Detailed balance

- Detailed balance sufficient, but not necessary condition for stat mech
- If the states α and ρ^* both are time-reversal invariant, the difference $P_{\alpha\beta}\rho^*_\beta - P_{\beta\alpha}\rho^*_\alpha$ is unchanged under time-reversal, while the net flux $\beta \to \alpha$ changes sign. Detailed balance follows from time-reversal invariance.
- Magnetic fields break time-reversal invariance (Exercise 9.13), so detailed balance need not hold.
- Flows in phase space have states $(\mathbb{P}, \mathbb{Q}) \to (-\mathbb{P}, \mathbb{Q})$ that are not invariant under time-reversal; for free particles the rate $(\mathbb{P}, \mathbb{Q}) \to (\mathbb{P}, \mathbb{Q} + \mathbb{P}\Delta t/m)$ is big, and $(\mathbb{P}, \mathbb{Q}) \to (\mathbb{P}, \mathbb{Q} - \mathbb{P}\Delta t/m)$ is small.