

Reactor physics for innovative reactor development and applications in space, medical and planetary science/革新炉開発と宇宙、医学、惑星科学への応用のための炉物理

The author has studied various types of innovative fission reactors with different nuclear fuels and expanding applications of nuclear energy released by neutron reactions or disintegrations of radioisotopes, aiming at utilization in many fields including space, medical diagnostics/therapy, planetary science, etc.

In the vast of those studies with different purposes, unique materials and rather different neutronic principles which are rarely applied in traditional light water reactors are required in analyses. Enriching transmutation chains, nuclear data for minor nuclides and cross sections for various nuclear reactions are essentials to move forward with extended nuclear applications for such emerging fields. The author's presentation will cover following topics.

Innovative power reactors; Long-life fast reactor, thorium-fueled water-cooled breeder reactor[1], beryllium-moderated thermal breeder using natural uranium, MA burner, fast reactor for LLFP transmutation[2], breed/burn reactor (CANDLE reactor), and high flux irradiation reactor.

Medical isotopes production; Ac-225 production for targeted alpha therapy (TAT) by fast neutrons, Ac-225 production by multiple neutron captures in thermal spectrum, Mo-99/Tc-99m production in commercial LWRs, Lu-177 production in commercial LWRs, assessment of dose absorbed by cancer cell.

Fission systems for space; Radioisotope thermoelectric generator (RTG), nuclear thermal rocket, alpha-particle propulsion, rotary space reactor, micro reactor on the moon, neutron propulsion, heavy-particle propulsion.

Planetary science; Geo-reactor worked in the primitive earth, geo-fast reactor in center of the earth.

References

- [1] Naoyuki Takaki, Deby Mardiansah, Core design and deployment strategy of heavy water cooled sustainable thorium reactor, Sustainability 2012, 4(8), 1933-1945
- [2] Satoshi Chiba, Toshio Wakabayashi, Yoshiaki Tachi, Naoyuki Takaki, Atsunori Terashima, Shin Okumura, Tadashi Yoshida, Method to Reduce Long-lived Fission Products by Nuclear Transmutations with Fast Spectrum Reactors, Scientific reports (2017) 7 1 (13961)
- [3] Neutronic Study on Ac-225 Production for Cancer Therapy by (n,2n) Reaction of Ra-226 or Th-230 Using Fast Reactor Joyo, Processes 2022, 10(7), 1239

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Session Classification: Reactor physics for innovative reactor development and applications in space, medical and planetary science/革新炉開発と宇宙、医学、惑星科学への応用のための炉物理