快报

中子输运的随机理论

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摘要　　运用概率理论，考虑　t时刻n个相空间点$(r, u_i\Omega_i)$ 单位体元中分别出现$N_i (i=1, 2, …, n)$个中子的概率P_N $(r, t, u\Omega)$，提出一个新的中子输运的随机理论，导出概率母函数F_n的非线性积分微分方程组。在某些近似下，n =1概率分布一阶矩方程恰好是中子平均数玻尔兹曼方程。将各向同性散射的单速中子随机理论应用于点堆模型。在一个超临界系统中，当$t \to \infty$时，出现有限个中子的概率为零，$P_N=0 (0 < N < \infty)$，即系统内或没有中子，或有无限多中子。给出了母函数的近似解，导出了母函数概率分布各阶矩的近似方程及解式。标准差公式表明，当初始中子数起伏ξ_0较大，初始中子平均数N_0不够多，或中子源强Q很弱时，对于$0 < \lambda < 1$的增殖系统，中子数的起伏很大，应予以重视。

关键词　 随机理论；中子输运；母函数方程；起伏

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Stochastic Theory of Neutron Transport

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Abstract Abstract: A stochastic neutron transport theory, in which we consider the probability $P_N(r, t, u\Omega)$ that the neutron densities $N_i(i=1, 2, …, n)$ emerge in the phase space point $(r, u_i\Omega_i)$ at time t respectively, was given by means of the probability theory, and a set of non-linear integral-differential equations for the probability generating functions $F_n(r, t, u\Omega, S)$ was derived. The equation for one-order moment F_1/S_1 under some approximation is just the Boltzman equation for the average neutron number. One-velocity neutron stochastic theory with isotropic scatting was applied to a point model. An approximate solution for the generating function and the equations for moments of the probability distribution and their solutions were derived. It is shown that in a supercritical system, at $t \to \infty$, the probability appearing finite neutrons is zero, $P_N=0 (0 < N < \infty)$, in other words, the system has no or infinite neutrons. A formula for standard deviation shows that the fluctuation of neutron number in the near critical $(0 < \lambda < 1)$ system should be paid our attention when the fluctuation of initial neutron number ξ_0 is larger and the initial neutron average number N_0 is not large enough, or neutron source Q is weaker.

Key words stochastic theory neutron transport equation for probability generating function fluctuation

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