Calculation of the gyroviscosity using a gyrokinetic formalism[1]

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— Gyrokinetic variables for parallel velocity, magnetic moment,
gyroangle and gyrocenter are obtained for arbitrary perpendicular wavelength electrostatic fluctuations to second order in the expansion for small Larmor radius of
the background magnetic field by demanding the gyrokinetic equation contain no
gyrophase dependent terms order by order. The resulting nonlinear gyrokinetic
equation is valid for arbitrary collisionalities and perpendicular wavelengths for electrostatic turbulence. The distribution function in these gyrokinetic variables when
Taylor expanded for large perpendicular wavelengths recovers the correct gyroviscosity and Reynold's stress tensor found by drift kinetic [1] and moment [2] approaches.
The full gyrokinetic generalization of the gyroviscosity and Reynold's stress tensor
is expected to be required to evaluate the coupling of the axisymmetric portion of
the radial electric field associated with zonal flow and neoclassical toroidal angular
momentum transport.

[1] A. N. Simakov and P. J. Catto, Phys. Plasmas 12, 012105 (2005).
[2] J. J. Ramos, Phys. Plasmas 12, 052102 (2005).

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