Abstract Submitted
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Entropy Exchange in Laser Cooling[1] H. METCALF, Stony Brook Univ. — Laser cooling is usually viewed as velocity space compression by a velocity-dependent optical force. Since such forces do not conserve energy, their full description must include the energy added to the light field at a frequency above that of the laser beams by spontaneous emission (SpE). Thus the light field must be part of the system under consideration. It is usually presumed that SpE is necessary to remove the entropy lost by the atoms. A closer look suggests that SpE does this by redistributing the light among the multitude of empty states of the radiation field. Here we show that the laser beams themselves constitute a sufficiently large reservoir of states so that stimulated emission can do precisely the same thing. We compare the entropy lost by the atoms with the entropy capacity of the laser beams. The entropy exchange between the atoms and the laser fields does NOT constitute a loss of entropy but merely its redistribution among parts of the system. Thus it doesn't violate the Liouville theorem or unitarity because neither the total entropy nor the system's phase space volume is reduced, but merely exchanged between its parts. The entropy in the light field is not dissipated until the outgoing beams hit the walls in a non-conservative, irreversible process. The walls are not part of the system, just as the empty modes into which SpE dumps the light are not usually part of it.

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