The Influence of Medium Polarization Inhomogeneity on the Channeling Radiation from a Positron Bunch

Hayk Gevorgyan, Lekdar Gevorgian

A. ALIKHANYAN National Laboratory

The 8th International Conference
Channeling 2018
Charged & Neutral Particles Channeling Phenomena

4. Comparison with experimental results

The theoretical spectrum of the radiation photons number is compared with the results of experiment [1]. The considering radiation spectrum is obtained with 4 GeV channeled positrons of the bunch parallel to the (110) planes of 80 μм long diamond monocrystal. In Fig.3 a comparison with experimental data at the hard frequency region is shown.

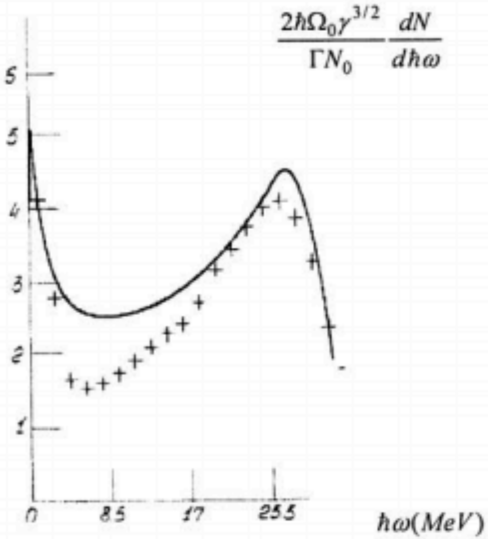

Fig. 3. The experimental data is signed by crosses. The solid curve is the spectral distribution obtained theoretically for the number of radiated photons at 4 GeV energy positrons channeling in the (110) planes of diamond crystal at zero angle of incidence.

INTENSIVE QUASI-MONOCHROMATIC, DIRECTED X-RAY RADIATION OF PLANAR CHANNELED POSITRON BUNCH

LEKDAR GEVORGIAN

Yerevan Physics Institute, Alikhanyan Brothers Str. 2, Yerevan 375039, Armenia

1. R. O. Avakyan, I. I. Miroshnichenko, J. J. Murray and T. Vigut, "Radiation of ultrarelativistic positrons moving in a crystal near crystallographic axes and planes"; *Sov. Phys. JETP*, **55**(6), (June 1982).

Channeling positrons

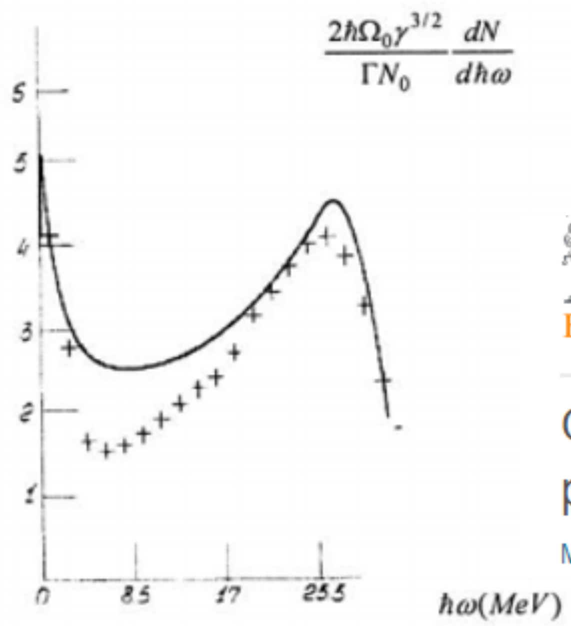

Fig. 3. The experimental data is signed by crosses. The solid curve is the spectral distribution obtained theoretically for the number of radiated photons at 4 GeV energy positrons channeling in the (110) planes of diamond crystal at zero angle of incidence.

Influence of crystal lattice on motion of energetic charged particles

Author: J Lindhard; Kongelige Danske videnskabernes selskab.

Publisher: København : Munksgaard, 1965.

ELSEVIER

Physics Letters A

Volume 57, Issue 1, 17 May 1976, Pages 17-18

On the theory of electromagnetic radiation of charged particles in a crystal

M.A. Kumakhov

Channeling, Polarization Inhomogeneity

The framework of Thomas-Fermi Stat. Model

Parameter of polarization (maximum at some point)

Adding term of inhomogeneity (probability) in form-factor

Energy threshold and difference in ranges

Parameter ***a*** and the formal radius of atom

Conclusion

Maximum points

Experiment

Thank you for your attention!

