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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 dose rate on one side of a slab due to either an isotropic or a collimated monoenergetic gamma ray source on the other side of the slab. Up to 50 homogeneous regions and 13 kinds of media are permitted.

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 program consists of two parts - OGRE-P1A-W, a code which generates histories in plane geometry and writes the details of each collision on magnetic tape, and OGRE-P1A-R, which reads the collision tapes and computes the dose rate due to the gamma rays emerging from the slab. Both tape writing and tape reading are accomplished simultaneously with computing.

The source is an infinite plane of monoenergetic gamma rays located on the face of the laminated slab. The source may be either monodirectional or isotropic in the half-sphere. The number of homogeneous slabs (regions) is limited to 50. The number of different kinds of media is limited to 13. The medium description is given on input cards by listing the number of media, and, for each medium, the number of elements per medium followed by the atomic density, electron density, and element absorption cross section. The absorption cross section is the sum of the photo-electric and pair-production cross sections. The slab is further described by a list of region thicknesses and medium numbers. (See summary of input to OGRE-P1A).

1. S. K. Penny, D. K. Trubey, and M. B. Emmett, "OGRE, A General Purpose IBM-7090 Program for the Solution of Gamma-Ray Transport Problems" (to be published).

The tape reading code requires a list of flux-to-dose conversion factors which are used to generate a statistical estimation dose rate at the "rear" surface of the slab. The standard deviation of the mean is computed. The uncollided dose rate is computed analytically using either $\exp(-T/\gamma)$ for the monodirectional case, where T is thickness in mfp and γ is the cosine of the angle (measured from the normal), or $E_1(T)$ for the isotropic case, multiplied by the flux-to-dose conversion factor at the incident gamma ray energy. Thus the dose rate is normalized per unit source photon per cm^2.

The tape-writing code has an option which will write the total cross section table for each medium on logical tape 30 for use by the processing code. If there is only one medium, tape 30 need not be used since the only cross sections needed are written along with the history parameters. This need be done only once for each media-array. The history parameters are written and read starting with logical tape 1 and proceeding upwards, using as many tapes as necessary (generally one or two). The number of history tapes to be used are input numbers. In the case of tape writing, an on-line message to the operator will be printed if more tapes are needed on the machine and the maximum number of tapes (specified in the input) has not been exceeded. Then the problem will continue. This is likely to happen if the tapes are bad and only a small amount of the tape can be used.

The histories will be terminated either by leakage or by failing either the energy cut-off or weight cut-off tests. In the case of the weight cut-off, a game of Russian Roulette is played. In processing the histories, an input number may be used to limit the number of histories processed.

Summary of Input to OGRE-P1A Programs

1. History Generating Code OGRE-P1A-W

Fortran Input Format	Data Description
(3E11.3, I3)	No. of histories, energy cut-off (Mev), weight cut-off, No. of tapes (Max).
(I3)	No. of media.
{ (I3)	No. of elements per medium, order determines medium number.
*{ (2E9.3,I3) }	Atomic density (atoms/b-cm), electron density (elect./b-cm), No. of cross section points.
{ (8E9.3) } *	(Energy-E(Mev), absorption cross section at E)* for log-log interpolation in code.
(Ø12)	Initial random number (must end in 1 or 5).
(2F6.2)	Initial energy (Mev), cosine of incident angle (zero or blank for isotropic distribution).
(2I4)	No. of regions, No. of media.
[6 (E8.2,I4)]	[Thickness (cm), medium number]* region by region.
(I4)	Write cross section tape 30 (0001, yes; blank or 0000, no).

*Repeat as necessary.

2. Processing Code	OGRE-P1A-R
(2I4,F7.1)	No. of tapes, blank, limit on total histories processed.
(I4)	No. of flux-to-dose conversion factors.
[10(E7.2)]	[E(Mev), Dose (E)]*.
(2I4,E8.2)	No. of regions, No. of media, cosine of incident angle (zero or blank for isotropic distribution).
[6(E8.2,I4)]	[Thickness (cm), medium number]* region by region.
Tape assignment	(both codes)

32 Input
31 Output
30 Cross sections (if needed)
1-N History tapes (N = No. of tapes to be used).

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*Repeat as necessary.

Note: Energy tables for cross section and dose conversion factors must monotonically increase.

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