A Lorentz invariant velocity distribution of a relativistic gas

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We examine the problem of the relativistic velocity distribution in a 1-dim relativistic gas in thermal equilibrium. We use numerical simulations of the relativistic molecular dynamics for a gas with two components, light and heavy particles. However in order to obtain the numerical data our treatment distinguishes two approaches in the construction of the histograms for the same relativistic molecular dynamic simulations. The first, largely considered in the literature, consists in constructing histograms with constant bins in the velocity variable and the second consists in constructing histograms with constant bins in the rapidity variable which yields Lorentz invariant histograms, contrary to the first approach. For histograms with constant bins in the velocity variable the numerical data are fitted accurately by the Jüttner distribution which is also not Lorentz invariant. On the other hand, the numerical data obtained from histograms constructed with constant bins in the rapidity variable, which are Lorentz invariant, are accurately fitted by a Lorentz invariant distribution whose derivation is discussed in this presentation. Our derivation is based on the special theory of relativity and the central limit theorem. For $v^2/c^2 << 1$ and $k_{B}T/(m_0 c^2) <<1$ the distribution tends to the Maxwell–Boltzmann distribution.