Computer Code Abstracts

NOISY 1

A Program for Calculation of Space-Dependent Spectral Densities in Cubical Reactors

1. Name of Program: NOISY 1.
2. Computer for which Program is Designed: UNIVAC 1108 and in a restricted form on an IBM 7090 and an IBM 7044.
3. Nature of Physical Problem Solved: Auto- and cross-spectral density functions are calculated for neutron fluctuations in nuclear reactors. The calculations are pointwise space dependent in cubical reactors which are homogeneous and bare. Either neutron fluctuations or the fluctuations seen by a neutron detector can be specified. Fluctuations between either two points or between two finite regions can be considered. The finite regions or simulated detectors must either fully overlap or not overlap and are restricted in shape to rectangular parallelepipeds. Diffusion theory with one energy and six delayed neutron groups is the level of complexity of the solution.
4. Method of Solution: Evaluation of an analytical expression (see item 3 under Material Available) for the above specified quantities for the desired range of input parameters. Input is reduced through use of a generalized input array generator.
5. Restrictions on the Complexity of the Problem: Maximum of 50 terms per dimension in the six-dimensional series. The limit is thus 50^6 or about 16 billion terms. This is large enough that the limit is really budgetary. Automatic convergence checking limits the maximum number of terms to ~300,000.
6. Typical Machine Time: Auto spectral density ≈ 10 sec/pt. Cross spectral density ≈ 30 sec/pt.
7. Related and Auxiliary Programs: Two auxiliary programs are used to generate Cal Comp graphs of output. SEARCH/DESTROY processes data elements generated by the program producing data for a Cal Comp graph drawing routine, SNOOPY. The IBM 7090 compatible version is automatically generated with a program called SUPER/SENDER.
8. Status: Complete and running.
9. Machine Requirements: 52K words on the UNIVAC 1108. 29K words on the IBM 7090.
10. Programming Languages Used: UNIVAC 1108 version. UNIVAC FORTRAN V (90% IBM FORTRAN IV compatible); IBM 7090 and 7044. FORTRAN IV.
11. Operating System or Monitor Under Which Program is Executed: UNIVAC-1108 version. Computer Sciences Corporation, Conversational Executive (CSCX) or Exec II; IBM 7090 version. IBM IBSIS System.
12. Other Programming or Operating Information or Restrictions: The two IBM-7090 versions (see item 13) differ from the UNIVAC-1108 version in the following respects. First, the limited version
    1. contains only that part of the program which does the auto spectral density calculation
    2. does not generate a data file
    3. contains no FORTRAN-V features
    4. does not contain several convenience routines (for example, date and time of execution are not correctly printed in the output)
    5. exists in only one of the two versions available (they differ in convergence checking logic)
    6. normal input and output tapes are restricted to logical units 5 and 6 rather than variables NI and NO
    7. is extensively overlayed.

    The complete but not tested version is still capable of doing both auto- and cross-spectral density function calculations. It has all of the other limitations listed above. It has not been run on the IBM 7090 because an overlay has not been developed for this. Such an overlay can be developed in a manner paralleling that already done for the limited version.
13. Material Available:
    1. Program Tape. Parity odd at 800 frames/inch.

       File No.

       a. Standard UNIVAC PCF file included absolutes, relocatables, and symbolics (load, object, and source modules).

       b. A one record long file containing the UNIVAC character set, FIELD DATA. The order is increasing octal digits where 46, 56, 76, and 77 have blanks.

       c. Data decks for a compile run and a load-and-execute run for the test case of Ref. 8 on the IBM 7090. Field Data.

       d. Source decks for the limited (but tested) IBM 7090 version. Card images in UNIVAC Field Data.

       e. Source decks for an IBM 7090 version made from File 1. Complete, but not tested. Card images in UNIVAC Field Data.

2. Short and long test decks for the UNIVAC version are stored in Field 1 as a symbolic named DATA/DECK.

3. Program description. Ref. 1.

14. *References:*

[1]JAMES R. SHEFF, User's Manual for NOISY 1—A Program for Calculation of Space Dependent Spectral Densities in Cubical Reactors, BNWL-1260, Battelle Northwest Laboratory (1970).

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PICA

1. Name of Program: PICA, a Monte Carlo intranuclear-cascade code package for medium-energy photon-induced nuclear reactions consisting of the programs PIC, MECCAN, and EVAP.

