Exploration of Jovian Atmosphere using Nuclear Ramjet Flyer

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We are proposing to conduct studies of a revolutionary new concept for exploring the atmosphere of Jupiter (and other planets). We propose to investigate the design, operation, and data gathering possibilities of a nuclear-powered ramjet flyer in the Jovian atmosphere. The MITEE nuclear rocket engine (Acta Astronautica, No. 2-4, 1999) can be modified to operate as a ramjet in planetary atmospheres. (Note: MITEE is a compact, ultra-light-weight thermal nuclear rocket which uses hydrogen as the propellant.) To operate as a ramjet, MITEE requires a suitable inlet and diffuser to substitute for the propellant that is ducted from the supply tanks in a nuclear rocket engine. Such a ramjet would fly in the upper Jovian atmosphere, mapping in detail temperatures, pressures, compositions, lightning activity, and wind speeds, e.g., in the highly turbulent equatorial zone and the Great Red Spot. The nuclear ramjet could operate for years because: 1) the Jovian atmosphere has unlimited propellant, 2) the MITEE nuclear reactor is a (nearly) unlimited power source, and 3) with no moving parts, nothing should wear out. The ramjet is extremely simple and lightweight, with three components: 1) a diffuser to compress the incoming atmosphere, 2) a heat source to heat the compressed gas, and 3) an exhaust nozzle to generate thrust. A conventional ramjet engine with a diameter to accommodate the MITEE nuclear engine weighs only 75 kg. Adding the ~100 kg MITEE engine, lifting and control surfaces, and an atmospheric monitoring instrument package, the total weight of the ramjet flyer is approximately 250 kg. To perform the mapping mission, the flight vehicle must first be transported into the Jovian atmosphere. This is a technically demanding, but by no means impossible, task. We note that on December 7, 1995, the Galileo Probe, having a mass of 339 kg (approximately 50% payload and 50% thermal shield), successfully entered the Jovian atmosphere. The ramjet flyer will essentially duplicate the Galileo Probe mission until our entry vehicle has decelerated to about Mach 1.5 (v = 1.3 km/s). At that point, the ramjet flyer will detach from the entry vehicle, and the nuclear engine will commence operation to propel the flyer in the speed range of about Mach 0.9 to 1.5. The nuclear-powered ramjet can produce sufficient thrust so that the flyer will be able to dive deeper into the Jovian atmosphere and climb back up as needed. We propose to establish the full envelope of conditions that can be explored with the ramjet flyer on Jupiter and on other planets.