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Study of collisional effects on GAMs and zonal flows

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Using the gyrokinetic code CGYRO [1] employing the model collision operator of Sugama [2], essentially the gyro averaged lowest order Hirshman-Sigmar operator the transition between the fully kinetic and the fully fluid regime has been mapped for GAMs and zonal flows. The collision operator is sufficiently accurate to reproduce the two-fluid damping of the GAMs and residual zonal flows in the limit of large collision number. Some surprises are found for the GAMs: A small number of collisions reduces the collisionless damping, possibly due to the destruction of resonant orbits. After reaching a minimum, the damping rate grows again for increasing collision frequency. Eventually, for edge typical safety factors, a maximum occurs in the damping rate at $\nu_{ii} \sim \omega_{GAM}$. The maximum damping is relatively small (much smaller than the one of the zonal flows) so that the worst quality factor of the GAM resonance is still of the order ~ 100 – which would allow, e.g., its external excitation. Finally, at very high collision numbers the damping rate decreases again, while the frequency approaches the fluid value [3,4].

References

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