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基于最速下降法的堆芯物理库子群参数调整方法研究

摘要

反应堆物理计算是核反应堆设计的核心技术之一，其计算精度直接影响反应堆设计可靠性。堆芯物理库为反应堆物理计算提供截面数据、裂变产额和衰变数据，因此堆芯物理库的准确度是保障反应堆物理计算精度的前提。此前中国核数据中心研制了 45 群能群结构的堆芯物理库 TPEX，临界基准检验后发现其预测的 keff 在能谱较硬的铀系统实验中存在系统性低估的现象。为提高 TPEX 库准确度，本课题创新的提出了一种基于逃脱截面的共振积分与子群参数调整方法，建立了基于最速下降法建立了一套自动化共振积分与子群参数调整系统 ADJ_RI 并研制了调整库 TPEX_adj，解决了 TPEX 库的缺陷，为堆芯物理库的工程应用提供数据与技术支撑。

关键词

堆芯物理；子群参数；调整方法

Abstract

Reactor physics calculation is a core technology in nuclear reactor design, and its computational accuracy directly influences the reliability of the reactor design. The core physics library provides cross-section data, fission yields, and decay data for reactor physics calculations; therefore, the accuracy of the core physics library is a prerequisite for ensuring the precision of reactor physics computations. Previously, the China Nuclear Data Center developed the TPEX core physics library with a 45-group energy structure. Criticality benchmark verification revealed that the predicted effective multiplication factor (keff) in harder-spectrum uranium-fueled systems was systematically underestimated. To enhance the accuracy of the TPEX library, a resonance integral and subgroup parameter adjustment methodology based on escape cross sections is proposed in this study. An automated resonance integral and subgroup parameter adjustment system, designated ADJ_RI, has been established using the steepest descent method, and an adjusted library, TPEX_adj, has been developed. This work resolves the identified deficiencies of the TPEX library and provides essential data and technical support for the engineering application of core physics libraries.

Keywords

Reactor Core Physics; Subgroup Parameters; Adjustment Method

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