ISS - Visible Passes

Search period start: 06 February 2020 00:00
Search period end: 16 February 2020 00:00
Orbit: 416 x 423 km, 51.6° (Epoch: 07 February)

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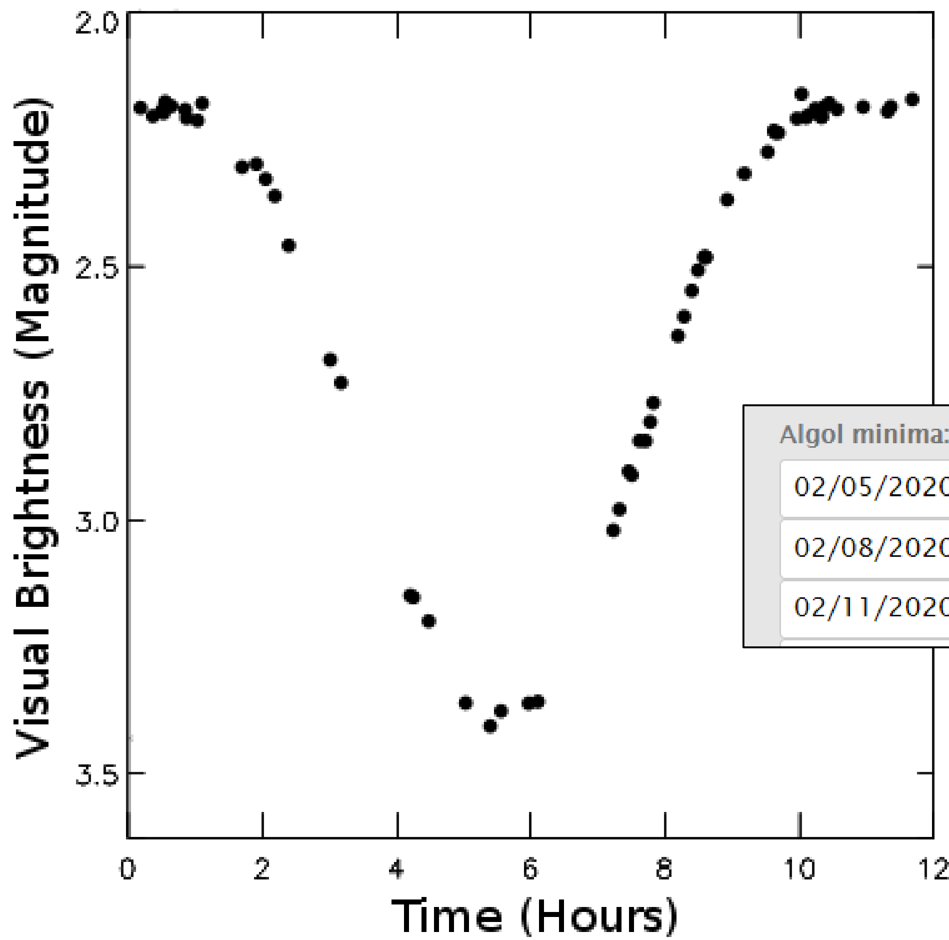
Passes to include: (•) visible only ( ) all

Click on the date to get a star chart and other pass details.

Date	Brightness (mag)	Start			Highest point			End		
		Time	Alt.	Az.	Time	Alt.	Az.	Time	Alt.	Az.
06 Feb	-3.2	19:11:32	10°	NNW	19:14:43	38°	NE	19:15:06	36°	ENE
07 Feb	-2.4	18:24:19	10°	NNW	18:27:04	22°	NE	18:29:46	10°	E
07 Feb	-1.7	20:00:56	10°	WNW	20:03:31	26°	WSW	20:03:31	26°	WSW
08 Feb	-3.1	19:13:02	10°	NW	19:16:20	54°	SW	19:19:14	13°	SSE
09 Feb	-3.8	18:25:25	10°	NW	18:28:47	74°	NE	18:32:07	10°	SE
10 Feb	-0.6	19:15:46	10°	W	19:17:41	14°	SW	19:19:35	10°	SSW
11 Feb	-1.3	18:27:19	10°	WNW	18:30:13	27°	SW	18:33:07	10°	S

Did you observe Algol's eclipse?



