# Recent Gyrokinetic Simulations with GYRO: Bohm Transport in DIII-D, the Local Limit of Global Simulations, and Transport Across a Minimum-q Surface*

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**Abstract**

In this presentation we summarize results from three major transport studies carried out with the global Eulerian gyrokinetic code, GYRO.[1] First, and most importantly, we discuss comprehensive simulations[2] which match, within experimental error bounds, the turbulent transport levels observed in DIII-D L-mode discharges 101381 and 101391. The experimentally-observed Bohm-like scaling of ion transport in these discharges was recovered, and the sensitive dependence of both electron and ion transport on ion temperature gradient was also explored. These were full-physics simulations which included trapped and passing electrons with pitch angle collisions, finite-$\beta$ fluctuations, real DIII-D flux-surface shape, linear and nonlinear $\mathbf{E} \times \mathbf{B}$ rotation, parallel flow shear, and radial variation of all equilibrium quantities.

Next, we revisit the issue of gyroBohm scaling (and the breaking thereof) in the context of a certain adiabatic-electron test case favoured by the GTC code.[3] For this case, we have shown that transport levels from local and global GYRO simulations are perfectly matched in the limit of small $\rho_* = \rho_i/a$. We also show that this limiting value is identical to the local value obtained by Dimits.[4] The confluence of local and global results, which we observe repeatedly and robustly, has been previously noted[5] in a more general context. For this particular case, we show that the transition point in $\rho_*$, where gyroBohm gives way to worse-than-gyroBohm scaling, is strongly dependent on the temperature-gradient profile. In particular, use of the original "humped" GTC profile leads to the requirement $\rho_* \lesssim 1/375$ for gyroBohm scaling, whereas the use of a more physical temperature-gradient profile in the same scenario gives rise to gyroBohm scaling and recovers the local limit at the much larger value $\rho_* \lesssim 1/150$.

Finally, we examine a conjecture regarding ion transport barrier formation in the vicinity of a minimum-$q$ surface.[6] The validity of the conjecture relies, ostensibly, on the absence of ITG modes in the minimum-$q$ region. Indeed, fluid transport simulations[7] have shown that when so-called nonresonant modes are ignored, a minimum-$q$ region can give rise to a barrier. However, a series of linear and nonlinear, as well as local and global, GYRO simulations show no evidence of mode suppression or of transport reduction in the minimum-$q$ region. Instead, we find that transport is smoothly increasing across a minimum-$q$ surface, and that this region is populated by nonresonant ITG modes characteristic of the low-shear regime. We also observe that as $\rho_* \to 0$, transport computed via a global simulation agrees with that from local simulations, even at the point where $s = 0$.

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