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Relic neutrinos: Physically consistent treatment of effective number of neutrinos and neutrino mass[1] JEREMIAH BIRRELL, Progam in Applied Mathematics, University of Arizona, JOHANN RAFELSKI, Department of Physics, University of Arizona — It is well known that the effective number of cosmic neutrinos, N_ν, is larger than the standard model number of neutrino flavors $N_\nu^f = 3$ due a small flow of entropy into neutrinos from $e\pm$ annihilation. Observational bounds from both BBN and the CMB suggest a value of N_ν that is larger than the current theoretical prediction of $N_\nu = 3.046$. We show in a model independent way how N_ν relates to the neutrino kinetic freeze-out temperature, T_k, which we treat as parameter. We derive the relations that must hold between N_ν, the photon to neutrino temperature ratio, the neutrino fugacity, and T_k. Our results imply that measurement of neutrino reheating, as characterized by N_ν, amounts to the determination of T_k. We follow the free streaming neutrinos down to a temperature on the order of the neutrino mass and determine how the cosmic neutrino properties i.e. energy density, pressure, particle density, depend in a physically consistent way on both neutrino mass and N_ν. We continue down to the present day temperature and characterize the neutrino distribution in this regime as well. See arXiv:1212.6943, PRD in press.

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