Wide Bandwidth Deep Space Quantum Communication

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We propose to asses the feasibility of quantum optical channels for wide bandwidth deep space communications. Quantum communications promises that several orders of magnitude increases in the equivalent classical data rate can be achieved, with the same transmitted power and antenna gain, through the implementation of communication complexity protocols.

The proposed communications channel transmits encoded information as quantum bits [14]. The classical information is encoded by entangling the quantum states of the transmitted electromagnetic field [16] (e.g. quantum Stokes operators [17]). Communication complexity protocols [18] are implemented to at least quadratically increase the number of effective logical bits which are transmitted per physical qubit [19]. The proposed quantum bit communications architecture can be scaled to interplanetary distances since entangling the quantum states of the optical field allows high intensity transmitters of entangled quantum states that can overcome the large free space losses.

The proposed quantum communication architecture does not require shared quantum entanglement between the transmitter and receiver nor does the proposed approach require a parallel, classical communication channel in addition to the quantum channel. Entangling the quantum states within a multi-level quantum bit, rather than shared quantum entanglement between transmitter and receiver, is more easily implemented with the technology available in the next 20-40 years and promises to be more robust, efficient and easier to space qualify than alternative architectures.

We will investigate whether multi-level quantum bits through optical field entanglement are realizable for a deep space satellite transmitter and whether interactions with the space environment will destroy the quantum entanglement. The feasibility of implementing communication complexity protocols for deep space communications will be assessed. While we will concentrate on the critical deep space communications challenge, optical field entanglement is a generically important problem which, if realized in practice, would find wide applicability across numerous disciplines and might stimulate rapid progress in quantum computing.