KEYWORDS Quantum information／quantum optics／lasers

A source of bright, continuous quantum light

Assistant Professor, Principles of Informatics Research Division
BYRNES Tim
情報学プリンシプル研究系　助教
バーンズ ティム

background / purpose (研究背景・目的)

Light, as we are familiar from everyday experience, can have very different properties depending on how it is created. For example, light from LEDs are quite different to laser light, even though they are made of the same frequency. However, it is known that there are special states of light that are completely "quantum" in their nature. In the field of quantum optics, the state of light is characterized by the Wigner function. If the Wigner function has any region that is negative, it has quantum properties. In the figures below we show the difference between laser light and "quantum light". We see that "quantum light" has strong negative region showing their quantum behavior.The problem with such "quantum light" is that it is quite difficult to make. Existing methods using non-linear crystals are too weak to be practical, and photon subtraction methods only work probabilistically. No methods exist to produce it continuously, like a laser. We have developed a method where quantum light is produced continuously.

the contents of the research (研究内容)

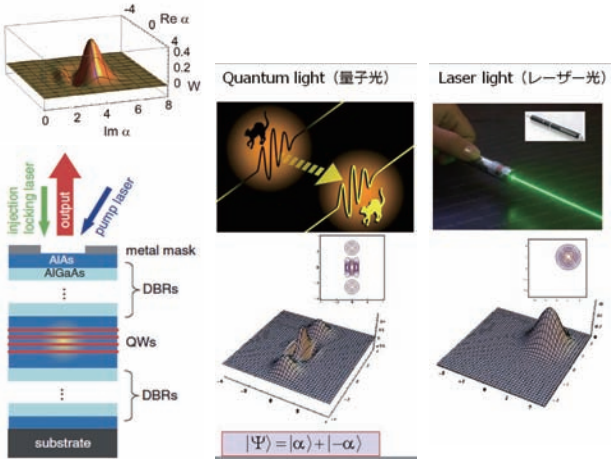
The light is produced in a semiconductor structure as shown in the Figure. The structure shown, called a microcavity quantum well, allows for particles called "exciton-polaritons" to be excited within the regions marked as red. When a sufficient number of the exciton-polaritons are created, a phenomenon called Bose-Einstein condensation can be made to occur. In Bose-Einstein condensation, the particles spontaneously form coherence, which means that their underlying wavefunction all become phase coherent. Once the exciton-polaritons become phase coherent, they leave the semiconductor by emanating through the top of the structure. The light that escapes from the structure has a peculiar nature: they are all phase coherent because due to the Bose-Einstein condensation, but they simultaneously repel each other, because of the interactions between the exciton-polaritons. Using this technique we have shown that it is possible to produce "quantum light", continuously. This allows for the potential of producing a new type of laser, but one that produces "quantum light" conveniently, improving on current methods which only produce this in pulses.

possibility of the application to industry (産業応用の可能性)

- Improved security for bank transactions on the internet
- Encrypted email communications via secure channels
- Single box quantum light source solutions for use in university and research applications
- Components for future quantum computing technologies

invention of the researcher (研究者の発明)

- JP2012－237119（光発生装置および光発生方法）



連絡先：バーンズ ティム［情報学プリンシプル研究系　助教］　URL　http://nii.timbyrnes.net　Email：tbyrnes[at]nii.ac.jp