The photo-spintronics: A possible way to quantum devices

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Although practical implementation poses a formidable challenge, quantum computers are expected to exceed the computational efficiency of ordinary machine because of quantum algorithms that outperform the best known algorithms doing the same tasks on a classical computer. In quantum computation, logical operations are carried out on the qubit, the quantum state of a two-level system, whereas on the classical bit of the one and zero in classical computation. In quantum computation, information is to be stored, transmitted, and processed as well as in classical computation. On the classical computers, information is represented by a sequence of the ones and zeros in various forms of electrical, magnetical, optical, and mechanical signals. We have chosen a suitable form to handle the information for storing, transmitting, and processing. Transformation of the signals is rather straightforward in the classical computers because of the one-and-zero nature of signals corresponding the on-and-off. In the quantum computers, however, it would be a daunting difficulty, since the information of the qubit has to be transformed keeping quantum phases between the quantum states of the two-level system.

In this work, we address this problem on the transformation between the spin-polarization of electrons (up and down) and the polarization of light (right- and left-handed) as an example. We study which physical mechanism can make the faithful transformation (the one-to-one correspondence of the quantum phase) possible. It is certainly important to control the spin of electrons by any means in a sense of future spin-device technology. Calculations are carried out in terms of the relativistic layer-KKR method to estimate the efficiency of modeled devices.