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Subquantum Processes as the True Cause of the Canonical Distribution and the Entropy

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Abstract

This paper views canonical distribution as the consequence of subquantum processes. It is these processes that lead to the macrosystem's irreversible evolution towards the maximum freedom in realizing its state, *i.e.* towards maximum entropy. The paper presents a formula which connects the macrosystem's entropy with the maximum number of its state realizations as a consequence of subquantum processes.

Keywords

Canonical Distribution, Entropy, Subquantum Processes, Irreversibility

1. Introduction

Papers [1] [2] interpret the observed physical phenomena as a manifestation of certain processes in the subquantum world. Accordingly, physical formulas represent a mathematical reflection of such processes.

A fundamental thermodynamic value entropy S is linked to one of the most important formulas of statistical physics, canonical distribution,

$$\rho(E_n) = \frac{e^{-\beta E_n}}{\sum_m e^{-\beta E_m}}.$$

through the equation

$$\ln \rho(E) = -S$$

here, E is the energy of a macroscopic system.

Thus, it is clear that if we want to understand the physical basis of entropy, we should understand what physical processes are reflected by the formula of canonical distribution.

Two models are used for the derivation of canonical distribution. In one of them, the system under consideration is assumed to be a sub-system of a very large system; the environment of the sub-system is often called the thermostat. But since the boundaries of the thermostat are unknown, as it is unknown what is beyond them, the total system is called the Universe, modestly placed in quotation marks—"Universe" (e.g. see [3]). Only eigenstates of the "Universe" are considered as the "Universe" states. All states of the "Universe" are assumed to be equiprobable, *i.e.* the "Universe" is assumed to be in equilibrium.

In another model the "Universe" is assumed to consist of an enormous number of systems identical to the system under consideration [3].

Paper [2] has demonstrated that the above assumptions do not have any relation to physical reality. Instead of reasonable physical models, mathematical schemes are used to manipulate the achievement of desirable results. We have got used to these artificial schemes for the lack of others, but our habit can't make them true.

In [2] we used the method of the most probable distribution [3] [4] to derive canonical distribution as the most probable distribution of macrosystem states which result from subquantum processes. In [2] those processes are called hidden internal processes, the system states with energy E_n which appear as their result were called "instantaneous" states (E_{ni}-states), and the actual appearance of these states in the macrosystem was called "visits of E_{ni}-states".

Following [2], let us use N for the number of the system's cumulative visits of its "instantaneous" energy states over time t and let ν_n be the number of visits of E_{ni}-states, corresponding to the energy E_n, over this time. Obviously,

$$N = \sum\nolimits_n \nu_n \tag{1}$$

Let's introduce the value

$$E_t = \sum\nolimits_n \nu_n E_n . \tag{2}$$

Numerous "configurations" determined by various sets of numbers of visits ν_n correspond to the value E_t. Each "configuration" may be realized in P ways corresponding to the number of permutations of the visits:

$$P = \frac{N!}{\nu_1!\nu_2!\cdots\nu_l!\cdots} . \tag{3}$$

To find the maximum of the function P, [2] used the Lagrange method, which involves finding the extremum of the function

$$\ln P - \alpha\sum\nolimits_i \nu_i - \beta\sum\nolimits_i \nu_i E_i . \tag{4}$$

when conditions (1) and (2) are observed. In (4) α and β are the Lagrange multipliers.

Taking into account the Stirling approximation

$$\ln(m!) = m(\ln m - 1), \tag{5}$$

we find that the maximum of function P corresponds to the most probable distribution

$$\nu_n = \frac{N e^{-\beta E_n}}{\sum_m e^{-\beta E_m}}. \tag{6}$$

and canonical distribution

$$\rho(E_n) = \frac{\nu_n}{N} = \frac{e^{-\beta E_n}}{\sum_m e^{-\beta E_m}}. \tag{7}$$

Let us show now that entropy is determined by the maximum number of macrosystem states which are generated by subquantum processes.

