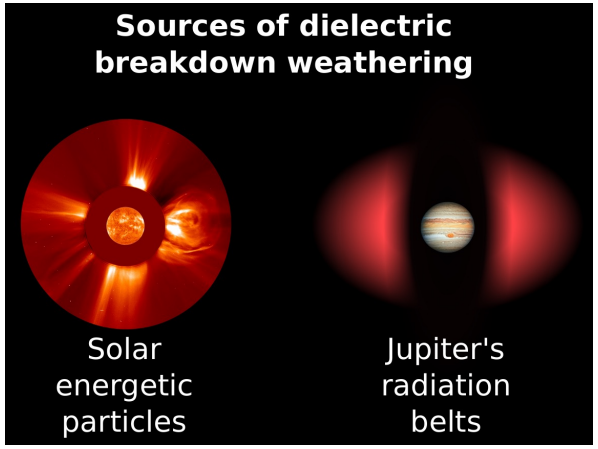
The Possibility of Dielectric Breakdown Weathering Throughout the Solar System

- Laboratory and spacecraft experiments show that electrical insulators exposed to sufficiently high fluxes of energetic charged particles experience dielectric breakdown, or "sparking"

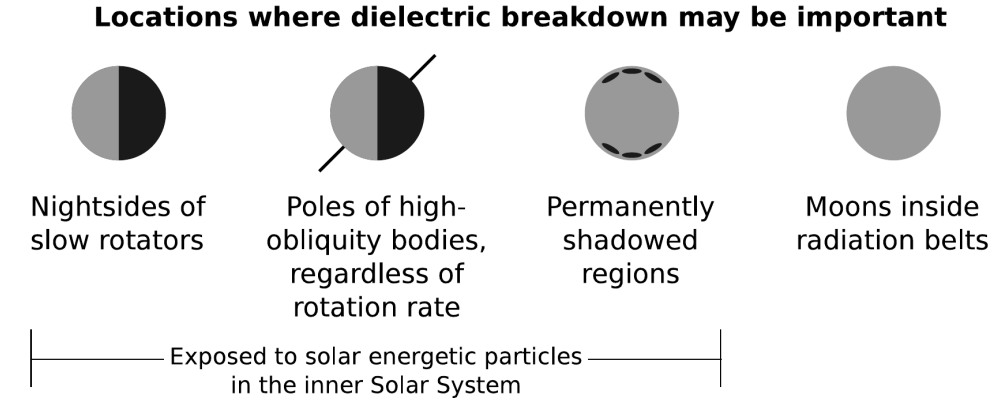
Cartoon of tiny sparks that may occur on the Moon's cold nightside during large solar energetic particle events.

- Cold regolith on airless bodies can be directly bombarded by energetic charged particles, and bodies in the inner Solar System or Jupiter's radiation belts are exposed to potentially breakdown-causing fluxes of particles (figure at right).



- Cold materials are more electrically insulating and thus more likely to undergo dielectric breakdown. It is critical to better understand the conditions under which it occurs and how it may affect planetary surfaces.

- Our previous work showed that dielectric breakdown may space weather lunar regolith as quickly as micrometeoroid impacts. Now we extend that work to show that dielectric breakdown due to solar energetic particles or radiation belts may cause space weathering on airless bodies throughout the Solar System.
- Based on the energetic particle fluxes and thermal conditions needed for dielectric breakdown, we show that it may be important in the polar regions of Mercury, the moons of Mars, and some asteroids. Also, Jupiter's radiation belts caused repeated breakdown on the Voyager 1 spacecraft, and we find possible evidence that breakdown may continually process the surfaces of seven moons orbiting within the belts (Adrastea, Metis, Amalthea, Thebe, Io, Europa, and Ganymede) (cartoon below)



A. P. Jordan (2022), Reevaluating how charged particles cause space weathering on airless bodies, *Icarus*, *376*, 114878, doi:10.1016/j.icarus.2021.114878