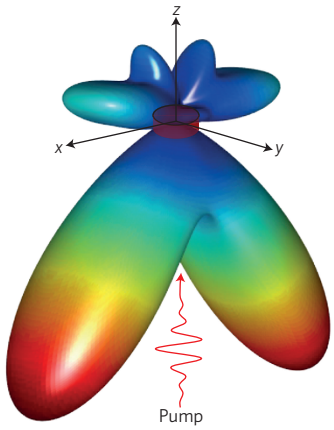
NANOANTENNAS

Second-harmonic control

Nano Lett. **16,** 7191–7197 (2016)



AMERICAN CHEMICAL SOCIETY

Nanoantennas made from nanodisks of the semiconductor AlGaAs are capable of efficient second-harmonic generation and also controlling the directionality and polarization of the emission, say researchers from Australia, Italy and China. Such nanoscale sources of light could prove useful for applications in nonlinear imaging, biomaging and hologram generation.
The study was performed by a team from the Australian National University, the University of Brescia and Nankai University. The researchers fabricated nanodisk antennas with diameters 300–700 nm and studied the efficiency of the second-harmonic generation at 778 nm in the forward and backward directions when pumped with infrared light at 1,556 nm. Nonlinear conversion efficiencies exceeding 10^{-4} were measured and it was also shown that the nanoantennas are capable of generating complex vector beams with radial polarization. *OG*

OPTOMECHANICS

Cooling dynamics

Phys. Rev. Lett. **117,** 173602 (2016)

Optomechanical interactions open up a new range of applications such as cooling nanoparticles and squeezing of light. However, processes reported so far are based on only a linear light–matter interaction, linear in both the position of the oscillator and the amplitude of the optical field. Now, Piergiacomo Zucconi Galli Fonseca and co-workers from University College London in the UK have developed a hybrid trap consisting of an optical cavity field overlapped by a Paul trap and observed for the first time cooling dynamics of levitated nanoparticles via nonlinear coupling. Silica nanospheres (radius 209 nm) were illuminated by a 1,064-nm laser in the hybrid trap. The mechanical frequency of the particle was shifted with respect to the cavity resonance by using two cascaded acousto-optic modulators. The system exhibited an unusual split-sideband structure; frequency-doubled sidebands were observed only in the first few milliseconds after the particle was trapped. The cooling rates were in the 1,000 s^{-1} range. The cooling rates were further enhanced by trapping the particle away from the Paul-trap centre where it was drawn away from the centre of the antinode of the optical potential. *NH*

OPTICAL COMMUNICATIONS

Kramers–Kronig receiver

Optica **3,** 1220–1227 (2016)

Coherent optical communication schemes are attractive because of their potential for efficient, high-capacity data transmission, however, this comes with the trade-off of more complex and costly equipment for signal generation and detection. Now, Antonio Mecozzi and collaborators have proposed a receiver that combines the advantages of coherent schemes with simple direct detection. An information-carrying signal and a frequency-offset continuous-wave local oscillator (LO) found at the left edge of the signal spectrum are launched into the transmission system. Following direct detection of the total field intensity, the complex-valued electric field of the signal is extracted from the measured photocurrent thanks to the Kramers–Kronig relation linking the phase of the total field to its intensity. Use of the Kramers–Kronig relation holds as long as the total transmitted signal is minimum-phase, which in this scheme requires that the amplitude of the LO is larger than that of the signal. The authors simulate the performance of the coherent receiver in a back-to-back configuration, and find that the receiver behaves in a linear manner for minimum-phase signals. If the power of the LO exceeds the signal power by ~6 dB, then in theory, bit error rates lower than 10^{-2} can be achieved with an optical signal-to-noise ratio above ~16 dB for a 24 Gbaud, Gray-coded, 16 quadrature-amplitude-modulated signal. *GD*

X-RAYS

Gold nanoparticle source

ACS Photon. http://doi.org/bssq (2016)

Optically excited gold nanoparticles can act as an efficient source of hard X-rays. That's the conclusion of a study performed by an international collaboration of scientists from Taiwan, Japan, Australia and Lithuania. The team excited an aqueous suspension of gold nanoparticles (diameter 10–100 nm) with near-infrared, femtosecond laser pulses (800 nm, 40 fs) and observed that the resulting nanoplasma emitted hard X-rays with an energy of 15 keV (wavelength 1 Å). The X-ray generation is driven by bulk plasmon excitation in gold at 138 nm following a 6-photon absorption of the infrared laser pulses. The most efficient X-ray generation was for gold nanoparticles of 40 nm diameter and when the laser pulses were pre-chirped to a duration of 370 fs. According to the researchers, future studies will need to discover a means for controlling the directionality of the emission in order for the approach to find use in practical applications. *OG*

TERAHERTZ SCIENCE

2D photon echo

Proc. Natl Acad. Sci. USA **113,** 11800–11805 (2016)

Nonlinear 2D rotational spectroscopy of gas-phase molecules has been performed in the terahertz (THz) frequency range by researchers from the USA and Israel. Two time-delayed collinear THz pulses were generated from a $LiNbO_3$ crystal by optical rectification and focused into a gas cell containing CH_3CN at room temperature at 70 torr. The field strength of each pulse was 400 kV cm^{-1} inside the sample gas cell. The transmitted THz pulses were detected by electro-optical sampling with a ZnTe crystal. The 2D time-domain nonlinear signal was recorded as a function of the time difference between the THz pulses and the read-out delay time. The team observed four types of third-order signal that arose from three THz field interactions with the molecule dipoles: rephasing (photon echo), non-rephasing, two-quantum, and pump–probe signals. The different phenomena could be distinguished from the time-domain traces of the nonlinear signal. The 2D rotational spectroscopy permitted direct measurement of rotational dephasing, population relaxation dynamics and spectral correlations. *NH*

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