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Properties of the lunar wake inferred from hybrid-kinetic simulations and an analytic model

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There is renewed interest in the Moon as a potential base for scientific experiments and space exploration. Earth's nearest neighbour is exposed directly to the solar wind and solar radiation, both of which present hazards to successful operations on the lunar surface. In this paper we present lunar wake simulation and analytic results and discuss them in the context of observations from the ARTEMIS mission. The simulation results are based on hybrid-kinetic simulations while the analytic model is based on the formalism developed by [Hutchinson, 2008]. The latter makes assumptions of cylindrical geometry, a strong and constant magnetic field, and fixed transverse velocity and temperature. Under these approximations the ion fluid equations (with massless electrons) can be solved analytically by the method of characteristics.
In this paper the formalism presented by Hutchinson is applied by including plasma density variations and flow within the lunar wake. The approach is valid for arbitrary angles between the interplanetary magnetic field and solar wind velocity, and accounts for plasma entering the wake region from two tangent points around the Moon. Under this condition, two angle-dependent equations for ion fluid flow are obtained, which can be solved using the method of characteristics to provide the density inside the wake region. it is shown in Fig1 and Fig2 that the model provides excellent agreement with observations from the ARTEMIS mission [Angelopoulos, 2011], and with large-scale hybrid-kinetic plasma simulations [Paral and Rankin, 2012].
It will be shown that the analytic model provides a practical alternative to large-scale kinetic simulations, and that it is generally useful for determining properties of the lunar wake under different solar wind conditions. It will be useful as well for predicting properties of the plasma environment around the Moon that have not yet been visited by spacecraft.

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-Hutchinson, I. (2008),Oblique ion collection in the drift approximation:How magnetized Mach probes really work, Physics Of Plasmas, 15, 123503, doi: 10.1063/1.3028314
-Angelopoulos, V. (2011), The ARTEMIS mission, Space Sci. Rev. (Netherlands), 165(1-4), 3–25.
-Paral and Rankin (2012),Dawn-dusk asymmetry in the Kelvin-Helmholtz instability at Mercurry, Nature Communications, 4, 1645, doi:10.1038/ncomms2676,

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