TWOTRAN SPHERE

1. Name or Designation of Program: TWOTRAN SPHERE.

2. Computer for Which Program Is Designed and Others upon Which It Is Operable: CDC 7600, CDC 6600.

3. Nature of Physical Problem Solved: TWOTRAN SPHERE[1] solves the two-dimensional particle transport problems for (r,θ) spherical geometry. Both direct and adjoint, homogeneous (k_{eff} or parametric eigenvalue searches), or inhomogeneous time-independent problems are solved subject to vacuum, reflective, periodic, or input specification of boundary flux conditions. Both anisotropic inhomogeneous problems and general anisotropic scattering problems are treated.

4. Method of Solution: Energy dependence is treated by the multigroup approximation and the angular dependence by a discrete ordinates approximation. Space dependence is approximated by the diamond difference scheme with a set-to-zero negative flux control. Anisotropic scattering and anisotropic inhomogeneous sources are represented by finite spherical harmonics expansions. Within-group iterations, k_{eff} iterations, and eigenvalue search iterations are accelerated by a coarse mesh particle rebalancing algorithm.

5. Restrictions on the Complexity of the Problem: The variable dimensioning capability of FORTRAN IV is used so that any combination of problem parameters leading to a common vector length less than LENXCA can be used. LENXCA is slightly greater than 36 000 words for the CDC 7600. With a few exceptions only within-group problem data are stored in fast memory, and data for all other groups are stored in auxiliary storage. Arbitrary numbers of groups of up- or downscattering are allowed.

6. Typical Running Time: A six group, adjoint, S_4, 30×5, k_{eff} problem required 0.69 min on the CDC 7600. A fifteen group, S_{10}, P_3 scattering, 14×46, isotropic inhomogeneous source problem required 12.8 min on the CDC 7600. In general, problems will require significantly more execution time than with the general geometry TWOTRAN program[2] because TWOTRAN SPHERE uses a special quadrature with more directions for a given S_n and because an additional angular derivative has to be treated numerically.

7. Unusual Features of the Program: Unusual features include coarse mesh convergence acceleration, coarse mesh spatial, and angular organization to permit larger problems, general anisotropic scattering and inhomogeneous source option, input specification of top, bottom, or right boundary fluxes, built-in discrete ordinates constants (S_2, S_4, . . . S_{16}), positive spatial difference scheme, and FIDO cross-section input option.

8. Related and Auxiliary Programs: General-geometry TWOTRAN.[2]

9. Status: In use.

10. Machine Requirements: Six output units (disk, drums, or tapes) in addition to three system input/output units are required. A CDC extended core storage unit or a large bulk memory is also required. (Disk, drums, or tapes can be substituted for this requirement.)

11. Programming Language Used: FORTRAN IV with a small amount of mixed integer-floating arithmetic and generalized subscripting. Minor use of 10 H Hollerith formats, decode, and encode statements.

12. Operating System or Monitor Under Which Program is Executed: CROS (Los Alamos operating system for CDC 7600).[3]

13. Any Other Programming or Operating Information or Restrictions: TWOTRAN SPHERE uses a local cross-section library (subroutine LAXS), an algorithm to reduce core size (subroutine REDUCE), a system routine to obtain bulk memory size (subroutine GETQ), and special plotting routines for contour and projective flux displays. These features may be removed simply.

14. Material Available: FORTRAN deck, test problems, and test problem results are available from the Oak Ridge Radiation Shielding Information Center.

15. Acknowledgment: This work was performed under the auspices of the U.S. Atomic Energy Commission.

16. *References*:

[1]K. D. LATHROP and F. W. BRINKLEY, "TWOTRAN SPHERE: A Fortran Program to Solve the Multigroup Transport Equation in Two-Dimensional Spherical Geometry," LA-4567, Los Alamos Scientific Laboratory (1970).

[2]K. D. LATHROP and F. W. BRINKLEY, "Theory and Use of the General-Geometry TWOTRAN Program," LA-4432, Los Alamos Scientific Laboratory (1970).

[3]"Elementary Guide to the Control Data 7600," RAY DAVENPORT, Ed., Programmer's Information Manual, Vol. 5A, Los Alamos Scientific Laboratory (1972).

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