized may need to revisited thanks to analysis performed by scientists in Austria and Australia. Gabriel Araneda and co-workers have shown that spin–orbit coupling of light can introduce wavelength-scale systematic discrepancies between the actual position of the emitter and the estimate of traditional centroid calculations relying on the paraxial approximation. For certain polarizations and small numerical apertures the error can become arbitrarily large. The team tested their analysis by imaging a single trapped atom and also 100-nm-diameter gold nanoparticles. In the latter case, the apparent positions of the nanoparticle imaged by right- and left-circularly polarized light are displaced relative to each other by 145 ± 6 nm for a numerical aperture of 0.41 that increases to a value as large as 430 ± 7 nm (four times the size of the nanoparticle) for elliptically polarized light. The findings may affect super-resolution imaging schemes that rely on emitter localization algorithms. *OG*

https://doi.org/10.1038/s41566-018-0323-0

OPTICAL METROLOGY

Axion sensor

Phys. Rev. Lett. **121**, 161301 (2018)

A current challenge in modern physics is to design experiments for ascertaining the existence of the axion — a proposed dark matter particle found in theories beyond the standard model of particle physics. Now, Ippei Obata and co-workers from the University of Tokyo and Kyoto University, Japan, have investigated the use of an optical ring cavity that makes it possible to search for a tiny difference in the phase velocity of left- and right-handed circularly polarized photons that, in principle, is induced by coupling of photons to axion dark matter. The team used a double-pass bowtie cavity to realize a null experiment with strong rejection from environmental disturbances. Analysis of their set-up suggests that the sensitivity level of the photon–axion coupling constant was estimated to be 3×10^{-16} GeV^{-1} for a low-mass range below 10^{-16} eV, which is beyond the current bound by several orders of magnitude. *NH*

https://doi.org/10.1038/s41566-018-0321-2

FIBRE SENSORS

State-of-charge monitoring

Light Sci. Appl. **7**, 34 (2018)

A plasmonic fibre sensor developed by a Chinese–Canadian collaboration can provide an optical means for monitoring the state of charge of supercapacitors. The device, designed and fabricated by Jiajie Lao and co-workers from Jinan University, Carleton University and the National Research Council of Canada consists of a gold-coated optical fibre featuring a tilted fibre Bragg grating that has a surface plasmon resonance that is sensitive to local chemical changes. When the sensor is closely attached to the surface of the supercapacitor's electrode the change in charge density and ion distribution that takes place during charging or discharging induces a change in the reflection of the plasmon resonance. In particular, during charging, the strength of the reflection at the plasmon resonance wavelength of 1,553.8 nm from the sensor is seen to slightly decrease and vice versa during discharge. These optical transmission changes can be used to infer the state of charge of the supercapacitor. *OG*

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