Galactic cosmic ray induced ionisation on Venus and its effect on cloud droplet stability

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Galactic cosmic rays are ubiquitous in solar system atmospheres. On Venus, the altitude of peak ion production due to cosmic rays (the Pfotzer-Regener maximum) occurs at ~63 km, within the optically thick region of the upper clouds. This indicates the possibility of electrical effects on droplets within Venusian clouds. Motivated by this, our VENI (Venusian Electricity, Nephology, and Ionisation) project explores effects of galactic cosmic ray (GCR) induced ionisation on cloud droplets in circumstances with relevance to Venus’ atmosphere. Charge is known to lower the critical supersaturation required for cloud droplets to form; slightly larger droplets are stable at lower saturation ratios if sufficiently charged. Condensation of gas directly onto ions is also potentially possible on Venus if the atmosphere is sufficiently supersaturated. GCRs and the secondary charged particles they produce are therefore anticipated to affect cloud droplet behaviour on Venus.

Experiments have been conducted using electrically isolated droplets, through levitation in a standing acoustic wave. The droplets are monitored with a high-magnification CCD camera to determine their evaporation rate and charge. The charge is measured both by the deflection in an electric field and by passing the droplet through a custom-built induction ring. A relationship between the evaporation rate and charge of the droplets is found to be consistent with theory, allowing droplet lifetime to be predicted for a given charge. Further experiments using sulphuric acid droplets in a carbon dioxide environment offer more direct relevance to the Venusian environment and cosmic ray enhancement due to solar energetic particles (SEPs) in space weather events will be simulated using a corona source.