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QUANTUM COMPUTING ON THE MOON: TOWARDS SUSTAINABLE SPACE-BASED COMPUTING SYSTEMS

Abstract

The field of space architecture is emerging as the next frontier for mankind. Utilizing space-based resources helps us not only unlock new frontiers in technology but also improve existing ones. This study delves into the potential of advancing the realm of quantum computing through the utilization of lunar resources, namely, the Lunar Crater Hermite, as a promising candidate for future quantum computing endeavors.

While quantum computing serves as the next revolution in the paradigm of modern computing, it comes with its own set of challenges, namely, qubit stability. Qubits require ultra-cold temperatures near absolute zero and minimal ambient pressure to operate. These conditions help them evade the phenomenon of decoherence, which is detrimental to computational accuracy. The proposed solution explores the relocation of a quantum computer to the lunar crater Hermite, which offers a temperature of 27 kelvin with almost no ambient pressure thanks to its sparse exosphere. This study investigates the feasibility of such a proposition, evaluating its potential impact on operational costs and computing efficiency which are expected to decrease and increase, respectively, to conclude if a lunar-based quantum computer proves to be a sustainable alternative to conventional earth-based systems. To carry out this investigation, a comparison is drawn between the power draw and heat transfer rate for the cryogenics used on earth-based systems and the extrapolated values for the same in the environment offered by Hermite. Furthermore, we factor in the costs of deploying the computer on the moon to evaluate whether it is an economically viable solution.

The study then addresses the challenges that must be overcome to ensure the proper and efficient functioning of such ventures. These include, but are not limited to, ensuring that the Quantum Computer Module can deploy and operate autonomously, mitigating risks posed by asteroid and micro-asteroid activity, ensuring protection against cosmic radiation, and finally, sourcing a suitable power source. We explore how these problems have been tackled in previous missions of a similar nature, while at the same time, we explore new emerging technologies as possible solutions. By integrating quantum computing with lunar resources, this research not only advances the frontiers of computational technology but also contributes to the vision of sustainable space system architectures.

Keywords: Quantum Computing, Hermite, Temperature, Pressure, Lunar Resources, Cryogenics