Fortunately, by carefully shaping the spectral density of the ensemble, it should in principle be possible to satisfy both requirements and thereby realize a true single-photon source with a near-unity efficiency. Furthermore, the researchers believe that this could be implemented using currently available technology. They intend to assess how experimental imperfections, which may increase unwanted noise, affect the approach. They are also exploring the idea of creating a quantum memory by combining the outputs from two ensembles using a beam splitter. *OG*

QUANTUM OPTICS

Multiparticle entanglement

Science **344,** 180–183 (2014)

Multiparticle entanglement is useful for enabling tasks such as quantum simulation, quantum computing and quantum-enhanced metrology. However, the engineering of large-scale entangled quantum states in atomic systems is currently limited to fewer than 20 entangled qubits. To overcome this technical limitation, Florian Haas and co-workers from École Normale Supérieure in France have developed a method based on the simultaneous, coherent interaction between about 40 ^{87}Rb atoms and the light field of an optical cavity. They used a high-finesse optical cavity formed by a small gap between the ends of two optical fibres. Precisely tuning the resonator length to match the wavelength of a weak impinging laser beam led to light transmission with a narrow linewidth. Although an ensemble of ^{87}Rb atoms in their internal ground state was transparent to a light field resonant with the cavity, a single microwave excitation rendered the resonator opaque, heralding the presence of the entangled W state — a coherent superposition state of all possible combinations that place one quantized excitation in the excited state. The scientists created and analysed entangled states having mean atom numbers of up to 41 and experimentally demonstrated multiparticle entanglement. *NH*

QUANTUM OPTICS

Higher dimensions

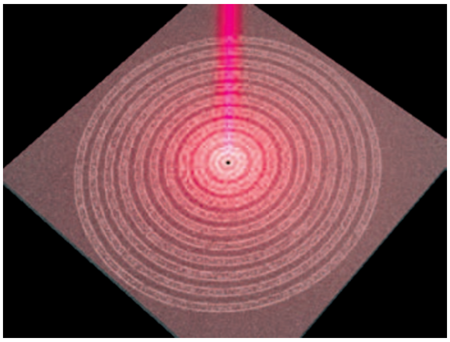
Proc. Natl Acad. Sci. USA **111,** 6243–6247 (2014)

Increasing the complexity of entangled states by extending their dimensionality allows fundamental tests of quantum behaviour to be performed. However, it remains challenging to generate, detect and verify high-dimensional entanglement. Now, Mario Krenn and co-workers from Austria, the UK and Spain have developed a unique method to extract information regarding the dimensionality of entanglement, as well as to verify high-dimensional entanglement. They performed a proof-of-principle experiment using two orbital angular momentum entangled photons. The entangled photon pair was generated using spontaneous parametric downconversion in a periodically poled potassium titanyl phosphate crystal, and the photons were separated using a polarizing beam splitter. In both arms of the set-up, the spatial modes of the light were transformed by a spatial light modulator to Laguerre–Gaussian modes having angular quantum numbers of up to 11 and radial quantum numbers of up to 13. The team analysed the correlations of 186 modes of two photons and experimentally demonstrated the largest entangled photonic Hilbert-space dimension realized to date of 103 × 103. *NH*

PLASMONICS

Bullseye beaming

ACS Photonics **1,** 365–370 (2014)



The transmission of light through very small holes in metal films is known to be surprisingly efficient. A beam of light emerging from such holes can be tailored not only by adjusting the size of the hole, but also by placing diffractive elements on the film. A popular approach to enhance transmission by plasmonic effects is to use a periodic relief structure consisting of concentric rings (a bullseye structure) around the aperture. In recent work, Jue-Min Yi and colleagues from the Universities of Strasbourg and Toulouse in France have considered the effect of the incident polarization and the design of the bullseye structure on the light exiting the aperture. The researchers claim that previous studies overlooked the role of polarization on the transmission characteristics of this structure and that their work is the first extensive experimental study. The aperture and concentric grooves and rings were optimized to generate an intense beam and to tailor the directivity and 'gain' of the structure. The scientists conclude that the efficiency of surface plasmon conversion can be increased by increasing the number of rings, but that the propagation length of about 25 μm limits the maximum size of the rings. *DP*

BEAM SHAPING

Hollow Gaussian beams

Appl. Phys. B **115,** 55–60 (2014)

Light beams with a dark hollow spatial intensity profile are of considerable interest due to their wide range of potential applications. In particular, hollow Gaussian beams are expected to be useful for tasks such as particle trapping and free-space optical communication. Now, researchers at Soochow University in China have theoretically proposed and experimentally demonstrated a simple and convenient method for generating such beams. It involves using a spiral phase plate to convert a Laguerre–Gaussian beam into a hollow Gaussian beam. The team obtained reasonable agreement between experimental measurements and theoretical calculations for the focusing properties of their generated beams. *SP*

OPTICAL SIGNAL PROCESSING

Efficient digitization

Appl. Phys. Lett. **104,** 111101 (2014)

There are two main problems associated with conventional analog-to-digital converters — the maximum frequency that can be captured is limited to half the sampling rate (the so-called Nyquist rate) and a 'big data' storage problem in real-time instruments due to the long digital record length associated with Nyquist sampling. Now, Mohammad Asghari and Bahram Jalali from University of California at Los Angeles in the USA report that a self-adaptive stretch, which they term an anamorphic stretch transform, can help solve both problems. The approach enables digitizers to capture waveforms beyond their usual bandwidth limit, with the size of digital data size also being reduced at the same time. The approach relies on warping the signal's complex field in the analog domain before sampling and digitizing by reshaping the signal with a nonlinear transformation. The signal reshaping is then combined with complex field detection followed by digital reconstruction. In a proof-of-principle demonstration, the researchers compressed the modulation bandwidth of an optical signal by a factor of 500 and reduced its modulation time–bandwidth product by a factor of 2.73 while achieving a 16 dB improvement in the power efficiency compared to that obtained using a conventional dispersive Fourier transform. *RW*

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