APPLIED MATHEMATICS COLLOQUIUM

Integral equation methods for Beltrami Fields, Electromagnetics, and Plasma Equilibria

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Abstract: Beltrami (force-free) fields B are those vector fields which are proportional to their own curl: curl(B) = kB, with k a scalar. Beltrami fields arise in many areas of applied mathematics and physics. For example, in fluid dynamics, Beltrami flows are those flows whose velocity and vorticity are parallel. In plasma physics, magnetic Beltrami fields inside a fusion device at equilibrium arise via Lorentz force balancing under constant pressue. In this talk, I will describe recently developed integral equation methods for calculating Beltrami fields, paying special attention to toroidal geometries (with problems in plasma physics in mind). By viewing Beltrami fields as special-case time-harmonic Maxwell fields (with wavenumber k), their calculation can be reduced to a boundary integral equation similar to those found in electromagnetics. Using existing integral representations for electromagnetic fields, robust representations of Beltrami fields and well conditioned integral equations are immediate consequences.

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