Corralling the devices capable of operating in the cold of deep space

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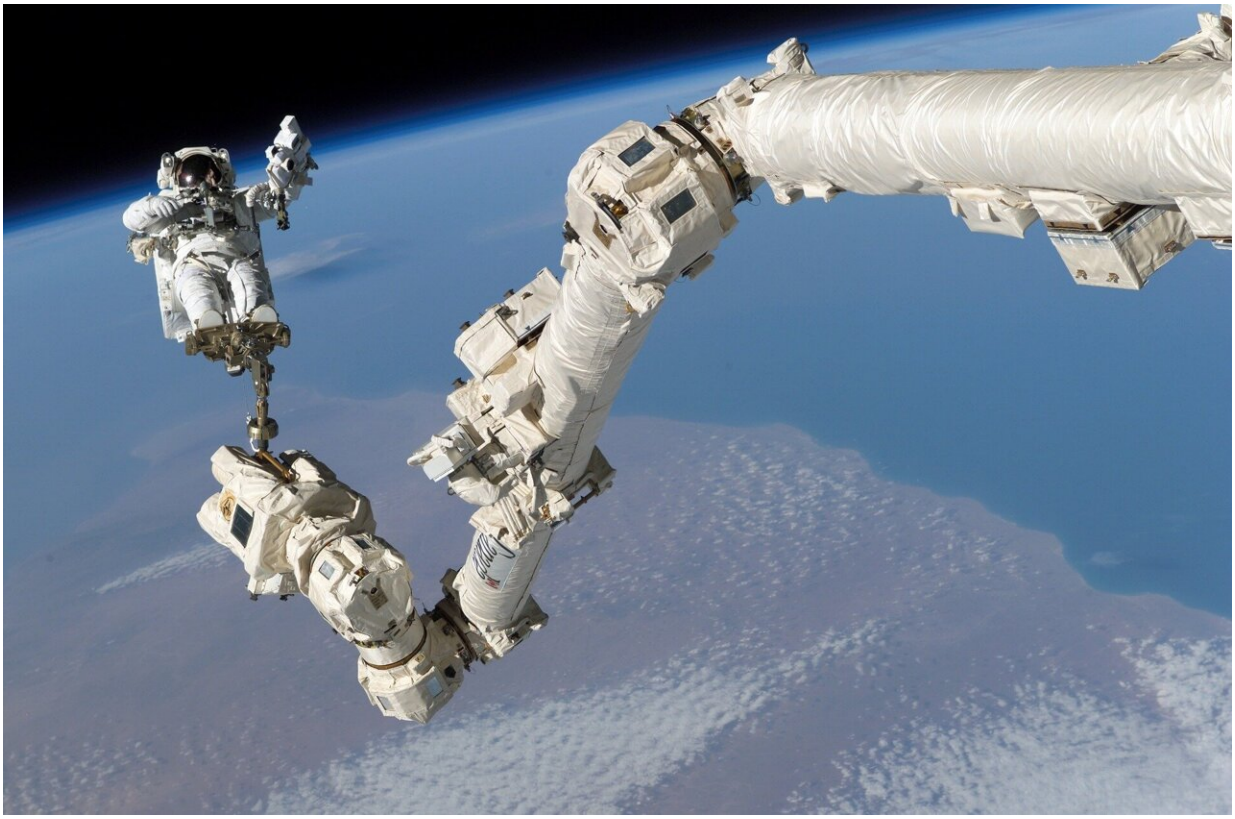

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The future of electric aircraft and deep space missions will rely on our ability to develop electrical and electronic components that can operate at the very low temperatures of the upper atmosphere and the cryogenic

temperatures of space. A review of such technology is presented in the *International Journal of Powertrains*. The review looks specifically at semiconductor devices, passive components, and superconducting devices that operate at very low temperatures.

Mustafeez Ul-Hassan, Yalda Azadeh, Asif Imran Emon, and Fang Luo of the Department of Electrical and Computer Engineering at Stony Brook University, New York, U.S., point out that in terms of aeronautics and space travel there is a pressing need to usurp pneumatic, hydraulic, and mechanical systems with electrical components.

In terms of aircraft, such components will operate at the low temperatures of high-altitude flight, but also benefit from being held at cryogenic temperatures in terms of improving their efficiency. Indeed, the development of superconducting technology that by necessity operates at such temperatures would not only make electric aircraft more feasible and improve space travel option but improve the generation efficiency of wind turbines.

As such, developing the requisite technology for advanced transportation would as a spin-off improve the sustainability of power generation for those on the ground too. The team points out that certain components that would be desirable in various setups are yet to be developed.

Cryogenic, simply means a temperature or condition that leads to freezing. However, in the modern technical vernacular it usually refers to very low temperatures rather than the everyday temperature of freezing water for example. We commonly discuss cryogenic conditions as being achievable through the use of liquid nitrogen, which is at 77 Kelvin, liquid hydrogen, 33 Kelvin, or liquid helium at 4 Kelvin.

The Kelvin scale of temperature in absolute scale in which the coldest possible temperature is 0 Kelvin and there are no negative temperatures.

We do not talk of degrees on the Kelvin scale but the temperature separation between integer values is equivalent to a degree on the Celsius scale. 0 Kelvin is -273.15 degrees Celsius. 0 degrees Celsius is thus 273.15 Kelvin.

The team surveys devices, passive components, converters, and superconducting machines and suggests that their findings will "help to flesh out the behavior of such components and can serve as a database for the successful design of cryogenic power conversion systems."

More information: Fang Luo et al, Review of Power Electronics Converters and Associated Components/Systems at Cryogenic Temperatures, *International Journal of Powertrains* (2022). DOI: 10.1504/IJPT.2022.10048260

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