Pramāṇa, Vol. 15, No. 2, August 1980, pp. 175–179. © Printed in India.

Coherent bremsstrahlung from relativistic channelled positrons

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MS received 8 February 1980; revised 29 May 1980

Abstract. Poor beam collimation leads to overcompensation of suppression of coherent bremsstrahlung in the axial channelling case. This fact has been used to study the effect of beam divergence on the radiation emitted by relativistic (axially) channelled positrons. It has been found that due to beam divergence in the experiment of Alguard and co-workers in which radiation of 56 MeV positrons channelling along ⟨110⟩ rows of a silicon crystal is observed, coherent bremsstrahlung becomes an important contributing factor to the high frequency part of the observed spectrum.

Keywords. Coherent bremsstrahlung; channelling; beam divergence; positrons; axial spectrum.

1. Introduction

When relativistic positrons (or electrons) move along major axes or between major planes of a crystal they emit a radiation which is highly directional, highly polarised and considerably more intense (than ordinary bremsstrahlung). This radiation (channelling radiation) was first predicted by Vorobiev *et al* (1975), and later by Kumakhov (1976). Considerable studies have been made towards the understanding of the characteristics of the planar channelling radiation of relativistic positrons (see, for example, Pantell and Alguard 1979 and references cited therein.) In particular, the characteristics of the planar chanelling radiation (like peak energy) have been understood (Alguard *et al* 1979). But the ($\approx 37\%$) enhancement of the radiation of 56 MeV positrons observed under axial channelling conditions by Alguard *et al* (1979) near 100 keV is not theoretically understood. This prompted us to undertake this investigation.

From the viewpoint of the incident angle, the condition of axial channelling is somewhat similar to the condition of occurrence of intense coherent bremsstrahlung in the sense that intense coherent bremsstrahlung and axial channelling both require the positrons (or electrons) incident in a direction which differs from a major axis only by a small angle (see Palazzi 1968 for coherent bremsstrahlung). [One consequence of this fact is that intense coherent bremsstrahlung cannot be expected under planar channelling conditions, since in planar channelling case the incident direction differs significantly from a major axis.] Therefore, coherent bremsstrahlung would compete with the axial channelling radiation. The purpose of the present paper is to study the contribution of coherent bremsstrahlung under axial channelling conditions.