IAF HUMAN SPACEFLIGHT SYMPOSIUM (B3)
Utilization & Exploitation of Human Spaceflight Systems (3)

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INVESTIGATION OF GRAVITATION EFFECTS ON QUANTUM ENTANGLEMENT ON THE ISS - SPACEQUEST

Abstract

The theory of quantum mechanics was developed at the same time as general relativity. These two well-tested theories in physics provide us with a formidable understanding of nature. However, the conflicts between both theories have to be resolved. Quantum mechanics allow to make accurate predictions of atomic spectra and could be used to explain the stability of matter itself. This came on the cost of having to refrain from concepts that were deeply rooted in everyday experience back then.

The scientific purpose of SpaceQUEST is the investigation of gravitation effects on quantum entanglement by means of single photon detection on the International Space Station (ISS), transmitted from ground by a photon source and with a second detector on ground.

SpaceQUEST therefore constitutes the first actual experimental attempt to observe effects that could only be explained by considering simultaneously quantum mechanics and general relativity. The mission objective is to observe the behavior of correlation between correlated photons measured on ground and in space in temporal and polarization degree of freedom. It will allow to draw a comparison between the predictions made from the standard and alternative theories. In addition, the SpaceQUEST apparatus is fully capable to perform QKD, although "disguised" as a fundamental-physics experiment.

The SpaceQUEST setup consists of two parts: A ground based part and a space based apparatus located on the ISS. The space-borne apparatus will be located in the WORF Facility within the American Destiny Module of the ISS. The two experimental apparatuses are connected by an optical link along which single photons, i.e. elementary excitations of the electromagnetic field, are sent from the ground segment to the space segment. Single photons are created in the ground segment in a process that produces photons pairwise with quantum entangled properties (i.e. single photon down conversion in an optically non-linear crystal). The entanglement exists simultaneously on the temporal as well as on the polarization degree of freedom of the photons.

The presented ESA project SpaceQUEST is related to the development of the space segment (ISS instrument). It is currently in phase A/B executed by OHB System together with the University of Waterloo. This paper presents the current status of the project.