Form Factor, Longitudinal and Transverse

$$F = F_Z(\omega) \cdot F_R(\omega, \vartheta)$$

$$F_Z(\omega) = \left|< e^{(-ik_{\parallel}Z)} >\right|^2 = \left|\int f(Z)\, e^{(-ik_{\parallel}Z)} dZ\right|^2$$

$$F_R(\omega) = \left|< e^{(-ik_{\parallel}R)} >\right|^2 = \left|\int f(R)\, e^{(-ik_{\perp}R)}\, dR\right|^2$$

- There are probability density functions (bunch particle density distribution functions)
- And probability functions (form factors of bunch)
- On longitudinal Z (movement direction) and transverse R directions.

Coherent Radiation

- Is necessary the availability of radiation (at least a single particle radiation):

$$N_s \neq 0 \qquad N_{sp} \neq 0$$

- Is provided the coherence condition:

$$N_b F \gg 1 \qquad F \to 1 \qquad N_b \gg 1$$

- Due to bunch distribution, spontaneous radiation amplification takes place :

$$N_{tot} = N_s \cdot N_b (1 + (N_b - 1)F)$$

$$K = N_b F = N_b \qquad F \to 1$$

Longitudinal Gaussian Asymmetry

Case of short wavelengths and the following st. dev.s

$t = (\sqrt{2}\pi\sigma_z)/\lambda \gg 1$ $\lambda < \sigma_z$ $G(t) = NF_p(t)$

$p\sigma_z$ σ_z $0 < p < 1$

$$F_p(t) = \left[\frac{W(pt) - W(t)}{1+p}\right]^2 \quad , \quad W(t) = \frac{2}{\sqrt{\pi}}\int_0^t e^{(x^2 - t^2)}dx$$

1.Possibility of generating Coherent THz

An Electron Bunch:

E=50 MeV

Long.Size=18μm

$N = 1.56 \cdot 10^9$

FEL:

Spat. Period=l=2.73 cm, q=3.5 $q = \gamma\psi$

Radiation:

At a zero angle, 30 THz (10μm)

Line width 10^(-2)

2.Possibility of generating Coherent THz

An Electron Bunch:

E=50 MeV

Long.Size=12μm, or t=5.33

$N = 1.56 \cdot 10^9$

Weak Asymmetry:

p=0.5, pt=2.66

W=(2.66)-W(5.33)=0.266-0.108=0.014

FEL:

Spat. Period=l=2.73 cm, q=3.5

Radiation: $6.6 \cdot 10^{15}$

At a zero angle, 30 THz (10μm)

F(p=0.5, t=5.33)= $F_{0.5}(5.33) = 6 \cdot 10^{-3}$

n=100, Line width 10^(-2)

$G \approx 9.7 \cdot 10^6$

References

FEL efficiency increase (partial coherence)

[1] L. A. Gevorgian, N.K. Zhevago. Dokladi Akad. Nauk. SSSR 267 (3) (1982) 599.

General formula for a frequency-angular radiation

[2] N. A. Korhmazyan, L. A. Gevorgian, M.P. Petrosian. Sov. Phys. Tech. Phys. 22 (1977) 917.

Thank you for your attention!

Bunch Radiation

- Photon Number Frequency-Angular Average Distribution is:

$$N_{tot}(\omega,\vartheta) = N_{sp}(\omega,\vartheta) + N_{coh}(\omega,\vartheta)$$

$N_s(\omega,\vartheta)$ ← For any source of radiation

F ← For freeform distribution of bunch

$$N_{sp}(\omega,\vartheta) = N_s(\omega,\vartheta)\cdot N_b(1-F)$$

$$N_{coh}(\omega,\vartheta) = N_s(\omega,\vartheta)\cdot {N_b}^2 F$$

- Where N_b is the number of particles in a bunch

Նոսր գազ պարունակող (λ_p` միջավայրի պլազմային ալիքի երկարությունը) հարթ օնդուլյատորում ռելյատիվիստիկ էլեկտրոնի անցմամբ ձևավորված ճառագայթման ֆոտոնների թվի հաճախային բաշխման համար ունենք [34,35]

$$\frac{dN_{ph}}{dx} = \frac{\pi \alpha n}{2} q^2 F(x,R) \quad , \qquad F(x,R) = 1 + \left(2Qx - 1 + \frac{R}{2x}\right)^2 , \qquad (42)$$

որտեղ $x = l/(2\gamma^2\lambda)$ -ը հաճախությունն է անչափ միավորներով, l -ը օնդուլյատորի տարածական պարբերությունն է , γ -ն էլեկտրոնի էներգիան է էլեկտրոնի հանգստի էներգիայի միավորներով (Լորենց ֆակտոր), α -ն նուրբ կառուցվածքի հաստատունն է , n -ը էլեկտրոնների տատանումների թիվը, $q = \gamma\psi$ -ն օնդուլյատորի պարամետրն է, ψ -ն էլեկտրոնի շեղման անկյան մեծագույն արժեքն է, $Q = 1 + q^2/2 \, , R = \left(l/(\lambda_p\gamma)\right)^2$: