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Total statistical weights of atoms and ions

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The total statistical weight of an atom or ion equals the number of energy levels of the atom or ions when subjected to a magnetic or an electric field (Zeeman or Stark effect). In the theoretical limit of zero perturbation the number of bound levels goes to infinity, as does the total statistical weight. With a known perturbation the statistical weight is finite and can be calculated by summating 2J+1 for all levels which are degenerated in zero electric and magnetic fields, the m levels. The structure of the J states depends on the coupling scheme, the Glebsch-Gordon coefficients. The number of levels for each J corresponding to a principal quantum number n is independent of the scheme. Here I will present one formula for the total statistical weight between any chosen principal quantum numbers for any Rydberg Sequence. The statistical weight contribution is surprisingly easy: $f(L_p,S_p)\cdot n^2$, where $\mathbf{L}_p$ and $\mathbf{S}_p$ are the orbital and spin angular momentum quantum numbers of the parent term to the Rydberg Sequence. This helps improve the calculations of atomic and ionic partition functions. Each m-level makes the contribution of unity to the statistical weight and its contribution to the partition function is $\exp(-E/kT)$, where E, k and T are the excitation energy of the level, the Boltzmann's constant and the temperature. Only a tiny fraction of the energy levels of atoms and ions are known (observed) for high values of the principal quantum number so the partition function must be calculated numerically. For low values of perturbation, like in stellar plasmas there are sometimes thousands of bound levels having negligible energy differences. The statistical weights of those levels are calculated with this formula and then multiplied with the $\exp(-E/kT)$ factor to get their contribution to the partition function.

Biography

Mattias Eriksson has his expertise in atomic physics and astrophysics. He started his research within atomic physics at Lund University where he took his PhD in 2006. There he did research about hyperfine structure of atoms, symbiotic stars (topic of PhD) and radiation processes. After his time in Lund he worked as research fellow at Space telescope science institute in Baltimore, USA and as high school teacher in Jönköping, Sweden. Since 2010 he is working at a University College in Karlskrona, Sweden where he is teaching mathematics and physics. His research is currently within statistical weights and partition functions.

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