Theoretical and experimental heat diffusivities in the DIII-D edge plasma

W. M. Stacey
Georgia Tech, Atlanta, GA, 30332

We have previously developed a methodology[1] for inferring experimental heat diffusivities in the plasma edge from measured temperature and densities profiles and other quantities which takes into account radiative cooling, recycling neutrals, convection, transient heating and other important effects. More recently, working in consultation with several transport theorists and modelers, we have implemented the capability to also use the same experimental data to predict the heat diffusivities in the plasma edge according to various models and theories (ions—neoclassical[2], itg[3], drift Alfven modes[4], radiative thermal instabilities[5]; electrons—paleoclassical[6], etg[7], tem[8], drift resistive ballooning modes[9], radiative thermal instabilities[5]) reported in the literature and used in transport codes.

A comparison of experimentally inferred and theoretically predicted ion and electron thermal diffusivities has been made for 2 H-mode and 1 L-mode shots in DIII-D. Threshold conditions for the onset of itg, the coupled tem, and etg modes were evaluated using the experimental data. The effects of *ExB* and *dq/dr* shear were investigated, using experimental values of the radial electric field and the safety factor.

A summary of the results for the L-mode shot is shown in Figs. 1.(neo_ch = neoclassical Chang-Hinton, itg = ion temperature gradient, da = drift Alfven, ti = thermal instability, paleo = paleoclassical, tem = trapped electron mode, drb = drift resisitive ballooning). Two values of the inferred experimental heat diffusivities are shown (stars): "Eq56" uses the conductive heat flux profile, and "Eq60" uses the total heat flux profile. More detailed results comparing various models will be presented for the L-mode shot and for 2 H-mode shots.

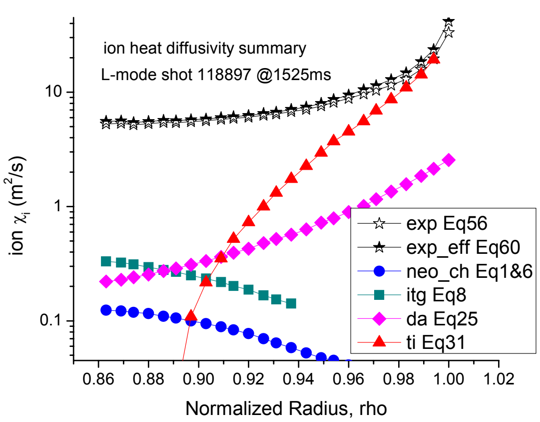

Figure 1a Summary of ion heat diffusivity comparison of theory with experiment for DIII-D ELM-free L-mode shot 118897.

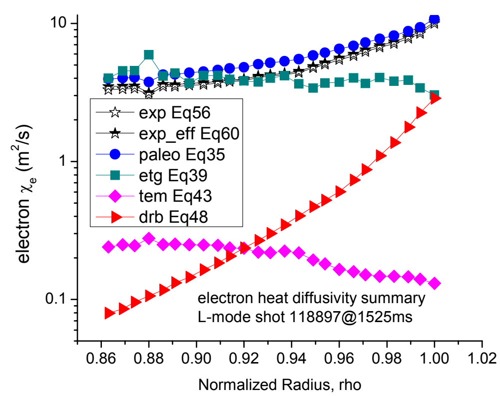

Figure 1b Summary of electron heat diffusivity comparison of theory with experiment for DIII-D ELM-free L-mode shot 118897.

[1] PoP,13,072510(2006); PoP,13,112506(2006); PoP,14,012501(2007); PoP,14,122504(2007).
[2] PF,25,1493(1982); PF,29,3314(1986); PFB,4,2547(1992).
[3] NF,26,1515(1986); PoP,7,1494(2000); *Collective Modes*,IOP,Bristol(2000); NF,45,468(2005); PoP,2,1648(1995); PPCF,47,483(2005); PPCF,39,1461(1997).
[4] PRL,81,4396(1998); CPP,38,118(1998). [5] PoP,6,2452(1999). [6] NF,45,1120(2005).
[7] PoP,8,4096(2001); *Tokamaks*,Clarendon,Oxford(1997); PPCF,48,A93(2006); PFB,4,319(1992);PoP,7,1494(2000).
[8] NF,11,67(1971); *Collective Modes*,IOP,Bristol(2000).
[9] PFB,4,1846(1992); PFB,5,3712(1993); PoP,5,1793(1998); PRL,87,3230(1997).