Algol minima:

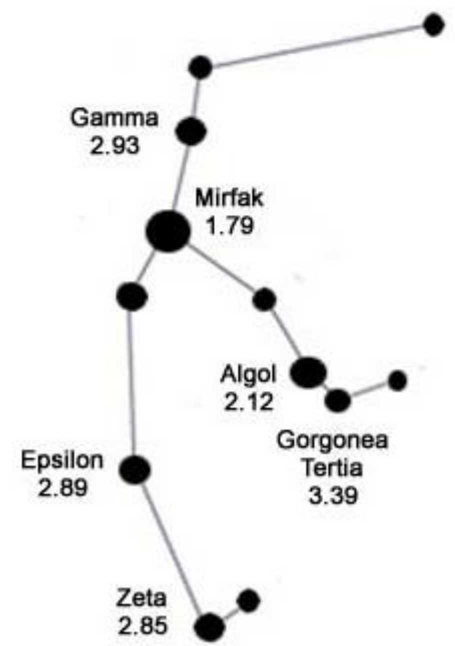
02/05/2020 @ 10:21 pm

02/08/2020 @ 07:10 pm

02/11/2020 @ 03:59 pm

magnitude 2.1→3.4

A factor of 3.3x dimmer



"Equilibrium Temperature"

- **What is the temperature of an object at a distance (D) from the Sun?**

- **Do you understand the problem?**
  - **What are some important factors?**
  - **Draw a diagram.**

- **Develop a plan.**

Energy Balance

In general, at a distance D from any star:
energy received = energy emitted

$$(1\text{-}A) \cdot [L_{star} / 4\pi D^2] \cdot \pi r^2 = 4\pi r^2 \sigma T^4$$

$$T^4 = (1\text{-}A) * (L_{star} / 4\pi D^2) / 4\sigma$$

$\sigma = 5.670367 \times 10^{-8}\ \mathrm{W \cdot m^{-2} \cdot K^{-4}}$
r = radius of the absorbing object
A = albedo = reflectivity

Solution

$$T^4 = (1-A) * (L_{star} / 4\pi D^2) / 4\sigma$$

$$D^2 = (1-A) * (L_{star}/16\pi\sigma T^4)$$

"Albedo" ("A")
reflectivity or "whiteness" (percent)

- **The percentage of reflected energy vs. incident energy**
  - **varies with wavelength**
  - **varies with direction (illumination, observation)**

- **Examples:**

– Enceladus	0.8	
– Earth	0.3	(average)
– Moon	0.14	
– Rings of Uranus	0.02	

“Emissivity” (“ε”)

- **A measure of the efficiency of a source to radiate like a perfect blackbody.**

- **A value of 0% is perfectly black.**
- **A value of 100% is perfectly reflective.**

Problem

What concept(s) are involved?

- **Imagine you observe two objects in the Kuiper Belt from the Earth when they are at opposition. One object is 50 AU from the Earth, the second object is 100 AU from the Earth.**

- **If both objects have the same albedo, A= 0.5, and the same diameter (500 km), then what is their flux ratio in reflected visible light observed from the Earth (i.e., closer object/farther object) ?**

- **Also calculate their apparent magnitude difference (closer – farther object).**

