

3.6.5 Non-isotropic neutron flux treatments

Before proceeding with derivations from the one- and two-speed diffusion theories, it is appropriate to pause and comment on the many approximations that were made in developing these models and to outline the more accurate efforts that are required for detailed reactor analysis and design. In reviewing the extensive assumptions that were made in the preceding sections it is surprising that the simple diffusion theories work at all; indeed to the extent that they do, that success is largely a result of judicious choice of the averaging used to arrive at the effective cross-sections.

One set of assumptions was that the angular neutron flux was isotropic (or nearly so). Several approaches have been developed to model anisotropy, the deviations from this isotropy. One is to select a number, N , of angular directions and to represent the neutron flux as the sum of fluxes in each of these discrete directions. This leads to a set of neutron transport equations, one for each of the discrete directions. These are known as the S_N equations. A preferred alternative is to represent the anisotropy using a finite series of N spherical harmonic functions and to develop neutron transport equations for each of the terms in this series. These are known as the P_N equations, the most commonly used having just one non-isotropic term (P_1 equations). However, in many circumstances in most large reactors the assumption of an isotropic neutron flux is reasonably valid except perhaps in the neighborhood of non-isotropic material (that is, for example, highly absorbing) or at a boundary that results in a highly non-isotropic neutron flux. Such regions or boundaries can then be given special treatment using one of the above-mentioned approaches.