The total energy of macrosystem

$$E = \sum_n \rho(E_n) E_n \tag{8}$$

Using Equations (3), (5), (6), (7), (8) and taking into account that $\sum_n \nu_n = N$, $\sum_n \rho(E_n) = 1$, for maximum P we receive:

$$\begin{aligned}
\ln P_{\max} &= \ln N! - \sum_n \ln(\nu_n!) \\
&= N(\ln N - 1) - \sum_n \nu_n (\ln \nu_n - 1) \\
&= N \ln N - \sum_n \nu_n \ln \nu_n \\
&= N \ln N - \sum_n N\rho(E_n) \ln\left(N\rho(E_n)\right) \\
&= N \ln N - N\sum_n \left(\rho(E_n)\ln N + \rho(E_n)\ln\rho(E_n)\right) \\
&= N \ln N - N \ln N \sum_n \rho(E_n) \\
&\quad - N\sum_n \rho(E_n)\ln\rho(E_n) \\
&= -N\sum_n \rho(E_n)\ln\rho(E_n) \\
&= -N\sum_n \frac{e^{-\beta E_n}}{\sum_m e^{-\beta E_m}} \ln \frac{e^{-\beta E_n}}{\sum_m e^{-\beta E_m}} \\
&= -N\sum_n \frac{e^{-\beta E_n}}{\sum_m e^{-\beta E_m}} \left(\ln e^{-\beta E_n} - \ln \sum_m e^{-\beta E_m}\right) \\
&= N\left(\beta\sum_n \rho(E_n)E_n + \sum_n \rho(E_n)\ln\sum_m e^{-\beta E_m}\right) \\
&= N\left(\beta E + \ln\sum_m e^{-\beta E_m}\right) \\
&= -N \ln \frac{e^{-\beta E}}{\sum_m e^{-\beta E_m}} \\
&= -N \ln \rho(E),
\end{aligned}$$

from which it follows:

$$\frac{\ln P_{\max}}{N} = -\ln\rho(E) = S \tag{9}$$

2. Discussion and Conclusion

Entropy is one of the fundamental concepts of science. Formula (9) connects entropy to the maximum number of system state realizations as a consequence of subquantum processes.

As we know, both classical and quantum mechanics have resulted from the observation of systems with small number of objects. If the number of objects (e.g. particles) in a system is small and calculations are possible, the mechanics show amazing accuracy. However, it is not obvious that mechanics can be directly extrapolated on the systems with macroscopic number of objects. Be that as it may, such extrapolation has caused the irreversibility problem which so far has not been theoretically resolved in terms of unitary quantum dynamics, in spite of the efforts of highly qualified scientists. Experiments [5] [6] have demonstrated that direct extrapolation of quantum mechanics on macrosystems is inaccurate.

In compliance with quantum mechanics the function of the system state can be represented as:

$$\psi = \sum\nolimits_n c_n(t)\psi_n, \tag{10}$$

where ψ_n are eigenfunctions of system Hamiltonian,

$$c_n(t) = c_n(0)\exp\left(-\frac{i}{\hbar}E_n t\right). \tag{11}$$

Quantum mechanical average system energy, *i.e.* its total energy, equals

$$E = \sum\nolimits_n |c_n|^2 E_n.$$

Remember that according to quantum mechanics the value $|c_n(t)|^2$ determines the probability of system energy being equal to E_n.

In compliance with (11) we have:

$$|c_n(t)|^2 = |c_n(0)|^2.$$

We see that quantum mechanics does not allow the system to pass into a state with a set of $|c_n(t)|^2$ different from the initial set. However, experience shows that in a macrosystem left to its own devices after an impact inducing certain initial conditions, the probability of the system's having energy E_n after some time (the relaxation time) becomes described by canonical distribution, *i.e.* it does change.

The speed of arriving at the canonical distribution does not depend on the properties of the surface of the macrosystem, nor on the structure of its environment. Thus, the influence of environment does not explain the transition of the probabilities of the system being in a state with energy E_n to canonical distribution. This means that there must be processes which determine the transition of the initial distribution of probabilities to the canonical distribution.

Hence, canonical distribution may be derived as a result of processes within the macrosystem itself—the processes not described by the existing quantum formalism. We call these processes "subquantum".

The solution of the Schrödinger equation is called the wave function. This function determines the distribution of probability of the values of the system's physical characteristics (e.g. the particle coordinates or energy). Quantum mechanics says nothing about subquantum processes which determine the distribution of probability. At the same time, the wave function is the reflection of those processes.

We consider that the states which are described by canonical distribution (7) are the consequence of the subquantum processes, which cause the macrosystem's irreversible evolution towards the maximum freedom in realizing its state with a given total energy, *i.e.* towards maximum entropy, expressed by (9).

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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