Nuclear Reactor Physics

Reactor Modeling and Simulation

Reactor Physics, Design and Engineering

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- Design, modeling and simulation of Nuclear Reactors under Normal & Accidental Conditions
- Multi-scale, multi-physics Modeling for Severe Accidents

→ Advanced Modeling & Simulation for Improved Safety and Improved Knowledge of Nuclear Reactors

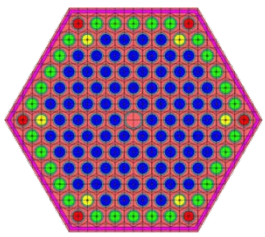
1. Outline of Research Areas

- To enable safe and efficient operation of nuclear reactors, it is vital to have advanced, highly reliable software for simulation and analysis
- Simulation of nuclear reactors under accidental conditions poses considerable problems – effective modeling and analysis requires both numerical analysis and physical modeling
- For licensing applications, it is required to show that the numerical analysis of nuclear reactors is accurate, reliable and predictive of reactor behavior under a wide range of operational and accidental conditions.

2. Research Topics

- **Void Effect and its uncertainty**
- Under severe accidents, the coolant may disappear from the core. It is difficult to accurately predict the core characteristics under voided conditions. Improved modeling is required, as well as advanced uncertainty analysis, to gain confidence that the void effect is well understood and well calculated

$$S_s(\boldsymbol{r}, E, \boldsymbol{\Omega}) = \int_0^{\infty} dE' \sum_{l=0}^{\infty} \frac{2l+1}{4\pi} \Sigma_{sl}\left(\boldsymbol{r}, E' \rightarrow E\right) \sum_{m=-l}^{l} \phi_{lm}(\boldsymbol{r}, E', t) Y_{lm}\left(\boldsymbol{\Omega}\right)$$



- **Re-criticality of degraded core configurations**
- After the Fukushima accident, there has been quite some discussion about the potential risk of re-criticality of the molten and deformed fuel. Under accidental conditions, the risk of re-criticality is small, but cannot be excluded. Therefore, it is necessary to develop tools and analysis methods to analyze the risk of re-criticality for a large range of accidental conditions.

- **Analysis of deformed reactors**
- Simulation methods for deformed geometries do not really exist. The Fukushima accident shows the need for advanced simulation tools, capable of treating deformed reactors.

Vision of nuclear power and nuclear energy

Improve our understanding of nuclear systems, so that we can be confident that our analysis is correct

→ Advanced and non-traditional methods & simulation

→ **Safe, reliable, cheap and sustainable nuclear power for the future!**

Message to students

Work in an interesting, exciting and challenging field, including physics, mathematics and computational science. An international orientation and a get-to mentality are required!