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Sheath collapse at critical magnetic field angle due to kinetic effects

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The Debye sheath is shown to vanish completely in magnetised plasmas for a sufficiently small electron gyroradius and small angle between the magnetic field and the wall. This angle depends on the current onto the wall. When the Debye sheath vanishes, there is still a potential drop between the wall and the plasma across the magnetic presheath. The magnetic field angle corresponding to sheath collapse is shown to be much smaller than previous estimates, scaling with the electron-ion mass ratio and not with the square root of the mass ratio. This is shown to be a consequence of the finite ion orbit width effects, which are not captured by fluid models. The wall potential with respect to the bulk plasma at which the Debye sheath vanishes is calculated. Above this wall potential, it is possible that the Debye sheath will invert.

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