Introduction to Ringworld Technology

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Motivation

- "Domiciled on a planet, living space will not be a major problem for [Type I] cultures. But emergent Type II societies will find no such ready-made living quarters in orbit." – Robert Freitas

- Earth is a single planet

  - Limited area for urban development

  - Limited food production capacity

  - Limited waste heat disposal

Instead of relying on natural land, we must build our own.
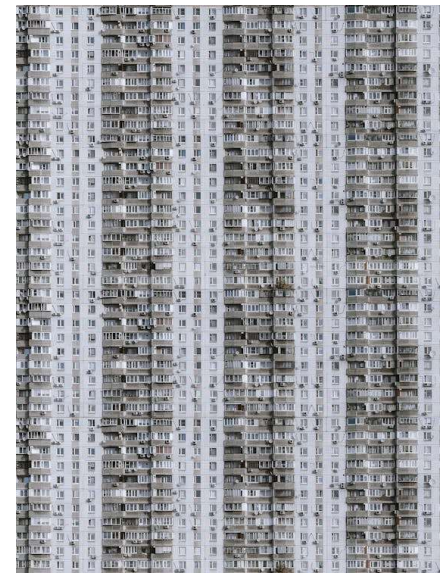
We have faced this problem before

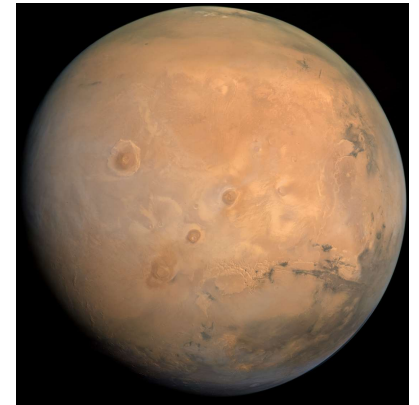Natural spaces   Artificial Reproduction   Improvement
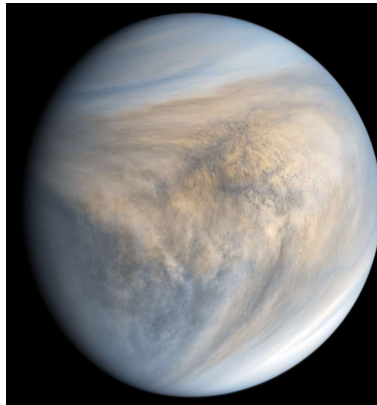
Potential solutions

Reproducing and Improving

Terraforming

- Finding more caves

- Rocky planets: 2x Earth
- Ice giants: 30x Earth
- Gas giants: 500x Earth

- Requires huge effort
- Potential complications

Images from Kevin Gill, Gregory Revera, Ittiz, Daein Ballard

Space Habitats

- Reproduce the cave

- Centrifugal gravity
- Options
  - O'Neill cylinder
  - Stanford torus
  - Cole planetoid
- City-sized, not planet-sized
  - Large numbers required
  - Problems with orbit coordination
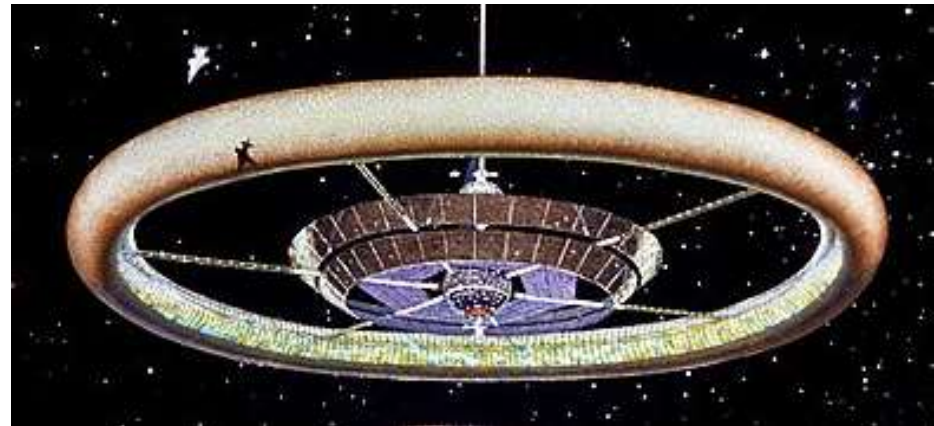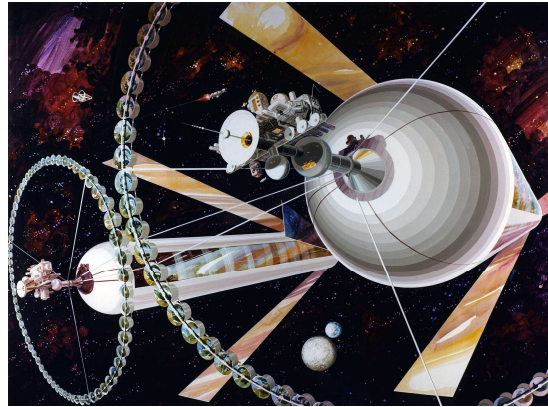
Ringworld

