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蒙卡程序 **RMC** 在聚变中子学中的应用研究

关键词

RMC、蒙特卡洛、CFETR、聚变中子学

摘要

本研究探讨了 Reactor Monte Carlo（RMC）代码在聚变中子学中的应用，并评估其在聚变反应堆分析中的关键能力。在模型适配方面面，为了满足现今大多以 MCNP 格式设计的聚变装置模型，能够转换成 RMC 格式，我们开发了 M2R 模型转换工具，并通过 CFETR 模型的转换验证了其准确性。此外，本研究针对 CFETR 模型开展了全局中子通量分布计算，采用减密度方法生成权窗，并经过三次迭代获得完整的全局通量分布，验证了 RMC 在减方差和深穿透中子输运计算方面的可靠性。同时，为评估 RMC 的 CAD 几何输运能力，我们利用 Paramak 设计了一个半托卡马克模型，并分别在 RMC 和 OpenMC 中进行模拟，结果吻合良好。总体而言，本研究证明了 RMC 在复杂反应堆模型分析、深穿透中子输运计算及减方差方法应用方面的有效性和可靠性。

Abstract

This study explores the application of the Reactor Monte Carlo (RMC) code in fusion neutronics and evaluates its key capabilities in fusion reactor analysis. In terms of model adaptation, to accommodate the prevalent use of MCNP-format models in fusion device design and enable their conversion to RMC format, we developed the M2R model conversion tool and validated its accuracy through the conversion of the CFETR model. Additionally, this study conducted global neutron flux distribution calculations for the CFETR model, employing a density reduction method for weight window generation. Through three iterations, a complete global flux distribution was obtained, verifying the reliability of RMC in variance reduction and deep-penetration neutron transport calculations. Furthermore, to assess RMC's CAD-based transport capabilities, we utilized Paramak to design a half-tokamak model and performed neutron transport simulations in both RMC and OpenMC, yielding consistent results. Overall, this study demonstrates the effectiveness and reliability of RMC in complex reactor model analysis, deep-penetration neutron transport calculations, and variance reduction applications.

Keywords

RMC, Monte Carlo, CFETR, Fusion neutronics

Author: Mr 国禹, 曾

Presenter: Mr 国禹, 曾

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