Two-fluid tearing mode instability in cylindrical geometry

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The two-fluid tearing mode instability in a plasma cylinder of finite aspect ratio is investigated. An analytic dispersion relation for a force-free equilibrium with constant density and temperature in the cylindrical geometry for general ion skin depths, the characteristic length of the two-fluid effect, has been derived by extending the theory for the slab geometry [1]. The dispersion relation shows the continuous dependence of the growth rate and the real frequency on the ion skin depth d_i ranging from single MHD limit ($d_i << L$) to electron MHD ($d_i >> L$). Analytic representations of dispersion relations that cover a wide range of parameters are useful to carry out benchmark tests of extended-MHD simulation codes [2]. It is found that the real frequency appears due to the combination of the two-fluid and curvature effects. The scaling law for the real frequency in the regions of small and large skin depth as well as for the growth rate is also found. The numerical analysis shows good agreement with analytical dispersion relation and inner solutions of eigenfunctions for a wide range of the ion skin depth and resistivity.

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