

Practice Problems Related to Rate Equations and Detailed Balance

1. Explicitly show that the “neutrino Einstein relations” (see equations (8) and (9) in the notes) are the same as the normal photon Einstein relations.
2. Actual atoms have more than two levels. Suppose that you have a three-level atom. Carry out the same analysis as for the normal two-level Einstein relations. What do you find?
3. Explicitly list astronomical sources, and/or events, that are or are *not* in (a) thermal, (b) dynamical, and (c) nuclear equilibrium.