MIRRORS FOR HARNESSING SOLAR ENERGY IN CAVE EXPLORATION AND OTHER LOW-LIGHT SETTINGS J. C. Johnson[1,2,3], P. A. Johnson[1,3], and A. A. Mardon[2,3], [1]Faculty of Engineering, University of Alberta (email: jcj2@ualberta.ca), [2]Faculty of Medicine and Dentistry, University of Alberta (email: paj1@ualberta.ca) [3]Antarctic Institute of Canada (103, 11919-82 Str. NW, Edmonton, Alberta CANADA T5B 2W4; email: aamardon@yahoo.ca)

Introduction: Solar energy is an essential resource for both illumination and energy capture in space, especially in light-limited deep space geography such as caves. For the purposes of this abstract, we will be consider lunar caves. Existing models, such as space-based solar power (SBSP) for the harnessing of solar energy, utilize collecting satellites with solar panels in orbit. However, this conception is limited both conceptually and economically. Firstly, a phenomenon known as the sparse array curse may interfere with the transfer of energy from satellite to the surface. [1] Second, the conversion of photons to electrons and vice versa may result in significant energy loss and difficulty in management of overheating. Resources and costs associated with satellite launching, maintenance, and risk management must additionally be considered for. Here, we propose the integration of the SBSP model on the lunar surface with the use of mirrors on the Moon for solar energy capture for use in exploration and *in situ* resource utilization.

Seasonal differences: Seasonal differences, which exist on the lunar surface, are unlike that observed on the Earth. This is primarily due to the difference in the Moon's axial tilt in reference to the ecliptic being approximately 1.54°, in contrast to the Earth at 23.44°. [2] Solar irradiation is thus less variable on the Moon and as such depends more closely on variables such as topography, location, positioning, phasing and rotation of the Moon. Due to these variables and axial tilt, peaks of eternal light (PELs), which are theorized to always receive illumination, and craters of eternal darkness, which remain in permanent shadow never being exposed to sunlight, both exist on the lunar surface. For instance, PELs have been suggested on the Peary Crater at the lunar north pole, which is a high point receiving illumination for the full lunar day.

Novel design: Unlike the SBSP conception of placing solar panels on satellites within orbit to capture solar energy, we suggest the placement of specially designed mirrors at PELs on the lunar surface to reflect light towards solar panels on the lunar surface in order to obtain solar energy. By doing this, the sparse array curse would not be a concern. Additionally, the properties of the mirrors utilized can be designed and adjusted to accommodate varying degrees of concave angles, sizes and numbers, and reflective capacities, providing a suitable medium through which solar energy can be captured. This would ensure a nearly unlimited supply of solar energy and a single conversion process from photons to electrons, in contrast to SBSP where energy is lost due to multiple conversions. Furthermore, using mirrors enable the adjustment of light reaches solar panels eliminating the risk of overheating. Finally, the mirrors would also reduce cost and resource expenditure.

Limitations: While this technology may be theoretically sound, there is no proof-of-concept to demonstrate its feasibility. The strength and durability of mirrors during space travel and on the lunar surface is important to consider for. Space debris or lunar dust may interfere with the reflection. Additionally, the stabilization and maintenance of mirrors and mirror surface may require more resources. Furthermore, there is a need for a mirror positioning goniometer or similar device to measure and determine angles of light reflection.

Conclusion: While space-based solar power has conventionally used solar panels on satellites to harness light energy, here we suggest the innovative utilization of mirrors for this purpose. The existence of PELs can be used to our advantage in a novel design allowing for continuous, unlimited access to a light source. However, this has yet to be tested and this may prove to have further limitations in practice.

References: [1] Benford, J., Swegle J.A., Schamiloglu E. (2015) "High Power Microwaves." CRC Press. [2] Lang, K.R. (2011), *The Cambridge Guide to the Solar System.* 2nd ed., Cambridge University Press.