On Rossi-Curve and Anomalous Photon Absorption

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In some recent papers the author[1] reported certain anomalies in the absorption of RaC γ-photons and their correspondence with the second and third Rossi maximum of cosmic-rays under large thickness of lead absorber. From these correspondences it was suspected that some new type of penetrating radiation might be the common origin of the absorption anomalies and the second and third Rossi maximum. Recently Pfotzer[2] and Bothe[3] have concluded, that in order to explain all the relevant experimental facts about these maxima it is necessary to postulate the existence of a hitherto unknown type of penetrating radiation. Clay, Wansdronk and Dekker[4], who have recently investigated the absorption of RaC γ-rays in lead with two large ionisation chambers, have denied the existence of any absorption anomaly as reported by the author. However their experimental results allow an other interpretation. The experimental values of absorption coefficient per cm in lead as obtained by Clay and his co-workers together with those of ours and some of those theoretically calculated by Hirshfelder and Adam[5], taking into consideration multiple scattering, are given in the Table 1.

Thickness of Pb absorber [cm]	Absorption coefficient [cm^{-1}] Clay et al.[4]	Author	Hirshfelder et al.[5] (for 3 MeV Photon)
10–17	0,43	0,49	0,348 at 13,0 cm
17–20	0,28	0,465 ± 0,04	0,356 at 19,5 cm
20–23	0,21	0,439 ± 0,05	
23–27	0,17	0,307 ± 0,03	
27–30	0,07	0,396 ± 0,07	
37			0,372
Approximate solid angle subtended by the detector to the source	$\pi/59$* & $\pi/40$	$\pi/1500$	2π

* Calculated assuming Ionisation Chambers are spherical.

Table 1. Experimental values of absorption coefficient in lead.

It may be noted that the solid angles subtended by the large ionisation chambers used by Clay are much larger than in our experiment. Consequently in their experiments a much greater percentage of secondary scattered radiation could enter the detector. It seems that this may account for the fact that the absorption coefficients obtained by Clay after 20 cm of lead absorber are smaller than those reported by the author. Also this secondary radiation may mask the hump (if any) in the absorption curve at about 23 cm of lead where the third Rossi maximum is also found. The minimum value for the absorption coefficient of γ-radiation as theoretically calculated by Heitler[6] is about 0, 475 cm^{-1}. It may be noted that the experimental values of absorption coefficient in lead after 20 cm of lead reported by Clay and his co-workers and those of the author are less than this theoretical minimum value. The values obtained by Clay, however, are much smaller. Clay interpreted these low values as due to multiple scattering. But by multiple scattering the primary beam becomes gradually softer with increasing thickness of absorber, and consequently the apparent absorption coefficient should increase with increasing absorber thickness. This is indicated by the calculated values of Hirshfelder and others taking multiple scattering into consideration. Because the absorption coefficient obtained by Clay continuously decreased to a value as low as 0,07 cm^{-1} for γ-rays of energy about 2,5 MeV and still have not reached the apparent minimum value, they suggest that this may be due to inhomogenity of RaC γ-rays. However it may be noticed that theoretically (Heitler[6] p. 216) practically no change is predicted in the value of absorption coefficient in lead for γ-rays of energy ranging from 2 to 5 MeV, where the absorption coefficient is minimum (e. g. about 0,475 cm^{-1}). The exact theoretical values of absorption coefficients in lead due to three processes e. g. (1) photoelectric absorption, (2) Compton scattering, and (3) pair formation are separately calculated by Heitler for γ-rays of energy about 2,5 MeV as given in the Table 2.

Photoelectric process	Compton scattering	Pair formation	Total values
0,104	0,340	0,078	0,522

Table 2. Absorption coefficient in cm^{-1} (theoretical values).

It may be noticed from this table that even if we completely ignore the absorption due to Compton scattering, the absorption coefficients due to photoelectric process and pair formation only cannot be less than 0,182 cm^{-1}.

From the above discussion it may be concluded that the extremely low value of absorption coefficient in lead of 0,07 cm^{-1} can only be interpreted by the assumption of a new penetrating radiation of secondary origin as suggested by the author.

[1] P. K. Sen Choudhury, Physic. Rev. **81**, 274 [1951]; Indian J. Physics Proc. Indian Assoc. Cultivat. Sci. **25**, 539 [1951].

[2] G. Pfotzer, Z. Naturforschg. **8a**, 353 [1953].

[3] W. Bothe, Z. Naturforschg. **8a**, 393 [1953].

[4] J. Clay, C. Wansdronk u. Th. J. Dekker, Physica **18**, 582 [1952].

[5] J. O. Hirshfelder u. E. N. Adam, Physic. Rev. **73**, 863 [1948].

[6] W. Heitler, Quantum Theory of Radiation, Oxford University Press, 1944.