Equilibrium particle distribution in a static gravitational field

Tadas Nakamura[1]

[1] FPU

http://mira.bio.fpu.ac.jp

Particle distribution function at thermal equilibrium in a gravitational field have been investigated. It is known from the relativistic thermodynamics that local temperatures in a macroscopic equilibrium state in a gravitational field are not uniform, but become higher at lower potential points. This is because energy is equivalent to mass in relativity, and subject to the gravitational field. The microscopic particle distribution function in this state is the subject of the present study.

We assume the equilibrium state with a constant acceleration in a flat spacetime (Minkowsiki spacetime) instead of in a curved spacetime assuming the acceleration has essential the same effect as the gravitation, as usually done in this kind of study.

What we employ here is the Maximum entropy approach based on information theory proposed by Jaynes. The conservation laws such as the energy conservation play the essential role in this approach. In
relativity, not only the energy but the momentum and angular momentum play the same role. The angular momentum is the conserved quantity resulting from the rotational symmetry in the four dimensional Minkowski space. It has six components; three correspond to ordinary spatial rotation and other three corresponds to the Lorentz boost. The conservation of the latter three determines the equilibrium particle distribution with constant acceleration.

The result of the Maximum entropy calculation will be reported along with a discussion on its applicability.