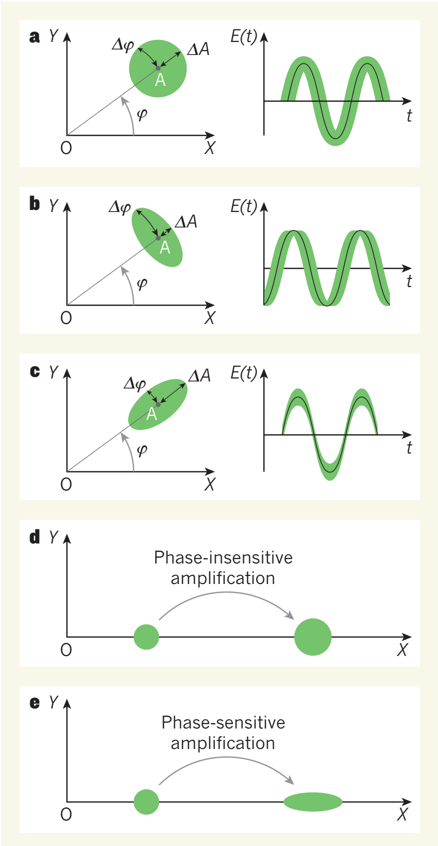

Figure 1 | Coherent and squeezed states. **a**, Conceptual representation of a coherent state of light. X and Y represent the quadratures of the light's electromagnetic field at frequency ν: $E(t) = X\cos(2\pi\nu t) + Y\sin(2\pi\nu t)$, where t is time. The distance OA is the field's amplitude A, and the angle φ is the phase (where the field's peaks and dips lie). The size of the disk represents the uncertainties in the amplitude and phase, ΔA and $\Delta\varphi$, which are equal in value. The field's temporal evolution is shown on the right. **b**, A squeezed state, in which ΔA is smaller and $\Delta\varphi$ larger than their coherent-state equivalents. **c**, A phase-squeezed state, in which $\Delta\varphi$ is smaller and ΔA larger than their coherent-state analogues. **d**, In a type of field amplification known as phase-insensitive amplification, the total uncertainty (area of the disk) is amplified. **e**, In phase-sensitive amplification, the total uncertainty remains constant. Corzo *et al.*[1] have applied this form of amplification to faint images.

— approaches 2 for large values of the gain. By contrast, the noise figure for the PSA can be unity, independently of the value of the gain[4].

The first demonstrations[5,6] of noiseless amplification (that is, with no degradation of the signal-to-noise ratio of the input signal) by means of PSA were followed by a proposal to apply it to the light fields associated with faint images[7], which was subsequently demonstrated experimentally[8]. In their study, Corzo *et al.* attained PSA noiseless amplification, based on four-wave mixing, of faint images in a set-up[9] that had been used to demonstrate quantum entanglement between spatially extended light fields. Previous noiseless amplification of images[8,10] has been achieved using certain crystals that display a nonlinear optical response when light propagates through them. The authors' image amplifier is based on an atomic vapour of rubidium that exhibits a highly nonlinear optical response owing to the 'near-resonant' nature of the interaction between the rubidium vapour and the light fields. As a result, 'pump' light beams at frequencies ν_1 and ν_2 do not need to be tightly focused in the amplifying medium, thereby relaxing the requirement of phase matching and allowing a larger number of image pixels to be amplified.

In Corzo and colleagues' experiment, the four-wave mixing process involves two pump fields whose frequencies (ν_1 and ν_2) are nearly the same as the frequencies associated with two atomic transitions in a vapour of rubidium, ν_{ge} and ν_{ie}. The signal to be amplified is at a frequency ν_S, such that $\nu_1 + \nu_2 = 2\nu_S$. Unlike many four-wave-mixing experiments, spontaneous emission noise is negligible as long as ν_1, ν_2 and ν_S are sufficiently detuned from ν_{ge} and ν_{ie}. The authors show that, for a gain of 3.9, the noise figure remains nearly equal to unity for this PSA approach to amplifying faint images, and is well below the predicted value for an ideal (with no added noise) PIA method. What's more, they demonstrate that this amplifier can provide gain for more than 2,000 pixels, allowing the amplification of fairly complex image patterns.

The authors' PSA technique could be used in several applications, for example when a detector (camera) is either insufficiently sensitive to light or too noisy. A future path for this research would be to create amplifiers that operate in the mid- and far-infrared, or X-ray, wavelength regimes. In the X-ray regime, a PSA could reduce the exposure of biological tissues to harmful radiation. However, most of these applications would require transposing the wavelength of operation of the current demonstration to these other wavelengths. In principle, this is possible using different sets of atomic transitions and/or systems. For applications in which there is no control over the light source (such as in astronomical imaging), another issue is the frequency bandwidth of the nonlinear medium. For interactions in rubidium vapour, the frequency bandwidth over which the nonlinear interaction occurs efficiently is very narrow and must be close to the atomic-transition frequencies. This provides additional motivation to develop nonlinear materials that can operate over broad bandwidths and have a large nonlinear response. ■

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NATURE

50 Years Ago

This year's Nobel Prize for Chemistry has been awarded jointly to Dr. M. F. Perutz … and Dr. J. C. Kendrew. This most welcome announcement follows quickly on that concerning the award of the Nobel Prize for Medicine to another member of the staff of the same Laboratory, Dr. F. H. C. Crick (jointly with Dr. M. H. F. Wilkins and Prof. W. Watson; see *Nature* of October 27, 1962, p.319) … The award was made for their work on the structures of globular proteins.
From *Nature* 10 November 1962

100 Years Ago

Attention has been directed to the relationship of tuberculosis and milk, and to the problem of a pure milk supply and the methods whereby this may be ensured … Now Bullock, from a very carefully survey of the literature of the subject, comes to the conclusion that pulmonary tuberculosis is produced almost always, if not exclusively, by tubercle bacilli of the *human* type. More than two-thirds of human tuberculosis is, therefore, certainly not due to the *bovine* bacillus or to milk infection. Bullock further remarks that the bovine tubercle bacillus plays a relatively unimportant rôle in the production of tuberculosis in man! … The fact is, we have no data indicating the infectivity by feeding of ordinary mixed milk … Assuming that a danger of tuberculous infection from milk exists, how can it be prevented? Pasteurisation has had a great deal said in its favour, and efficient pasteurisation does destroy the tubercle bacillus. But pasteurisation, as commonly carried out, is uncertain in its action, and there are various other objections to this process.
From *Nature* 7 November 1912