Summary: We discuss the energy density, temperature and entropy of dark matter (DM) and dark energy (DE) as functions of the scale factor $a$ in an expanding universe. In a model of non-interacting dark components we repeat a derivation from thermodynamics of the well-known relations between the energy density, entropy and temperature. In particular, the entropy is constant as a consequence of the energy conservation. We consider a model of a DM/DE interaction where the DM energy density increase is proportional to the particle density. In such a model the dependence of the energy density and the temperature on the scale factor $a$ is substantially modified. We discuss (as a realization of the model) DM which consists of relativistic particles diffusing in an environment of DE. The energy gained by the dark matter comes from a cosmological fluid with a negative pressure. We define the entropy and free energy of such a non-equilibrium system. We show that during the universe evolution the entropy of DM is increasing whereas the entropy of DE is decreasing. The total entropy can increase (in spite of the energy conservation) as the DM and DE temperatures are different. We discuss non-equilibrium thermodynamics on the basis of the notion of the relative entropy.

MSC:

83F05 Relativistic cosmology
85A40 Astrophysical cosmology
83C55 Macroscopic interaction of the gravitational field with matter (hydrodynamics, etc.)
80A10 Classical and relativistic thermodynamics
94A17 Measures of information, entropy

Keywords:
relative entropy; temperature; expanding universe; dark matter/dark energy interaction

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