Overview of GK theory with emphasis on conservation properties

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The modern theory of gyrokinetics is briefly reviewed. Dynamics is described in terms of a Lagrangian with canonical structure – dependent field variables appear only in the time component. The gyrokinetic and associated field equations are derived from the same Lagrangian by varying gyrocenter coordinate positions and field amplitudes. Energetic consistency follows from the general symmetry implied by the support of the equations by the Lagrangian, via the Noether theorem. Both local and global conservation forms are given. Conversion from canonical to plasma momentum uses the charge conservation equation which follows from continuity. The specific role of the time-dependent polarisation current is emphasised. All terms share the same symmetry properties, not only the lowest order ones; an example using a Lagrangian with finite ExB Mach number including third-order drift effects is given. Symmetry is dynamical/statistical, not spatial, and is evaluated using the PDF of zonal averages over a saturated turbulent state. Symmetry results from both local and global models are presented.