- Improving upon the cave

- Centrifugal gravity
- 10^3 to 10^7 times Earth's area
  - Economies of scale
- Thin profile allows stacking

- Problems
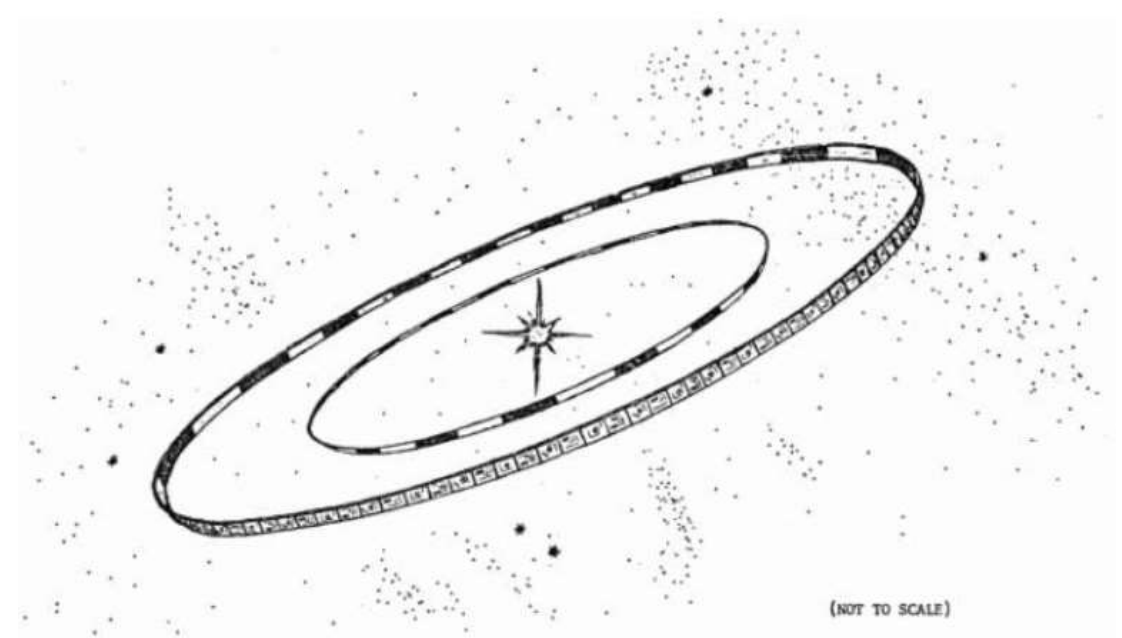 - Dynamical instability
  - Material strength
  - Atmosphere loss

