TRANSITION PROBABILITIES: THEIR RELATION TO THERMIONIC EMISSION AND THE PHOTO-ELECTRIC EFFECT

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Abstract

Assuming (a) Wien's formula for black body radiation, (b) that electrons ejected thermally from a hot body have the experimentally known Maxwell distribution of velocities, and (c) that photo-electric emission from a solid surface is independent of the temperature of the solid, a theory is developed which leads directly to Richardson's thermionic current equation without importing into the argument circumstances not realized in experiment or assumptions and approximations that can be questioned. Detailed consideration of the mechanism of emission and absorption along the lines of Einstein's derivation of Planck's radiation formula leads to the same expression for the ratio of absorption to emission B_ν/q_ν obtained in other theories based on application of the principle of detailed balancing of processes occurring in systems in equilibrium. It is thus shown that observed photo-electric and thermionic phenomena from solid surfaces may be regarded as experimental confirmations of expressions B_ν/q_ν deduced in such theories.

AMONG the theories developed to account for thermionic phenomena are those which regard the emission of electrons from hot bodies as a photo-electric effect connected with the associated temperature radiation.[1] This view of the matter is in formal harmony with the ideas underlying Einstein's derivation of Planck's formula. Inasmuch as these theories, for example, Richardson's theory of the so-called "complete photo-electric emission," lead to an expression for the relative efficiencies of light of various frequencies in ejecting electrons from a metal surface, they are intimately related to more recent theories designed to evaluate transition probability coefficients, notably those of Kramers,[2] Milne[3] and Becker[4]. Richardson's theory was developed by statistical and thermodynamical considerations of a system of free electrons in equilibrium with an adjacent hot body and necessitated assumptions and approximations which were open to question, as indeed, the author of the theory indicated. In the present paper an attempt is made to deduce from experimentally recognized assumptions the probability of photo-electric emission from a solid

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[1] Richardson, "Emission of Electricity from Hot Bodies," p. 110.

[2] Kramers, Phil. Mag. **46**, 836 (1923).

[3] Milne, Phil. Mag. **47**, 209 (1924).

[4] Becker, Zeits f. Physik **18**, 325 (1923).