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Laboratory experiments to investigate the effects of galactic cosmic ray ionisation on cloud droplet behaviour in Venus' atmosphere

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Galactic cosmic rays (GCRs) are the principal source of ionisation in planetary atmospheres. Upon entering the atmosphere, collisions occur between GCRs and other atmospheric molecules to produce a variety of secondary particles. This results in a vertical profile of ion production rate, determined by atmospheric density and GCR flux. The region of maximum ion production is known as the Pfotzer-Regener Maximum. On Earth this occurs at 15-20 km, well above the tropospheric clouds. The thick sulphuric acid cloud deck on Venus, on the other hand, coincides with this maximum at about 60 km. The presence of charge is known to influence cloud droplet microphysics on Earth, affecting the formation, growth, stability, and persistence of cloud droplets. GCRs are also known to modulate the observed atmospheric brightness on Uranus and Neptune, through their influence on droplets. It is therefore likely that the electrical effect of GCR ionisation also plays a crucial role in cloud behaviour on Venus.

The VENI (Venusian Electricity, Nephology, and Ionisation) project presented here examines the effects of charge on droplet lifetime and behaviour in a range of conditions. For this, individual droplets are initially levitated in an acoustic wave, processed visually using a high-speed camera, and monitored to determine evaporation timescales and related physical behaviour. A corona source is used to produce the ionisation rates typical of Venusian clouds, and to simulate transient space weather events such as solar flares. The droplet's polarity and charge magnitude are measured by creating an electric field around the droplet and observing the deflection. Secondary electrostatic levitation provides further droplet charge information. The results of these experiments are expected to produce unique experimental data with relevance to the atmospheric electricity and cloud microphysics in planetary atmospheres, provide further information relating to whether or not a GEC may occur on Venus, and will be important in future mission design and hazard mitigation.