Ring mass = 2.5×10^{27} kg
Radius = 1.5×10^{11} meters (1 AU)
Wall height = 2×10^6 meters
Floor thickness = 1000 meters
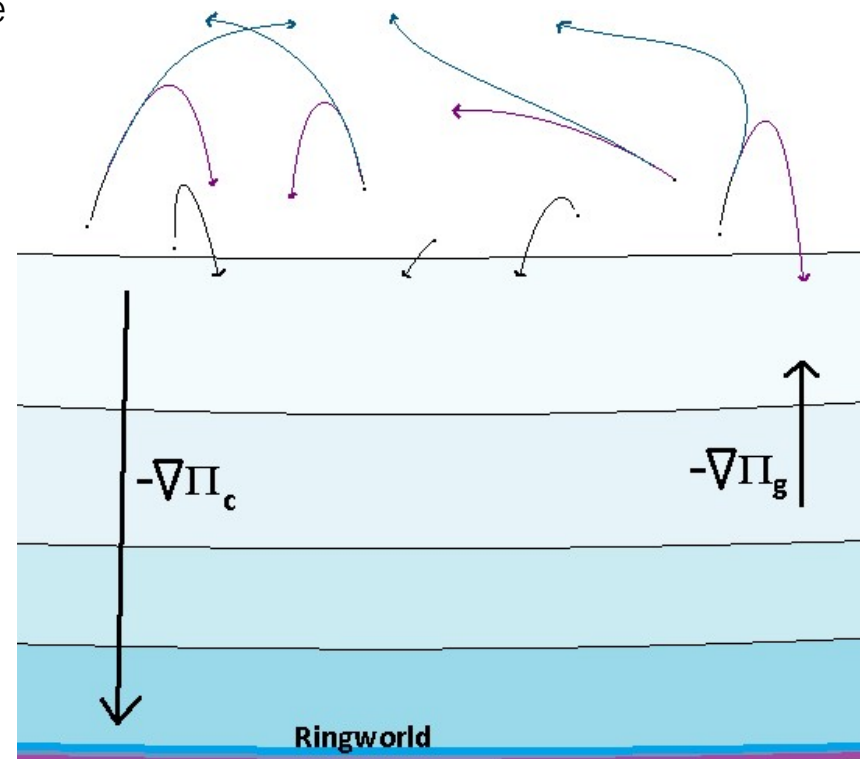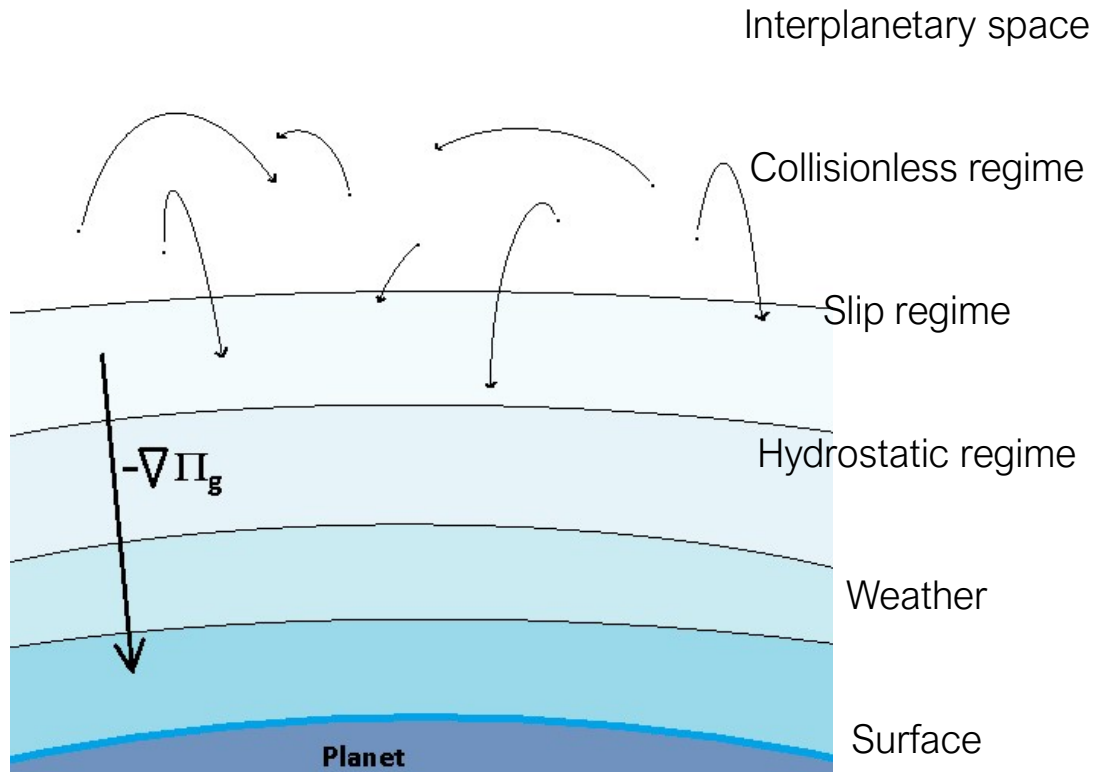
(NOT TO SCALE)

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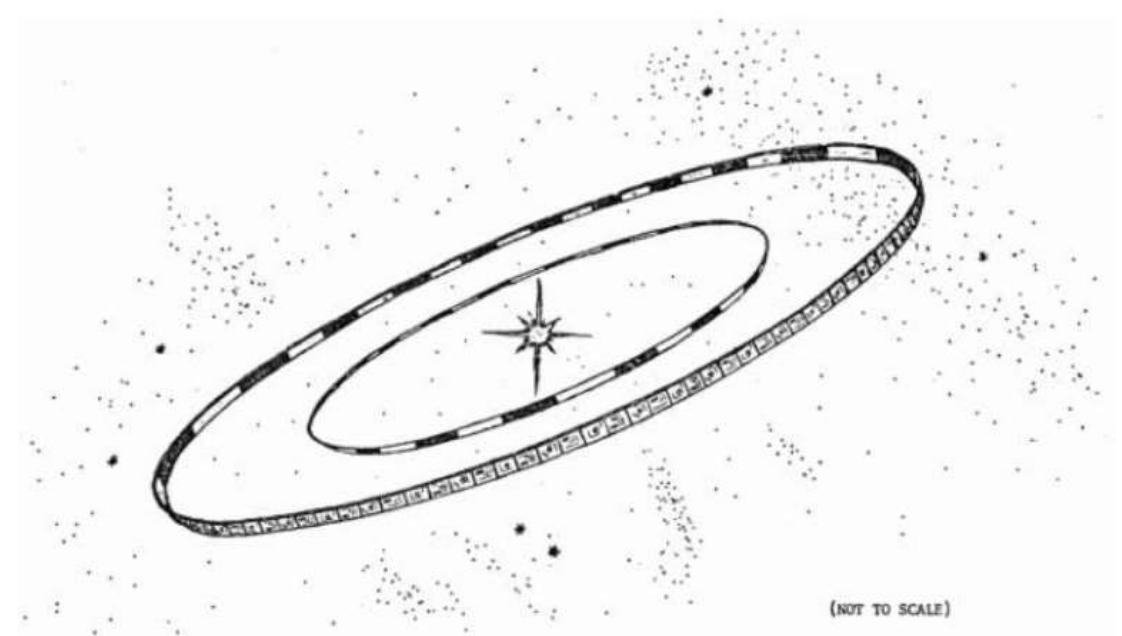
Ringworld

