Neutron Monte Carlo Code for Spherical Geometry. MND 4539 (January 19, 1963)

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MO322

1. Program name: MO322
2. Computer for which program is designed: Philco-2000 Programming system: FORTRAN II
3. Nature of the problem solved: MO322 is a one energy, Monte Carlo calculation of the fraction of neutrons absorbed in spheres randomly distributed in an otherwise infinite homogeneous medium. A finite number of spheres is loaded randomly into a three-dimensional box. This box is assumed to repeat in all directions to fill all space. Thus, each sphere which has its center in the box but which is cut by one or more sides of the box has from one to seven corresponding spheres outside the box which lean into the box and which are displaced from the original sphere along one or more coordinates by the width of the box. The neutron source is either flat in the region external to the spheres, flat in the spheres, or flat everywhere. Individual neutrons are followed in their wanderings through the box. When one leaves the box on one side, it re-enters with the same path orientation on the opposite side. Absorption and isotropic scattering are included in both compositions. The box can be reloaded with a different random distribution of spheres in the course of the calculation.
4. Restrictions on the complexity of the problem: 150 spheres in the box, 100 box loadings, 100 experiments per box loading, 500 histories per experiment.
5. Typical running times: With 100 spheres in the box making up 10% of the volume of the box the following times are representative:
   0.19 min to load the box
   5.7 min per 100 histories
   0.5–1.0 hr over-all, to get a reasonable answer.
6. Unusual features of the program: The variances in the track length estimates of the compositionwise absorptions have been reduced by dividing the average partial track lengths (in absorption mean free paths) by the average total track length. On the one hand, this makes the conventional statistical analysis, based on a normal distribution of the results of experiments, inapplicable. On the other hand it makes the program possible by reducing the running time to a reasonable value.
7. Present status: In use.
8. *Reference:* R. M. Cantwell, "MO322 and MO332—FORTRAN Programs for Calculating Neutron Absorption in Spheres Distributed Randomly." WAPD-TM-352 (October 1962).

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PLMCN-1

1. Name of code: PLMCN-1
2. Computer for which code is designed: IBM 7090, 7094 Programming system: Fortran II
3. Nature of problem solved: PLMCN-1 is a multiregion, multienergy group, time dependent Monte Carlo code for neutrons in a homogenous medium where the neutron interactions considered are scattering and absorption.

   The neutron source is an infinite plane perpendicular to the z-axis of the system at $Z = 0$. The original neutron energies are generated from an input energy spectrum. Initial neutron directions are picked from input angular distributions. There is an input angular distribution for each energy group. The maximum number of energy groups is 32 and the maximum number of entries in the angular distribution for each energy group is 50. The geometry of the system is described by specifying various planes parallel to the XY-plane. The result is a series of infinite slabs parallel to the source plane. Input is limited to 150 such planes and therefore limits the number of slabs (regions) to 150. (The plane at $Z = 0$ need not be inputed.)

   One material—homogenous and of constant density—occupies all regions. This material may be composed of a maximum of 5 isotopes (or elements).

   All answers are obtained by analytic estimation with the exception of Monte Carlo tallies of particle and neutron leakage from the system. Answers consist of the following:
   (1) The flux and dose rate for each slab (region) by energy group.
   (2) Neutron and particle leakage from the system.
   (3) The distribution of the neutron leakage from the boundary opposite the source plane by energy group and for each energy group, the angular distribution of neutrons.
4. Restrictions on the complexity of the problem: Maximum number of energy groups—32; maximum number of regions—150; maximum number of isotopes—5.
5. Typical running times: This code runs 1 to 3 min depending on the complexity of the problem.
6. Unusual features of the code: Russian roulette is played with any particle whose weight becomes too small. Splitting in prescribed regions and analytic estimation are used to increase the validity of the results for the least amount of computing time.
7. Present status: In use.
8. *Reference:* M. J. Kniedler and T. Jordan, PLMCN-1, Neutron Monte Carlo Code for Slab Geometry. MNI-C-2933 (January 19, 1963)

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