2. Computers for Which Programs are Designed: IBM 360/75 and 360/91.

3. Nature of Physical Problem Solved: PIC calculates the results of nuclear reactions caused by the collision of medium-energy photons with nuclei.[1,2] The photon energy range in which the calculations are applicable is $30 \lesssim E_\gamma \lesssim 400$ MeV. All target nuclei with mass numbers >4 are possible. The program PIC can accommodate incident monoenergetic photons as well as thin-target bremsstrahlung spectra, thin-target bremsstrahlung difference spectra, and thick-target bremsstrahlung spectra. For the last type of spectra the user must furnish the photon spectral data. PIC writes a history tape containing data on the properties of the particles (protons, neutrons, or pions) escaping from the nucleus. The data consists of the types of escaping particles and their energies and angles of emission. The associated analysis code MECCAN utilizes the data on the PIC history tape to calculate cross sections such as the nonelastic cross section or the doubly differential cross section for energy-angle correlated distributions. EVAP then carries the nuclear reaction through an additional phase, that of evaporation, and calculates the energy spectra of particles (protons, neutrons, deuterons, tritons, ^{3}He, and alpha particles) "boiled off" from the nucleus after the cascade has stopped, evaporation particle multiplicities, and evaporation residual nuclei (radiochemical) cross sections.

4. Method of Solution: The interaction of high-energy photons with nuclei is described by using the intranuclear-cascade and evaporation models. Monte Carlo methods are employed to provide a detailed description of each interaction. The initial interaction of the photon with the nucleus is obtained from the quasi-deuteron model of Levinger, that is, photon absorption by a neutron-proton pair moving within the nucleus or from one of the four pion-nucleon states formed in the photon-nucleon interaction. The effect of secondary nucleon-nucleus and/or pion-nucleus interactions following the photon absorption is accounted for by utilizing the intranuclear-cascade concept of high-energy particle-nucleus reactions. Each particle involved in a collision is traced through the nucleus using the appropriate particle-particle cross sections until the particle escapes from the nucleus or is captured by the nucleus. In all parts of the calculation, the Fermi momentum of the struck particle, the exclusion principle, and the nonuniform density distribution are taken into account. Following the cascade phase, the nucleus is usually in a state of high excitation. This excitation energy can be dissipated through particle emission. This de-excitation is handled by the evaporation model.

5. Restrictions on the Complexity of the Problem: The range of validity of PIC is from 30 to 400 MeV for the energy of the incident photon.

6. Typical Machine Time: The approximate machine time to obtain reasonable statistical accuracy is 30 to 60 min on the IBM 360/75 computer.

7. Unusual Features of the Program: PIC uses an exact sampling technique to determine the collision site and the types of particles in the reaction.

8. Related and Auxiliary Programs: The Nuclear Configuration Code[3] creates a modified nuclear configuration data input tape for PIC. In PIC three nuclear regions are used to approximate a continuous nucleon-density distribution in the nucleus, and the radii of these regions can be changed by using the Nuclear Configuration Code.

9. Status: The PICA code package is being used on the IBM 360/75 and 360/91 computers at the Oak Ridge National Laboratory Computing Center.

10. Machine Requirements: PIC, MECCAN, and EVAP each require ~470K bytes of core. PIC and EVAP require a minimum of two 9-track tape drives in addition to the standard I/O devices. MECCAN requires one 9-track tape drive.

11. Programming Languages Used: The programs are written in FORTRAN IV except for random-number generating subroutines, which are in assembly language.

12. Operating System or Monitor under which Program is Executed: IBM 360 Operating System, Level 18, FORTRAN H.

13. Other Programming or Operating Information or Restrictions: PIC consists of ~6400 source cards.

14. Material Available: The code package is available from the Radiation Shielding Information Center (RSIC) at the Oak Ridge National Laboratory.

15. *Acknowledgments*: This work was supported by the U.S. Atomic Energy Commission under contract with Union Carbide Corporation.

16. *References*:

[1]T. A. GABRIEL, M. P. GUTHRIE, and O. W. HERMANN, "Instructions for the Operation of the Program Package PICA, an Intranuclear-Cascade Calculation for High-Energy (30 to 400 MeV) Photon-Induced Nuclear Reactions," ORNL-4687, Oak Ridge National Laboratory (1971).