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Pros and cons of relativistic interstellar flight from the point of view of Physics

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The future of relativistic interstellar flights rests on three whales: technology, economy and psychology. Regarding technology, the main problem is fuel and propulsion. The proposed concept of relativistic matter propulsion powered by annihilation reactor looks technically viable and promising. Antimatter in a dense state (liquid or solid) with its extreme energy density is apparently the only fuel to power a multi-ton relativistic rocket. Annihilation reactor cannot be made without solving the problem of antimatter storage. The main candidate for fueling relativistic interstellar rockets is diamagnetic antihydrogen. Since antihydrogen is to be kept at a cryogenic temperature, the magnetic barrier with a gradient magnetic field can be induced by an array of superconductive coils with alternate direction of current mounted inside a storage tank. Thermodynamics dictates necessity of excess heat disposal and the only way to do this in space vacuum is radiation. Surface area and mass of radiator grow rapidly with the engine power. Though radiator is technically simple and can be manufactured relatively easily, its area and mass grow rapidly with the engine power and can become unacceptably large. Another physical problem is transformation of an innocuous interstellar gas into an ongoing stream of hard radiation. The velocity of oncoming ions, atoms and molecules comprising interstellar gas is equal to the map-velocity ν of a rocket and kinetic energy of hydtogrn nuclei and atoms in the rocket coordinate frame is m_0c^2 (γ–1)~1 GeV for v=0.5 c. Despite strong rarefaction of interstellar gas n~0.3 cm^-3, the flux of ions and molecules N=n×ν becomes so intense that it creates severe radiation hazard. In addition, relativistic dust grains in space can pierce the protective shield and damage the rocket body.

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