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Orbital-motion-limited theory of dust charging and plasma response[1] XIANZHU TANG, GIAN LUCA DELZANNO, Los Alamos National Laboratory — The foundational theory for dusty plasmas is the dust charging theory that provides the dust potential and charge arising from the dust interaction with a plasma. The most widely used charging theory for negatively charged dust particles is the so-called orbital motion limited (OML) theory, which predicts the dust potential and heat collection accurately for a variety of applications, but was previously found to be incapable of evaluating the dust charge and plasma response in any situation. Here we report a revised OML formulation that is able to predict the plasma response and hence the dust charge. It involves a corrected OML ion density expression for the background plasma where the plasma potential rises faster than $1/r^2$, which is always the case in the Debye shielding region. We also provide the first calculation of the plasma potential and the dust charge using the OML theory. Significant deviation from the Whipple approximation of the dust charge is found when the dust size is comparable to or larger than the Debye shielding length, which is a case of importance to laboratory applications, particularly magnetic fusion. This is attributed to the fundamental role of angular momentum conservation in setting the plasma electron and ion density near the dust particle.

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