# Investigation of zonal flow stability using spatial averaging

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Zonal flows are of great interest inside magnetically-confined plasmas as their interaction with turbulence may in principle be used to control plasma confinement via processes such as shearing of turbulent eddies due to the alternating nature of the velocities of the zonal flows. Zonal flows are structures with a poloidal wavenumber of zero and a larger radial wavenumber but with plasma flow in the poloidal direction. The growth of zonal flows from drift modes has been extensively studied and non-linear processes are found to be the driving forces, chiefly 4-wave interactions. The linear decay of zonal flows can be attributed to energy transfer to compressible poloidal oscillations(GAMs) via Landau damping and the non-linear decay can be attributed to a tertiary Kelvin-Helmholtz instability. However, building upon previous work, the linear stability of zonal flows was re-examined using a spatial averaging technique. In particular the spatial averaging was applied to the dispersion relation obtained from the linearised Extended Hasegawa-Wakatani equations. The spatially independent dispersion relation was solved to yield linear growth rates for a small drift wave perturbation against a zonal flow background. The growth rates come from resonance terms which suggests Landau-damping of zonal flows and transfer of energy to drift waves. The growth rates and energy predictions were compared to measurements from a simulation and found to match reasonably well under a certain range of parameters.