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# Positive and negative ion outflow at Rhea as observed by Cassini

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Rhea is Saturn's largest icy moon and hosts an ethereal oxygen and carbon-dioxide atmosphere as was detected when Cassini observed positive and negative pickup ions outflowing from the moon and an extended neutral exosphere. These pickup ions can form current systems which, with the resulting jxB force, act to slow-down the incident magneto-plasma and cause field-line draping. As well as impacting the plasma interaction, the composition and density of picked up ions provide key diagnostics of the moon's sputter-induced atmosphere and surface. During the first Cassini-Rhea encounter (R1), the Cassini Plasma Spectrometer (CAPS) observed positively and negatively charged pickup ions before and after passing through the moon's plasma wake respectively, in agreement with their anticipated cycloidal trajectories. On the subsequent more distant wake encounter (R1.5) however, only positively charged pickup ions were observed, indicating high loss rates of the negative ions in Saturn's magnetosphere. Here, using an updated model of Cassini's Electron Spectrometer response function, we are able to estimate the outward flux of negatively charged pickup ions, the first time such a plasma population has been constrained. Using test-particle simulations we trace both the positive and negative particles back to Rhea's exobase to better understand their production and loss processes and the implications for Rhea's sputter-induced exosphere. We also look to examine whether the calculated ion densities could generate ion cyclotron wave activity.