Future of Life in the Solar System

Future of Life in Solar System

Terra form other planets (Mars most likely)

Space Colonies

Solar Power from space

Dyson spheres

Robots

Von Neumann Devices

Future of Life in the Solar System

Seed other planets with
"bio-engineered organisms"

Use these to make more habitable for humans

Terraform (need H_2O, O_2, O_3)

e.g. Melt polar caps on Mars (10^{14} tons of ice)

2500 to 10000 years to build up atm. pressure, get liquid water

Terraformed Mars

Ocean in northern lowlands covers
25% of planet

Living in Space to Robots…

Space colonies
Solar Power satellites
↓

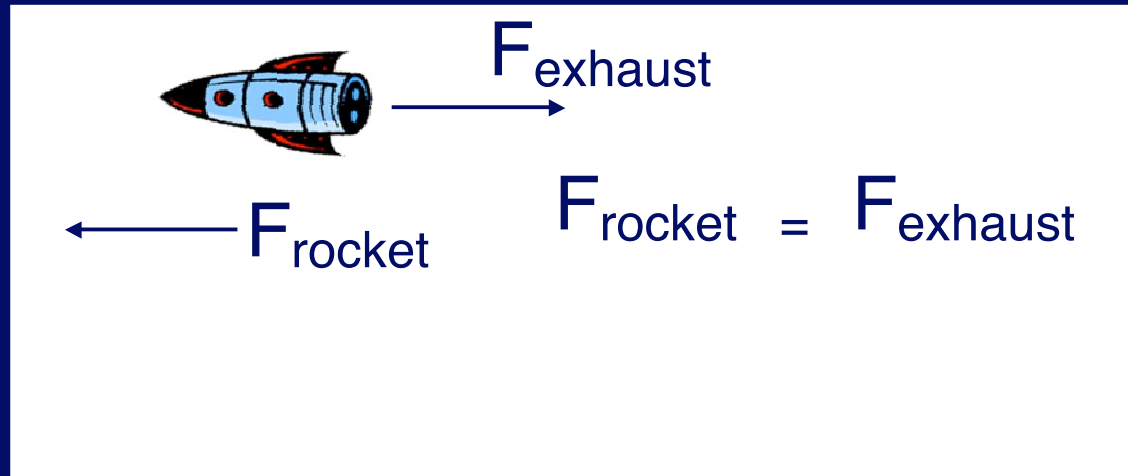Dyson sphere   (Type II Civilization)

Role of Robots
↓

Von Neumann device

Rockets

Principle: Newton's Third Law

$F_{exhaust}$

F_{rocket} $F_{rocket} = F_{exhaust}$

1. Exhaust velocity V_e (km s^{-1})

$$V_e \propto \sqrt{\frac{T}{M}}$$

2.   Thrust   (Force) $F = \dot{M} \, V_e$

(Newtons, Pounds)

($\dot{M}$ = rate of mass ejected)

3. Mass ratio

$$R_M = \frac{\text{Total Mass at Takeoff}}{\text{Mass After Fuel Used Up}}$$
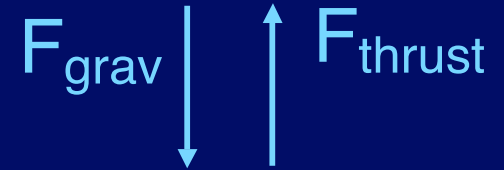
4.   Specific impulse   (s.i.)

$$\frac{\text{Thrust}}{\text{Rate of Fuel Use}}$$

(Newtons/kg/sec,

Pounds/Pounds/sec = "sec")

A measure of efficiency.

Highest possible s.i. with chemical fuels is < 500

Rockets

F_{grav} $\downarrow$ $\uparrow$ F_{thrust}

To take off: Thrust > Weight

To escape gravity $v > v_{esc} = 11.2$ km s^{-1}

(7 miles/sec)

Rockets

Multi-stage Rockets

Space Shuttle: Mass = 2×10^6 kg

F_{thrust} = 29×10^6 Newtons $R_M = 68$

s.i. = 455 sec.   ~ best possible with
                              chemical fuel

For more adventurous exploitation of Solar System
Probably want Nuclear Propulsion
Fission could give s.i. = 1.5×10^6 sec
(in principle, more likely to get 20,000 sec)

Current Initiative

- Human mission to Mars
- Several attempts to get started in past
- Exploration Vision in 2004
  - First return to Moon
  - Then Mars
  - Long-term program needed
  - http://www.nasa.gov/missions/solarsystem/explore_main.html