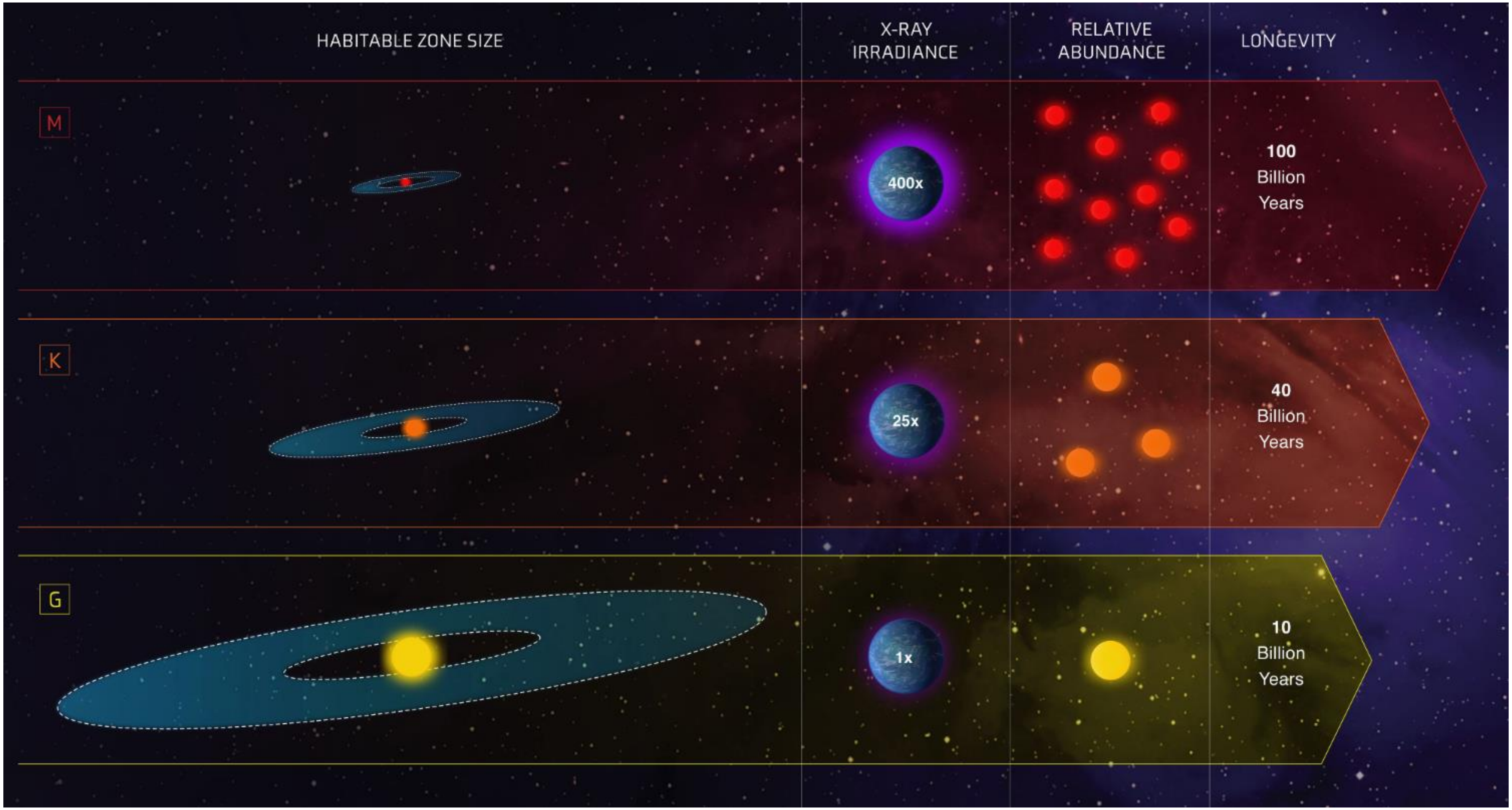
Problems

Habitable Zone: 273 – 373 K

What If?

- How does T_{eq} scale with albedo?
- How does T_{eq} scale with luminosity?
- What if the object is in synchronous revolution around the Sun?
- Does the width of the habitable zone depend on luminosity? If so, how?

Habitable Zones



“Width” of Habitable Zone

The likelihood of finding a planet in the habitable zone depends on the area in the habitable zone.

