Microscopic Description of Nuclear Fission

- Fission is a **key driver** of the stability of superheavy elements
- Multiple fission channels in **r-process nucleosynthesis**, including spontaneous, ν-induced or β-delayed
- Fission is important for **applications** such as nuclear forensics or carbon-free energy sources

- Most fission models used to generate databases for applications are phenomenological and fitted to experimental data that cannot be used for r-process or superheavy applications

  We need a truly predictive theory

- UQ of theoretical predictions hampered by the fact that models for different aspects of fission are "disconnected”

  We need a unified theory

- The recent developments of supercomputers **enables** such program,

  The theory and implementation is missing

Microscopic Description of Nuclear Fission

- Develop **microscopic nuclear Hamiltonians** for applications at nuclear chart scale
  a. Enable formally sound configuration mixing/beyond mean field approaches

- Build a theory of **large-amplitude collective motion** with **dissipation** and **fluctuations**
  a. Enable microscopic determination of cross-sections along different channels, e.g. fission vs neutron emission

- **End-to-end simulation**: unify theory of large-amplitude collective motion with reaction theory
  a. Fewer assumptions = more predictive power
  b. Feedback from experiment
  c. Each theory might have incompatible approximations

- Develop machine learning techniques for **surrogate modeling** of nuclear systems
  a. Enable tackling ill-posed problems
  b. Accelerate determination of nuclear properties

- Take full advantage of **exascale** computing capabilities
  a. Huge amount of time needed redeveloping codes for new architectures
  b. Constantly evolving architectures require good programming practices
  c. Computer scientists have a lot to bring to the community