

An Introduction to the Radiation-Thrust Based on Alpha Decay and Spontaneous Fission

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Abstract : As the key system of the spacecraft, various propelling system have been developing rapidly, including ion thrust, laser thrust, solar sail and other micro-thrusters. However, there still are some shortages in these systems. The ion thruster requires the high-voltage or magnetic field to accelerate, resulting in extra system, heavy quantity and large volume. The laser thrust now is mostly ground-based and providing pulse thrust, restraint by the station distribution and the capacity of laser. The thrust direction of solar sail is limited to its relative position with the Sun, so it is hard to propel toward the Sun or adjust in the shadow. In this paper, a novel nuclear thruster based on alpha decay and spontaneous fission is proposed and the principle of this radiation-thrust with alpha particle has been expounded. Radioactive materials with different released energy, such as ^{210}Po with 5.4MeV and ^{238}Pu with 5.29MeV, attached to a metal film will provides various thrust among 0.02-5uN/cm². With this repulsive force, radiation is able to be a power source. With the advantages of low system quantity, high accuracy and long active time, the radiation thrust is promising in the field of space debris removal, orbit control of nano-satellite array and deep space exploration. To do further study, a formula lead to the amplitude and direction of thrust by the released energy and decay coefficient is set up. With the initial formula, the alpha radiation elements with the half life period longer than a hundred days are calculated and listed. As the alpha particles emit continuously, the residual charge in metal film grows and affects the emitting energy distribution of alpha particles. With the residual charge or extra electromagnetic field, the emitting of alpha particles performs differently and is analyzed in this paper. Furthermore, three more complex situations are discussed. Radiation element generating alpha particles with several energies in different intensity, mixture of various radiation elements, and cascaded alpha decay are studied respectively. In combined way, it is more efficient and flexible to adjust the thrust amplitude. The propelling model of the spontaneous fission is similar with the one of alpha decay, which has a more complex angular distribution. A new quasi-sphere space propelling system based on the radiation-thrust has been introduced, as well as the collecting and processing system of excess charge and reaction heat. The energy and spatial angular distribution of emitting alpha particles on unit area and certain propelling system have been studied. As the alpha particles are easily losing energy and self-absorb, the distribution is not the simple stacking of each nuclide. With the change of the amplitude and angel of radiation-thrust, orbital variation strategy on space debris removal is shown and optimized.

Keywords : alpha decay, angular distribution, emitting energy, orbital variation, radiation-thruster

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