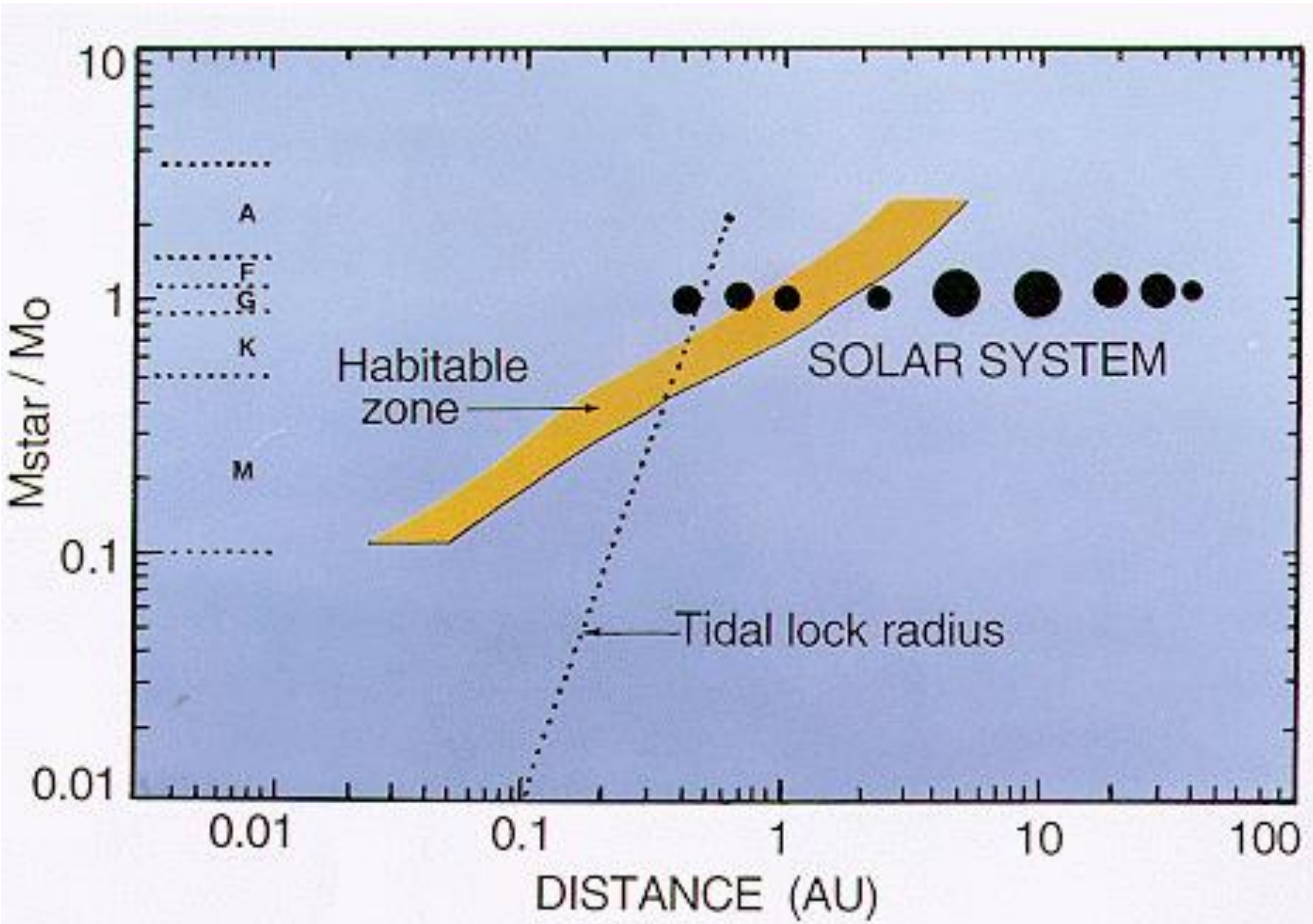
This area is proportional to D_o^2 - D_i^2, where D_o and D_i are the outer and inner boundaries of the zone, at temperatures of 273 K and 373 K, respectively.

