Near-Axis Expansions for Stellarators without the Assumption of Magnetic Surfaces NATHAN DUIGNAN, JAMES MEISS, University of Colorado, Boulder — The study of the structure of magnetic fields near the axis of a toroidal confinement device is known from the classical works of Solov'ev and Shafranov and Lortz and Nuhrenberg in the 1970s. The magnetic axis is taken to be a closed space curve determined by its local curvature and torsion. In these classic studies, as well as more recent work, it is conventional to assume the existence of magnetic surfaces as would be guaranteed by the magnetostatics equation $J \times B = \nabla p$. We revisit this calculation, without making the assumption of local surfaces, for the case of (near) vacuum fields. It is of interest, that instead of solving for a magnetic potential, $B = \nabla \phi$, one can reformulate the set of equations to find the vector potential $B = \nabla \times A$. At the magnetic axis the local coordinate system is chosen to rotate with the torsion of the axis, and Floquet theory is used to obtain the lowest order, linear behavior of the field lines. It is interesting that even if the local field lines are "instantaneously" of hyperbolic character, the one-period flow can be elliptic. A version of Hamiltonian Birkhoff-normal form theory with resonances, adapted to the situation of field-line flows, can be used to construct higher-order terms.

James Meiss
University of Colorado, Boulder

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