- Improving upon the cave

- Centrifugal gravity
- 10^3 to 10^7 times Earth's area
  - Economies of scale
- Thin profile allows stacking

- Problems
  - ~~Dynamical instability~~ Active control
  - ~~Material strength~~ Active support
  - Atmosphere loss???

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Radius = 1.5×10^{11} meters (1 AU)
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(NOT TO SCALE)

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Atmosphere retention

Interplanetary space

Collisionless regime

Slip regime

Hydrostatic regime

Weather

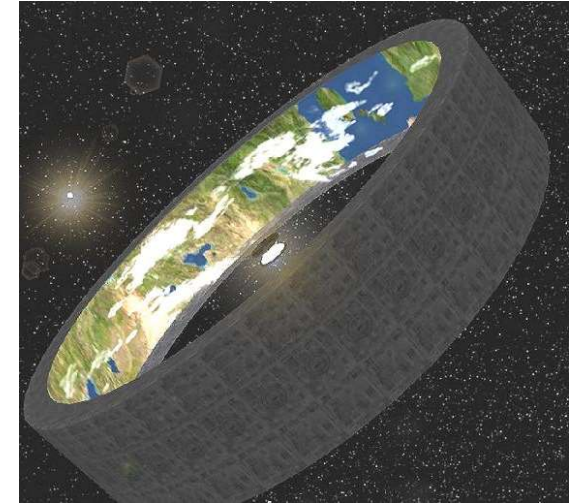Surface

$-\nabla\Pi_g$

Planet

$-\nabla\Pi_c$

$-\nabla\Pi_g$

Ringworld
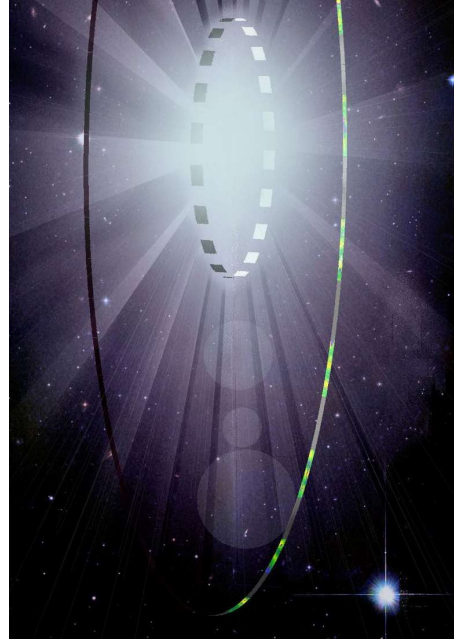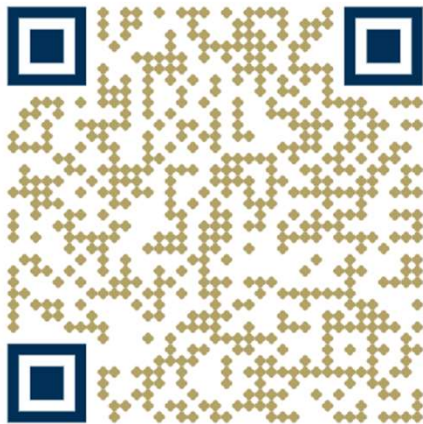
Next steps

- Collisionless particle simulation
- Development of a solver
  - Inertial or rotating coordinates?
- Stochastic initial conditions
- Future work
  - 3rd-body effects
  - Solar wind
  - Sensitivity to pressure and gravity
  - Effects of excessively small ring sizes (<1 R$_E$)
  - Sensitivity to nondimensional stellar mass $\frac{aR^2}{G}$
    - Sun ~ 0.005
    - Red dwarfs ~ 0.2 – 5
    - Blue giants ~ 0.00001

Images by Elowiny, Jones, and Steve Bowers

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