Measurement and active compensation of polarization drifts in a fiber quantum channel used for teleportation

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Since in many quantum communication experiments laser light is sent through optical fibers, it is necessary to check, if the birefringence of these fibers stays constant over time. Polarization drifts induced by thermal stress have to be compensated to enable efficient data transfer. Especially an 800 m long fiber used in our quantum teleportation experiment at the danube is checked with a 785 nm laser diode.

By means of an optical device developed by us it is possible to measure the polarisation state of the photons of a laser beam. The device consists of symmetric beamsplitters (BS), a polarizing beamsplitter (PBS), polarizers, a quaterwaveplate and light detectors (Fig. 1).

The general polarization state of a photon is determined by the real, normalized amplitudes a and b of its horizontal and vertical component and the phase φ between them. By measuring the intensities in three polarization basises (0°/90°, -45°/+45° and left/right circular) it is possible to calculate these quantities and also the purity p of the state. The results of a long time measurement are shown in Fig. 2.

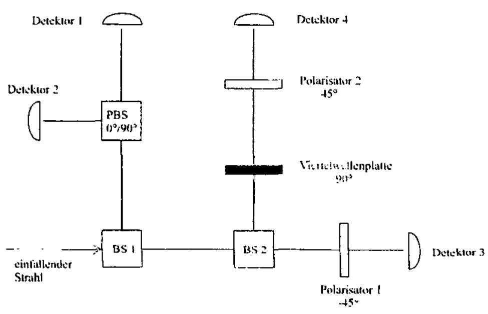

Fig. 1. Polarimeter

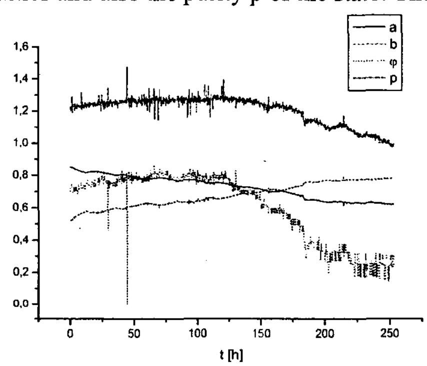

Fig. 2. Long time measurement

It turns out, that it is necessary to compensate the polarisation drifts (Fig. 3). In order to keep the output of the fiber horizontally polarized, we use a piezo fiber squeezer driven by a computer. First the contrast of the outputs of a polarizing beamsplitter (PBS) at the end of the fiber is minimized automatically to a value below 1:100. Then the computer checks every hour, if the contrast has increased above this value. In this case it is brought back below 1:100 again. Fig. 4 shows a typical curve of this contrast during 16 hours. By comparison you can see the contrast without polarization compensation in Fig. 5.

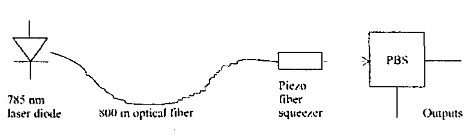

Fig. 3. Setup for active polarization compensation

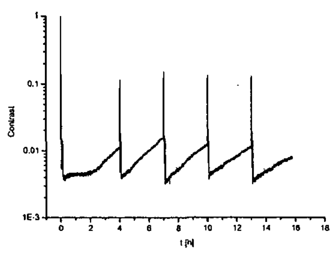

Fig. 4. Contrast with active polarization compensation

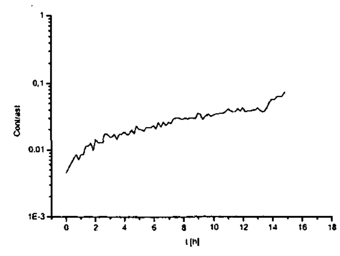

Fig. 5. Contrast without polarization compensation

With this stabilized quantum channel it is possible to perform high fidelity quantum teleportation experiments.

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