Radiation Guiding in Active Nano-Structures for Shielding and Nuclear Reaction Control Systems

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Abstract. In outer space the radiation complex having many origins, as galactic, solar and local from the spaceship own power system, that for the moment is dominant and is pounding the nuclear power systems for space.

The actual nuclear reactors for space are using booms, and partial shielding, in order to reduce the radiation inside the crew chambers, and to be as light as possible. This solution has the disadvantage that it reduces the outside maneuverability space for docking and space-walk that has to take in consideration the radiation zones around the spaceship. The main radiation attenuation method is called mass, because no matter (with some approximation) what material we are using, in order to get a radiation attenuation ratio, about same mass is required, no matter if it is hydrogen, water or tungsten for electromagnetic radiations with energies above 300 keV, inside gamma ray domain. For neutron attenuation, light, neutron absorbent materials are used for shielding surrounded by gamma absorbent shielding, which all together makes the nuclear power source heavier by a factor of 2 to 10 times.

The novel material relies on trapping the gamma radiation and neutrons inside specially engineered nano-structures, which guides it along the structure, changing its direction without changing its energy.

This type of material may take the emergent radiation, and redirect it on a preferred escape direction or towards an absorbent element. It may also turn around the neutrons, normally being lost outside through external surfaces and redirect them inwards to the reactor's core, and increasing its reactivity. Adding electrically controlled structures on along the radiation guide, that acts as electrically controlled path switches, for radiation, it is possible to control the radiation final direction. Using the radiation switches we may drive the escaped neutrons towards the reactor core, increasing its reactivity and power, or towards an absorbent where it can do fuel breeding or special isotope production, and decrease the core, power and reactivity. This is what is called active nuclear reaction shielding, because it acts like the actual reflector drums and shielding. This material is also good for other applications very useful in space as radiation concentrators for imaging or non-imaging purposes, and radiation modulators.

The shield made of the new material is lighter that the actual shielding, and it may be used as reactivity control device, having a response time in micro-seconds being by at least 1000 times faster than the actual reflective drums, allowing the nuclear reactor power (amplitude) modulation up to MHz frequencies, good for neutrino communication systems.

Keywords: radiation-guide, nano-structures, reactor-shield, active-shield, radiation concentrator, neutrino-communication, reactor-power-modulation.