$$D_o^2 - D_i^2 = L\,[1/T_o^4 - 1/T_i^4]$$

So, area α L

$$\text{width} = (D_o - D_i)\ \alpha\ L^{1/2}$$

Habitable Zones



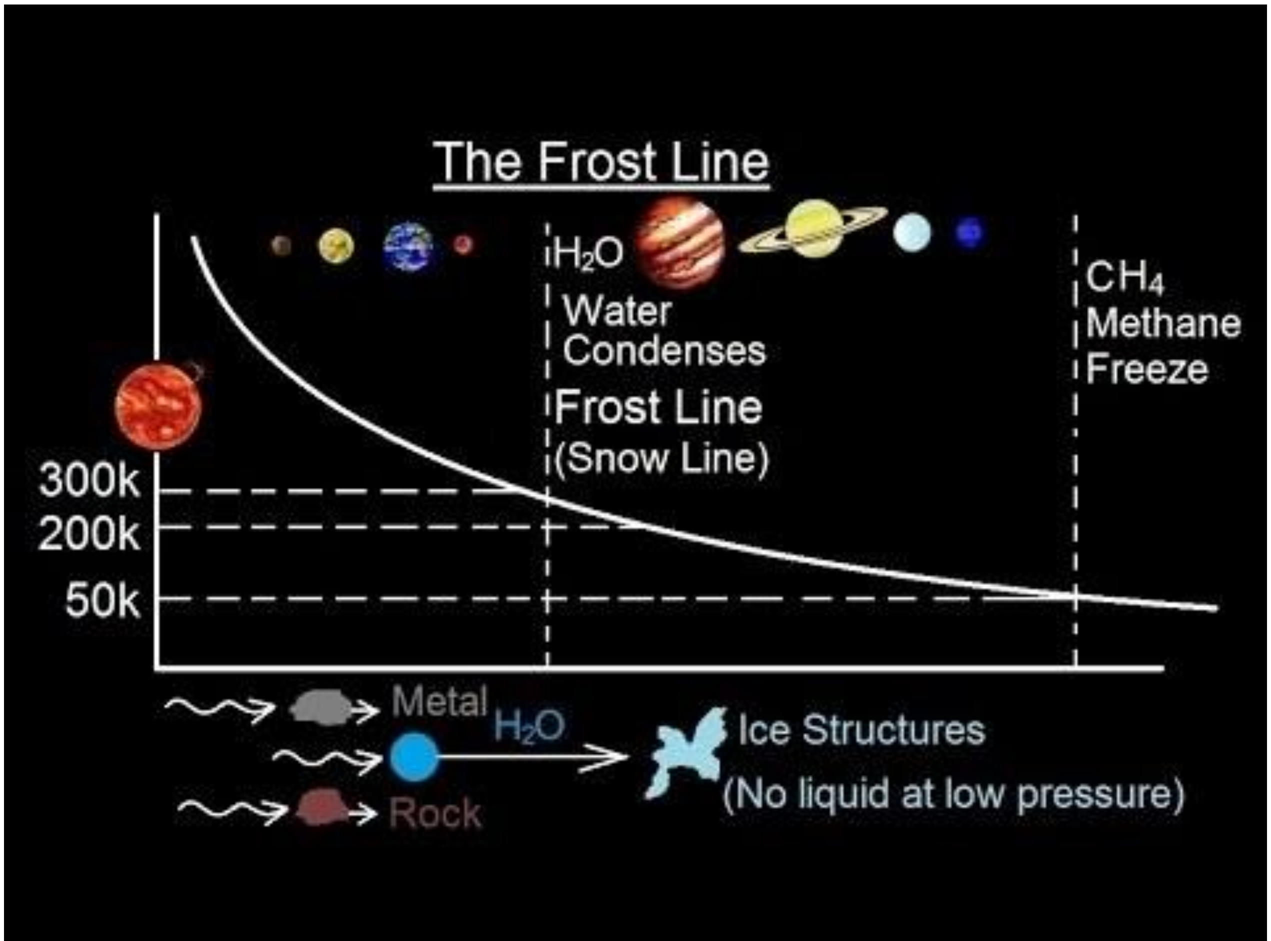
What if the object is in "synchronous rotation"?

