Nuclear Fusion Powered Titan Aircraft

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This paper discusses a system for Titan exploration enabled by nuclear fusion power. Titan is one of the most interesting locations in the solar system with a thick atmosphere, surface oceans, under-ice oceans and complex terrain. This paper provides a conceptual design of a fusion-powered system to explore many parts of Titan and enable the use of high-power instruments. The design includes a fusion-powered orbital transfer vehicle and an electric Titan science aircraft. A Direct Fusion Drive (DFD) propulsive engine could bring a sizable spacecraft to Titan orbit in less than two years. A second fusion reactor, configured as a closed-loop power generator would be used for an electric Titan science aircraft. Both reactors are based on the Princeton Field-Reversed Configuration (PFRC) concept which combines an FRC with a magnetic mirror. PFRC uses a novel radio-frequency plasma heating system and deuterium-helium-3 fuel. A lower-temperature plasma flows around the closed-field FRC region removing the fusion products. In the DFD propulsive configuration, this secondary flow permits direct and variable thrust and exhaust velocity. The science aircraft would do a powered entry to Titan and then have the capability to fly anywhere on the moon at subsonic speeds. The DFD-powered transfer vehicle would allow the in-orbit transfer stage to change inclination as needed to cover different areas of the surface.