Using laser to realize quantum communication

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Abstract: using the coherence of laser, superluminal quantum communication is realized at long distance, which opens up a new era of communication.

Key words: laser, coherence, quantum communication

Since the 20th century, laser has been another important invention of human beings after the relay of atomic energy, computer and semiconductor in the field of science and technology.

A laser, as the name implies, means that an atom is stimulated by radiation to produce new photons, which are then amplified to produce new emission light.

The process goes like this: suppose one atom at a high level E2 at the beginning, when the foreign photons of the energy for h nu is exactly equal to the one pair of the difference between the E2 level - E1, the atoms can be induced by in addition to the photon from high to low level E1 level E2 transition, then issue with photon induced the photon, not only the same energy, and emission direction and polarization direction and the phase of light waves are exactly the same. This means that an incoming photon will emit two identical photons, which is how light signals are amplified.

Obviously, if you want to generate a laser, the premise is that the stimulated radiation effect is greater than the stimulated absorption effect. However, under normal conditions, atoms are almost always in the lowest energy level (ground state),

So one of the biggest preconditions for creating a laser is that you have to have an inversion of the number of particles, so that more atoms are at higher energy levels.

Certain working substances, under certain conditions (the two energy levels of an atom are in a non-thermal equilibrium state), can produce a reversal of the number of particles.

The basic components of a laser include three aspects: working material, excitation source and resonator. The working matter, which is the material we're looking for, is the material that we're looking for to create a population inversion in this material; The excitation source is the atomic system used to excite the working matter to achieve this specific condition (the number of particles in the upper energy level increases and the number of particles reverses); Resonator cavity, the cavity formed by the laser, generally consists of two reflectors (at both ends of the laser), so that the light oscillates back and forth in the resonator cavity, causing a chain reaction, avalanche amplification, thus emitting laser at the output mirror.

The principle of laser generation determines the four characteristics of laser different from other ordinary light sources: monochromaticity, coherence, directivity and high brightness.

The coherence of laser can be divided into spatial coherence and temporal coherence. The temporal coherence is directly related to the monochromaticity of the light source.

The wave train length in coherent time is usually called coherent length. The longer the coherence length L is, the clearer the interference fringe is, and the better the coherence is. Assume that a laser from lambda between 1 ~ 2 lambda light frequency of the wave (there is no such thing as an ideal monochromatic light), then you can prove that the coherence length L = lambda ^ 2 / Δ lambda, Δ lambda = lambda 2 - lambda. 1. When the smaller Δ lambda, namely lambda and lambda. The closer to 1, 2 monochromaticity, the better, the greater the coherence length L, the better the coherence. According to the formula Δ lambda = 0, coherence length is equal to infinity, that is with the quality of photon interaction distance of infinity, and the role of the strength and distance has nothing to do, it must be wrong, but I do not make in-depth discussions here, some idea also not here to correct errors, such as wave train and phase, this is to avoid unnecessary disputes. L = length lambda ^ 2 / Δ lambda can be used as an approximation formula.

As shown in FIG. 1, light source 1 is placed on A and light source 2 is placed on C. The light from light source 2 is directed to point b between A and C by equipment. At light source 1, the information "hello" is represented by on and off codes, that is, by 0 and 1 codes.

By improving the light source and lengthening the coherence length, the point b can be moved until b coincides with c. as long as the image of light source 2 is observed at C, the information of light source 1 can be received.

Coherence length of the laser has reached several kilometers or even hundreds of kilometers, that is to say beams 1 and 2 are separated by a few axioms can, as long as the light 1 as a source, 2 as a source of absorption, light beam to control of beam is 1, 2 light beam will have change, it was a couple of kilometers on the true information from the beams 1 to 2. For example, encode the message "hello" and regulate beam 1. As a result of the interference, beam 2 changes accordingly, and beam 1 and beam 2 send the message "hello". This information is not beam 1, not beam 2, not the beam itself, but from beam 1 to beam 2, so it is not laser communication but quantum communication.

The coherence length of multimode he-ne laser is generally 20 cm, while that of singlemode is more than 100 m. Some semiconductor lasers have coherence lengths of several hundred meters, but small, simple semiconductor lasers have shorter coherence lengths (a diode laser has coherence lengths of 20 centimeters). The coherent length of a single mode fiber laser with a spectral line width of several kilohertz can be greater than 100 km. Optical frequency combs can also achieve similar coherent lengths due to the narrow spectral width between the teeth.

At present, single-mode fiber laser is the most suitable source for faster-than-light communication.

Fiber Laser, Fiber Laser) refers to the element with rare earth doped glass Fiber as the gain medium of the Laser, Fiber Laser can be developed on the basis of the optical Fiber amplifier: within the optical Fiber under the action of the pump are high power density, causing the Laser working substances of Laser level "population inversion", as appropriate to join the positive feedback loop (a cavity) can form a Laser oscillation output.

If the coherence length L = lambda ^ 2 / Δ lambda can be used as an approximation formula. Therefore, fiber laser 1 and fiber laser 2 can still be coherent in two places A and C which are hundreds of kilometers apart, that is to say, the beam of fiber laser 1 does not need to reach the point of C, and only in A place can be coherent with the beam of fiber laser 2 at the point of C.

Of course, fiber laser 1 and fiber laser 2 are 100 kilometers apart, and there are a lot of obstacles in the middle, which will affect the coherence of the two beams of light.

The influence of obstacles on laser coherence is one of the key factors of faster-than-light communication, which needs to be further tested.