Computer Code Abstract

ESN

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1. Program Identification: ESN is a one-dimensional (plane, cylinder, sphere), Lagrangian, time-dependent electron S_n transport code with electromagnetic fields.[1]

2. Function: ESN describes the transport of electrons in arbitrary moving materials in the multigroup picture.[2] Sources of any functional form are admissible. Scattering and slowing down are treated in the Fokker-Planck representation.[3] Energy transfers are allowed between adjacent groups. Electromagnetic fields enter the equations through $\boldsymbol{E}$ and $\boldsymbol{v} \times \boldsymbol{B}$ terms and are treated as effective collisional sources.[1] Cross sections are generated internally by the module. Output consists of leakages, angular and scalar fluxes, and energy deposition in the material.

3. Method of Solution: The ESN code solves the electron multigroup discrete ordinates transport equations by means of an exponential spatial differencing scheme based on inversion of the homogeneous transport equation.[4] The diamond approximation is employed in the angular domain with Gauss quadrature sets.[1] Time differencing is implicit. Electric fields can effectively upscatter and downscatter particles in energy and also redistribute particle directions; magnetic fields merely redistribute particle directions.[5] Acceleration schemes have not been implemented in ESN. For one-dimensional geometries, a single transport equation is solved using specific sets of angular coefficients appropriate to plane, cylindrical, or spherical geometries. A Fokker-Planck collision operator, geared to highly anisotropic forward scattering, is used in a two-term differential expansion[5] and appropriate transport cross sections are generated automatically by ESN. User sets can also be input. Standard inner and outer iteration schemes are also employed. Source-functional forms are user specified, as are boundary-angular fluxes.

4. Related Material: ESN is an outgrowth of a number of studies of efficient techniques for tracking electrons with S_n approaches.[6-8] SNEX is a predecessor.[9]

5. Restrictions: The code is structured for in-core execution and requires no peripheral tape or disk resources. Dimension statements are controlled by a parameter list. Thus, the size and complexity of problems are limited by user-available core storage. Core storage requirements scale directly as the product of the mesh size times number of energy groups times the angular quadrature (S_n order). From a physics modeling point of view, the code is best suited for electrons in the hundreds of kiloelectron volt range where bremsstrahlung is not important and where the Fokker-Planck collision operator is not strained by relativistic scattering corrections. Bremsstrahlung production is not treated in the present version, nor are atomic processes.

6. Computer: Cray-1 or CDC-7600.

7. Running Time: An S_8, 25-group electron transport calculation over 100 mesh cells for a monoenergetic 500-keV boundary source requires ~20 s of Cray-1 time and 1 min of CDC-7600 time.

8. Programming Languages: The ESN code is written in Fortran-IV. Efforts were made to code in machine- and installation-independent format.

9. Operating System: The Cray-1 version of ESN operates under the CTSS system with CFT compiler. The CDC-7600 version runs under the LTSS operating system with FTN compiler. The code is exportable, however.

10. Machine Requirements: Two input-output files are required. A typical 25-group S_8 calculation with 100 spatial mesh points requires 52 000 octal words of SCM and 248 000 octal words of LCM on the CDC-7600. The whole problem is contained in fast core memory on the Cray-1.

11. Material Available: Source deck, test problem results, and documentation are available at this time from the author.[1]

12. Acknowledgment: This work was supported by the U.S. Department of Energy.

13. *References:*

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