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REQUIREMENTS AND DESIGNS FOR LARGE PERMANENT SPACE STATIONS

Abstract

Large permanent human space habitats have been proposed for more than a century. They are usually enclosed vessels that rotate on a central axis to provide Earth-normal gravity on their inner surfaces. The suggested designs include rotating wheels, spheres, and cylinders. The basic requirements for a large permanent space station are to provide normal gravity, radiation protection, power, living and work area, and a life support system providing Earth-like atmosphere, food, water, and waste treatment. There seem to be no effective countermeasures against the effects of partial gravity and rotational gravity is required. Radiation protection is needed to reduce the incidence of cancer and can be provided by passive mass shielding or by active magnetic or electric shielding. Power can be solar or nuclear. The life support system should use an economical combination of external supply from Earth and other human habatitats and internal plant-based, biological, or chemical food production, oxygen and water recycling, and carbon dioxide removal. The most cost-effective design depends on the cost of producing life support material and equipment at different locations and the cost of transportation between them. Excess capacity and alternate approaches can be provided to reduce risk. For permanent space stations to become numerous, the further requirements are that they be self-sustaining and self-reproducing. Since space habitats will probably be too small to achieve economies of scale, they should participate in an exchange of materials, artifacts, and remote services to achieve high productivity and acceptable living conditions. Increasing the number of space habitats probably requires that one or several combined can construct a new habitat. A wheel or cylinder is easier to expand along the axis of rotation and then split than would be a sphere or torus. The needs for specialization and reproduction suggest that there will be a variety of space platforms with different capabilities and designs. Space stations designed for Low Earth Orbit (LEO) such as the International Space Station (ISS) are protected by Earth's magnetic field and need less radiation shielding. An interstellar spaceship would require nuclear rather than solar power and would necessarily be self-sustaining and have high reliability. Human progress increases at a faster rate as populations become larger and more connected so that a solar system having many large permanent space stations could produce unimaginable advances.