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Transonic Flow in a Tokamak[1] ELIEZER HAMEIRI, Courant Institute-NYU, LUCA GUAZZOTTO, University of Rochester — Observed poloidal velocity V_p in tokamaks is of the order of the poloidal sound speed ($c_{sp} \equiv c_s B_p/B$). At this range, the governing Grad-Shafranov (GS) equation changes type twice: From elliptic near the center (low velocity) to hyperbolic where $V_p \simeq C_{sp}$ and back to elliptic when the velocity is higher still. Previous work established the existence of a contact discontinuity across which density falls and the Mach Number increases. The GS equation is solved as if it is elliptic and a hyperbolic region never appears, presumably because it is very narrow. Here we consider this matter analytically. First, we approximate the nonlinear GS equation such that it can be solved analytically. Second, we construct a linear model problem having similar transitions of type as the transonic plasma equation. The model problem is solved analytically and shows the expected hyperbolic region. We treat the equation asymptotically, expanding in the ratio of sound to Alfvén speed, corresponding to the width of the hyperbolic region. As this becomes very small, the hyperbolic region shrinks to naught, leaving no trace left over, so that solving the GS equation as an elliptic problem with a contact discontinuity yields the correct asymptotic approximation to the solution.

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Luca Guazzotto
University of Rochester

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