Statistical Thermodynamics

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However important the absolute temperature T may be, it is the mean thermal energy U per particle which play a fundamental role in statistics [1]. This leads to determine D(E,U) the density of probability per unit of energy for the energy E of the particles. The problem is to show that the total energy of a given volume of gas shall be calculated by summing, on small segments of energy, the number of atoms with energy on these different segments. For a number N of atoms, this sum should be equal to N times the average U value per atom of thermal energy. To respect the average value of the energy; It should also be that the total probability on the set of the possible energy values must be equal to unity. To solve the problem it should be noted that the energy exchanges that produce high or low energy particles are less probable than those who leave particles in the vicinity of the aver-age value. There is therefore a maximum of statistical weight determining the probability value around average value. On the other hand it is their own volume which forbids two particles to occupy the same place but not the exclusion principle of Pauli. The study of the variations of UD(E,U) as a function of E/U shows that the highest values are in the vicinity of energy zero. This result is normal because if one atom has a very high energy, it should be that a large number of other atoms have ceded a large part of theirs in order to respect the average U. Taking the parallel with money this is to say that it takes a lot of poor to make one rich. The complete resolution of the statistical function leads to the following expression:

$$D(E,U) = \alpha/[(AU)(1+\exp\alpha(E/U-1)] \text{ with } A = 1.7054 \text{ and } \alpha = 1.5049$$

Let us consider the condensation of a gas. When the temperature T of a gas decreases the density of probability around zero Kelvin tends to infinity. The corresponding probability tends to one. Let then Eg be the heat of vaporization or sublimation. To belong to the gas the atoms must have energy higher than Eg. The kinetic energy E of the atoms of the gas is the amount of their energy above Eg. When the corresponding mean value U tends to zero, the gas will tends to condense in a liquid or a solid. This result is natural and can be considered as a necessary condition to which D(E,U) must satisfy. The fact that the high Tc superconductors are oxides suggests the formation of obstacles to current flow when the temperature rises. Hypothesis of soft collisions on these obstacles during which the electron gives its energy gives a good account for explanation of the resistivity of these oxides or metals in general. The model also takes into account of the transition to the superconducting state; at low temperature the obstacles related to thermal disorder disappear and the compound becomes superconducting [2,3].

References

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[3] Oudet X., The statistical Distribution of the Thermal Energy; In: Theoretical and Experimental Approaches to High-Tc and Conventional Superconductivity. Nova Science Publishers, Inc. 1991.