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Metriplectic Dynamics via Coupling to a Lie Group

Metriplectic systems provide a geometric formulation of non-equilibrium thermodynamics. They conserve total energy while a Casimir function, which plays the role of thermodynamic entropy, evolves monotonically. We describe a class of metriplectic systems obtained by coupling a Hamiltonian system to a Lie group via an equivariant momentum map. The dynamics couple a Hamiltonian flow with a double bracket (gradient) flow of the momentum map on a compact coadjoint orbit. Solutions of the metriplectic system can be constructed from the Hamiltonian flow by adding a geometric phase, and hence, the metriplectic contribution vanishes under projection to the symmetry-reduced manifold. We also show that the metriplectic entropy can be related to Shannon entropy by adding stochastic noise. As entropy production vanishes, the invariant measures of the stochastic processes converge to Souriau-Gibbs states on the coadjoint orbit at both finite and infinite (generalized) temperature. This is joint work in progress with Anthony Bloch.