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## Effect of tensor interaction on the r-process waiting point nucleus $Zn^{80}$ and its neighbors

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The production of heavy elements beyond Ge proceeds via r-process in stars. The abundance pattern of elements depends critically on the underlying nuclear processes.  $\beta$ -decay half-lives and neutron separation energies are important in r-process as long-lived 'waiting point' nuclei govern the advancement of r-process.  $Zn^{80}$  and  $Cd^{130}$  are believed to be most prominent 'waiting point' nuclei as evident from the abundance peaks. Binding energies and one/two neutron separation energies of Zn isotopes have been calculated through tensor interaction included Skyrme-Hartree-Fock theory. The parameters for tensor interaction have been optimized through reproduction of splitting of 1f shell model states of isoscalar  $Ca^{40}$  and  $Ni^{56}$  nuclei and iso-vector  $Ca^{48}$  nucleus. As a further check single particle states of the most well studied  $Pb^{208}$  and doubly magic  $Sn^{132}$  nuclei have also been calculated and compared with the experimental values. The confidence gained therein led us to explore the robustness of the neutron shell at  $N=50$  for Zn nuclei. The results vindicated our conjecture of fixing the tensor interaction parameters at Ca and Ni nuclei.

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## The theoretical study on the silicide nuclear fuels and cladding materials

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For the nuclear plants, the safety and efficiency of the reactors are the most concerned issues mainly determined by the performance of the applied materials. Hence, the structural design of new nuclear fuels and the development of new generation cladding materials have been the research focus for years. In our works, we have studied the crystalline structures of different members of uranium silicides by first principle calculations. The impact of defects on the stability and lattice structure of uranium silicide is investigated and predictions on the performance in the reactor are discussed. As the promising cladding materials, SiC/SiC composite is studied in our group as well. Non-equilibrium Molecular Dynamics simulations are performed to study the mechanism for the mechanical failure of the coating-matrix and coating-fiber interfaces. It is found that the mechanical strength of interface is strongly dependent on the temperature of the system. At 700-1000K, the shear strength is significantly reduced due to the phase transition of the pyrolysis carbon coatings. Furthermore, the implanted He atoms are also determined as a major factor that influences the mechanical behavior. The existence of He atoms in the coating materials may cause a significant increase in shear strength and have a delaying effect on the high temperature failure. By theoretical calculations, we have also found the feasibility of a novel way of space propulsion. According to the results of Monte Carlo simulations, the principle of near-light-speed particle propulsion (NcPP) was raised and the feasibility of applying it for inter-planet travelling was evaluated, which will also be introduced in the presentation.

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