Computer Code Abstract

TIGERP

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1. Program Identification: TIGERP, a one-dimensional, multilayer electron/photon Monte Carlo transport code with detailed modeling of atomic shell ionization and relaxation.[1]

2. Description of Physical Problem Solved: TIGERP describes the generation and transport of the electron/photon cascade in multislab geometries from several MeV down to 1.0 keV for those applications requiring a detailed description of atomic shell ionization and relaxation. Source particles can be either electrons or photons; monoenergetic or source spectra are allowed; and source angular distributions can be monodirectional, cosine law, or isotropic. The most important output data are (a) charge and energy deposition profiles, (b) integral energy and number transmission and reflection coefficients for both electrons and photons, and (c) transmission and reflection coefficients for electrons and photons that are differential in energy and angle.

3. Method of Solution: The TIGERP code combines condensed-history electron Monte Carlo[2] with conventional single-scattering photon Monte Carlo. The electron transport includes energy loss straggling, elastic scattering, impact ionization and the production of knock-on electrons, continuous bremsstrahlung radiation, and annihilation radiation. Photon transport includes photoionization, incoherent scattering, and pair-production, along with the generation of the corresponding secondary particles. The model allows for ionization of the K, L1, L2, L3, M (average), and N (average) shells, and for the subsequent generation and transport of the relaxation cascade. Electron cross sections and sampling distributions are obtained from DATAPAC-4 and LIBRARY TAPE 2 of the ETRAN Monte Carlo code system,[3] except that impact ionization is described by the theory of Gryzinski.[4] Photon cross sections are the analytical fits of Biggs and Lighthill,[5] except that photoionization partial probabilities and relaxation data are taken from the data base of the SANDYL code.[6] TIGERP is a user-oriented code in the sense that it was designed to provide both experimentalists and theorists with a method for the routine, but sophisticated, solution of basic transport problems; for example, only ten input cards are required for monoenergetic particle sources. On the other hand, the completeness with which TIGERP describes the radiation transport and the flexibility of its construction make it possible for the user to extend its capabilities significantly through relatively simple updates. Every output quantity is followed by the best estimate of its statistical standard error.

4. Related Material: TIGERP is essentially a generalization of the TIGER code[7] to include a more general description of ionization and relaxation phenomena that is essentially equivalent to that employed in the three-dimensional SANDYL code, but with the advantage of a CDC-7600 capability. Comments, suggestions, and/or consultation are welcomed by the authors.

5. Restrictions: The problem configuration is limited to no more than 50 material layers. A problem cannot involve more than five unique homogeneous materials, each of which contains no more than five elements.

6. Computer: CDC-7600 or CDC-6600.

7. Running Time: So many parameters affect the problem run time that it is not possible to estimate a "typical" machine time. However, the complex logic of the ionization and relaxation cascade adds substantially to the run times for those applications where contributions from these phenomena are significant.

8. Programming Languages: The code is written in Fortran IV. A major effort was made to remove nonstandard and installation-dependent usages.

9. Operating System: The CDC-7600 (6600) code runs under the SCOPE 2.1 (3.3) system with the FTN, OPT=2 compiler.

10. Machine Requirements: Four input-output files (two input cross-section files and two scratch files) and two system input-output files are required. On the CDC-7600 (6600), the small core (central) memory storage requirement is 160 000 octal words. In addition, 345 000 octal words of large core memory (extended core storage) are required. Data are transmitted to and from large core memory (extended core storage) in blocks of variable size, so that, with some program modifications, one may substitute disk, drum, or tape storage.

11. Material Available: Source deck, cross-section files, test problems, results of executed test problems, and the reference document[1] are available from the Oak Ridge Radiation Shielding Information Center.

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

13. *References:*

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[7]J. A. HALBLEIB, Sr. and W. H. VANDEVENDER, *Nucl. Sci. Eng.*, **57**, 94 (1975).