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OGRE-P1, A Monte Carlo Program for Computing Gamma-Ray Transmission Through Laminated Slabs

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ABSTRACT

A Monte Carlo IBM-7090 program, called OGRE-P1, has been written for the calculation of the dose rate on one side of a slab due to an isotropic, cosine, or collimated monoenergetic gamma-ray source on the other side of the slab. Up to 50 homogeneous regions are permitted.

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The Monte Carlo program OGRE-P1 has been written for the IBM-7090 to solve the problem of gamma-ray transmission through laminated slabs of various materials. It was written within the framework of the OGRE system[1] which is a general purpose gamma-ray program. Special routines used by OGRE-P1 to solve the plane problem include a source routine, a geometry routine, a routine for computing the estimator, and input and output routines.

The present version of the code replaces an earlier version reported previously.[2] The new version uses a new cross section scheme[3] and has the additional option of a cosine source. The other significant change is that collisions are immediately processed rather than written on magnetic tape for later processing.

The source is an infinite plane of monoenergetic gamma rays located on the face of the laminated slab. The source may be either monodirectional, isotropic in the half sphere, or cosine distributed about the normal. The number of homogeneous slabs (regions) is limited to 50. The media descriptions are given on input cards by giving the element densities for each medium. The slab is further described by a list of region thicknesses and medium numbers. A list of flux-to-dose conversion factors, used to generate a statistical estimation dose rate at the "rear" of the slab, is also required. The standard deviation of the mean "collided" dose rate is computed. The uncollided dose rate is computed analytically using $\exp(-T/\gamma)$ for the monodirectional case, where T is the thickness in mfp and γ is the cosine of the angle (measured from the normal), $E_1(T)$ for the isotropic case, or $E_2(T)$ for the cosine case multiplied by the flux-to-dose conversion factor at the incident gamma-ray energy. Thus the dose rate is normalized per unit incident photon current.

The basic cross section data for each element in the problem must be available on logical tape 29. This tape is described in ref. 3. A routine in OGRE-P1 reads this tape and generates the detailed cross sections needed (total and ratio of scattering to total) for each medium covering the range of energy required. The energy limits are input numbers and must overlap or coincide with the range bounded by the initial energy and the cutoff energy. This detailed cross section table will be written on logical tape 30. For subsequent runs of the same media-array and energy range, the tape 30 may be used and tape 29 is not needed.

The histories are reduced in weight at each collision to account for absorption. They are terminated either by leakage or by failing the energy cutoff or weight cutoff tests. In the case of the weight cutoff, a game of Russian Roulette is played. The number of photons which were terminated by each mechanism is printed out.

Summary of Input to OGRE-P1A Program

Fortran Input Format	Data Description
(3E11.3, Ø13)	Number of histories, energy cutoff (Mev), weight cutoff, initial random number (must end in 1 or 5).
(2F6.2, 2I4)	Initial energy (Mev), γ($\gamma < 0$, source cosine distribution; $\gamma = 0$, isotropic distribution; $\gamma > 0$, monodirectional source), number of regions, number of media.
[6(E8.2,I4)]	[Thickness (cm), medium number] region by region.
(I4)	Number of photon flux-to-dose conversion factors.
[10(E7.2)]	[E(Mev), DØSE (E)], E must monotonically increase.
(I2)	Cross section tape option, (2 if cross sections are read from tape 29 and written on tape 30, 1 if cross sections are read from tape 30].

The following input is necessary only if the previous integer describing the tape option is equal to 2:

(4I4)	NMED, NINT, ILØW, IHIGH	
⋮		
I4	Number of elements in a given medium	ith medium
⋮		
I4,E9.3	Element atomic number, density (gm/cc) of element	ith medium

NMED = number of media.

2^{NINT} = number of intervals in energy groups of cross section table.

$2^{IL\O W}$ = lower energy bound of cross section table (electron rest mass units).

2^{IHIGH} = upper energy bound of cross section table (electron rest mass units).

Note: $NMED[2^{NINT}(IHIGH-IL\O W) + 1] \leq 12569$

The following tape assignment is required:

32	input
31	output
30	detailed cross section tape
29	master cross section tape (if needed).

References

1. S. K. Penny, D. K. Trubey, and M. B. Emmett, "OGRE-A Monte Carlo System for the Study of Gamma Ray Transport," to be published.

2. D. K. Trubey and S. K. Penny, "OGRE-P1, A Monte Carlo Program for Computing Gamma-Ray Transmission Through Laminated Slabs," ORNL-TM-167, March 19, 1962.

3. S. K. Penny, M. B. Emmett, and D. K. Trubey, "A System for Generating Gamma Ray Cross Section Data for Use with the IBM-7090 Computer," ORNL-TM-234.

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