Quantum Point Detector Moving through a Dielectric Medium.

II. - Constant Acceleration (*).

I. BREVIK
Luftkrigsskolen (RNoAF Academy) - N-7004 Trondheim, Norway

H. KOLBENSTVEDT
Department of Physics, University of Trondheim (AVH) - N-7055 Trondheim, Norway

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Summary. — A two-level quantum point detector of the DeWitt type, uniformly accelerated through an infinite dielectric medium, is analysed. The present work is a continuation of an earlier one (Nuovo Cimento B, 102, 139 (1988)), which dealt with detectors moving with constant velocity. In first-order perturbation theory, expressions for transition probabilities and rates of emitted energy are worked out, assuming the medium to be non-dispersive. In the subluminal case, when the detector approaches the velocity of light, there is a strong enhancement of the emitted radiation. In the superluminal case, the situation becomes more complex due to the formation of the Cherenkov cone. A striking similarity between the present theory and the theory of the anomalous and normal Doppler regions for detectors in uniform motion is pointed out.

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1. - Introduction.

In this paper we continue our program (') of exploring the radiation emitted from a two-level pointlike quantum monopole detector in rectilinear motion.

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through an infinite isotropic and homogeneous dielectric medium. The medium is assumed to be at rest in the laboratory inertial frame. As in paper I, we replace for simplicity the electromagnetic field by a fictitious scalar field, assumed to respond to the medium in terms of a refractive index, which in general is a function of frequency, \( n = n(\omega) \). When performing practical calculations involving integrations over frequencies or angles, we shall however for simplicity take the medium to be nondispersive.

Whereas in I we were concerned with the case of detectors moving with uniform velocity, we study in the present paper the case of detectors in rectilinear uniform acceleration. This situation has so far been given very little attention in the literature. The situation may however be of considerable physical interest, because the influence of the medium is under certain circumstances quantitatively important, and also because there occur completely new, medium-generated phenomena. Perhaps the most noteworthy of these is the simultaneous appearance of Cherenkov radiation and acceleration radiation that takes place in the superluminal region of the detector. In a vacuum, processes of this sort do not occur at all. We recall from I that even the simple case of constant superluminal detector velocity exhibits close similarity with the well-known acceleration radiation occurring in a vacuum: if the radiation is emitted within the Cherenkov cone (anomalous Doppler effect), the detector becomes excited, just as in the vacuum acceleration process. Especially Ginzburg and Frolov\(^{(2)}\) have earlier stressed this effect. The structure of electromagnetism in a medium is thus rich, even in the simple case of uniform velocity, and for accelerated motion we should expect an increased level of complexity for the physical phenomena occurring.

All our calculations are performed in the laboratory inertial frame since in our opinion this offers the simplest interpretation of the phenomena (no complications due to horizons, etc.). See also the comments in ref. \(^{(2)}\). One of us has earlier considered point detectors accelerated through a vacuum\(^{(3,4)}\), and the present paper is essentially a generalization of those works to include the case of a dielectric medium.

In sect. 2 we give the basic formalism for calculating the transition probability, in first-order perturbation theory. In sect. 3 we discuss the case when the accelerated detector has not yet reached the velocity of light in the medium. The transition rate, as well as the rate of emitted energy, are calculated. Section 4 discusses the case when the detector has entered the superluminal region. In this region the Cherenkov cone is formed with a time-dependent opening angle. The transition probability associated with Cherenkov

