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TH/P2-29: Anisotropic Heat Transport in Integrable and Chaotic 3-D Magnetic Fields

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Understanding heat transport in magnetized plasmas is a problem of fundamental interest in controlled fusion. Three issues make this problem particularly difficult: (i) The extreme anisotropy between the parallel (i.e., along the magnetic field), EMBED Equation.3 , and the perpendicular, EMBED Equation.3 conductivities; (ii) magnetic field lines chaos which in general precludes the construction of magnetic field line coordinates; and (iii) nonlocal parallel flux closures in the limit of small collisionality. Motivated by the extreme anisotropy encountered in fusion plasmas, in which the ratio EMBED Equation.3 may exceed 1010, we mainly focus on the study of purely parallel transport, i.e., EMBED Equation.3 , but also report on recent extensions of the method to incorporate perpendicular transport and sources. Me propose a Lagrangian-Green's function (LG) that bypasses the need to discretize and invert the transport operators on a grid. The proposed method allows the integration of the parallel transport equation without perpendicular pollution, while preserving the positivity of the temperature field, and it is applicable to local and non-local parallel flux closures in integrable, weakly chaotic, and fully chaotic magnetic fields. We present applications of the method to: (i) Non-diffusive radial transport in fully chaotic magnetic fields, and fractal properties in weakly chaotic fields, (ii) parallel transport in the presence of internal transport barriers in reversed shear magnetic field configurations, and (iii) finite EMBED Equation.3 anisotropic transport. Concerning (i), we provide numerical evidence of non-diffusive effective radial transport (with both local and non-local closures) that casts doubts on the applicability of quasilinear diffusion descriptions. General conditions for the existence of non-diffusive, multivalued flux-gradient relations in the temperature evolution are derived. For (ii), we focus on the study of shearless Cantori, i.e. partial transport barriers located at the minimum of q. Finally, regarding (iii), we report on recent developments on the applications of the extended LG method to study transport in magnetic islands in the presence of sources with finite

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