Abstract Submitted
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Quantum Statistics and Astrophysical Photodisintegration Rates[1] GRANT MATHEWS, University of Notre Dame, YAMAC PEHLIVAN, Mimar Sinan Fine Arts University, TOSHITAKA KAJINO, National Astronomical Observatory of Japan, BAHA BALANTEKIN, University of Wisconsin — Tabulated rates for astrophysical photodisintegration reactions make use of Boltzmann statistics for the photons as well as the interacting nuclei. Here we derive analytic corrections for the Planck-spectrum quantum statistics of the photon energy distribution. These are deduced directly from the detailed-balance condition without the assumption of equilibrium. We show that these corrections affect not only the photodisintegration rates but also modify the conditions of nuclear statistical equilibrium. We deduce new analytic corrections to the classical Maxwell- Boltzmann statistics which can easily be added to existing reaction network tabulations. We show that the effects of quantum statistics, though generally small, always tend to speed up photodisintegration rates and become significant for nuclei and environments for which $Q/kT \lesssim 5$. We examine possible effects of these corrections on the r-process, the rp-process, the γ-process, and big bang nucleosynthesis. We find that, although in most cases one is justified in neglecting these corrections, several cases arise for which significant corrections could occur. These include an r-process with very high neutron density, or an rp- process with reactions dominated by a low-lying resonances and low proton separation energies.

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