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New approach for synthetic fits of Langmuir probe sweeps inside non-monotonic potential sheaths with applications for the Rosetta mission

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The Rosetta space mission ended 30 September 2016 and left us with over 2 years's worth of in situ comet measurements, covering parts of comet 67P's orbit towards and away from the Sun. The Rosetta Plasma Consortium (RPC) were responsible for a set of instruments that measured the comet's complex plasma environment, including two Langmuir probes (LAP) operated by the Swedish Institute of Space Physics, Uppsala (IRFU). LAP was mostly set to sweep mode, receiving current responses to varying levels of potential differences between probe and spacecraft (I-V characteristics). This has allowed the RPC-LAP team to estimate local plasma densities and temperatures, as well as measure the EUV flux from the Sun, and the spacecraft potential. In the current project, we take into account recent laboratory experiments of surface plasma emission and consider the presence of not only classical potential sheaths formed from the spacecraft surface expressible as a Debye sheath, but also non-monotonic sheaths with characteristic local maxima away from the spacecraft surface. We construct synthetic I-V characteristics using a combination of plasma parameters measured by previous RPC-LAP projects, and approximate the effect of the changing potential sheath on the I-V characteristics as an energy barrier similar to that formed by the probe in a monotonic sheath. Subsequently, we use Boltzmann factors to scale the local plasma density, and perform statistical analyses to compare the synthetic data with case studies of sweeps from the Rosetta mission. For instance, we compare the spread of the measured electron density with proxies for the spacecraft potential in the synthetic and real data. The synthetic I-V characteristics created in this project form the beginning of a project to take into account the complexity of potential sheaths formed by spacecrafts for Langmuir probe measurements in space.