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Maxwell-Juttner distribution for ideal gas of spinning particles

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We consider a statistical mechanics of a rotating gas of massive relativistic particles with nonzero spin. Applying the formalism of Gibbs ensembles, we derive a one-particle distribution function by positions, momenta, and directions of spin. For zero angular velocity, the distribution coincides with well-known Maxwell-Juttner distribution. For nonzero angular velocity, corrections caused by the presence of spin can be observed. The main attention is paid to the distribution function by directions of spin, and its dependence on angular velocity. It is shown that the rotation causes the polarization of the gas, with the majority of spins being directed along the angular velocity vector. This phenomenon is well known in non-relativistic systems, but the relativity increases the magnitude of the effect at high temperatures. We also observe a special kind spin-orbital interaction: the distribution function on-axis and off-axis affects in different ways. The phenomenon has no analogue in non-relativistic gas.

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