Pramāṇa, Vol. 15, No. 3, September 1980, pp. 279–290. © Printed in India.

Theory of radiation from relativistic positrons moving in the ⟨110⟩ axial channels of f.c.c. (diamond) crystal

RATAN LAL
Physics Department, Roorkee University, Roorkee 247 672, India.

MS received 31 March 1980; revised 21 June 1980

Abstract. The emission of radiation from relativistic positrons moving in the ⟨110⟩ axial channels of an f.c.c. (diamond) crystal has been studied. An expression for the radiation intensity has been obtained for the general case of positron motion. This expression has been simplified for the particular case of well-collimated incident beam. Enhancement of the radiation over (ordinary) bremsstrahlung has been discussed.

Keywords. Channeling radiation; axial channeling; electromagnetic radiation; relativistic positrons; radiation intensity; f.c.c. diamond crystal; incident beam.

1. Introduction

In recent years emission of electromagnetic radiation from channeling particles has been of great theoretical interest. Possibility of such a radiation was first explored by Kumakhov (1976) using classical theory, and was later described by Kumakhov and Wedell (1976) using quantum mechanical theory. Since then much theoretical progress has been made towards the understanding of the characteristics of the channeling radiation (Kumakhov 1977; Kumakhov and Wedell 1977; Terhune and Pantell 1977; Bazylev and Zhevago 1977; Wedell 1978; Pantell and Alguard 1979; Lal and Joshi 1980). However, the characteristics of the radiation emitted by axially channeled relativistic positrons, have not been studied while experimental measurements have been made of the axial spectrum (Alguard *et al* 1979). It was felt worthwhile to study the axial radiation properties of the channeling positrons.

In § 2, we consider the motion of the positrons moving along the ⟨110⟩ rows of an f.c.c. (diamond) crystal. We obtain in § 3 a general expression for the photon intensity. This expression is simplified in § 4, for the particular case of an one-directional collimated beam. General features of the radiation characteristics have also been discussed.

Throughout the paper we have taken $\hbar = c = 1$, where $2\pi\hbar$ is the Plank's constant, and c is the photon speed in vacuum.

2. Motion of the channeled positrons

Projection of the ⟨110⟩ rows of the f.c.c. (diamond) crystal on a (110) transverse plane is shown in figure 1. The z-component of the 4-coordinate (t, x, y, z), where t