- **A fast rotator would have about the same temperature all around**
  - **It would radiate from $4\pi r^2$ surface area**

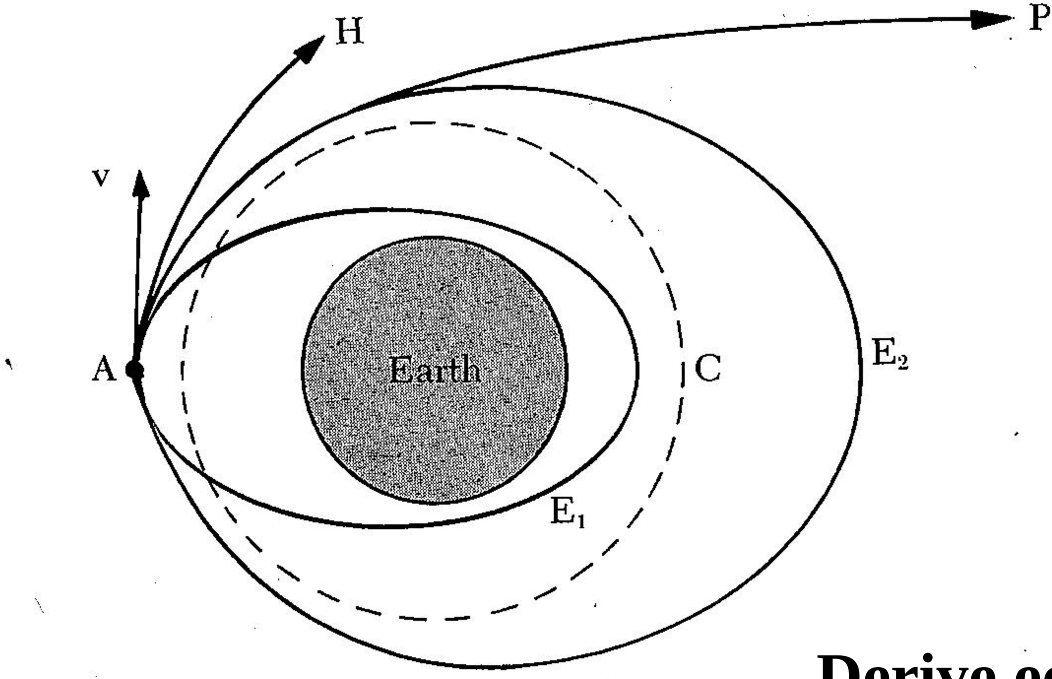
- **A slow rotator would have one hemisphere pointed longer at the Sun**
  - **It would radiate from $2\pi r^2$ surface area**

Special Regions in our Solar System & Exoplanets

"frost line" (~150 K); "habitable zone"; etc.



Orbital Mechanics and Energetics



Derive equations for circular and escape velocities.

Calculate These "Orbital" Velocities

- **Earth:**
  - **circular orbit (v_c)**
  - **escape (v_{esc})**

- **G = 6.6×10^{-11} $m^3\ s^{-2}\ kg^{-1}$**
- **Earth mass = 5.97×10^{24} kg**
- **Earth radius = 6.37×10^{6} m**

Velocities: Circular Orbit and Escape

- $mv_c^2/r = GMm/r^2$
- v_c = SQRT [GM/r]

- **Equation 3.56 in your book:**
  - energy = E = K + U = $\frac{1}{2}mv^2 - GMm/r$
  - E = 0
  - v_{esc} = SQRT [2Gm/r]
  - $v_{esc} = \sqrt{2}\, v_c$ at the same distance from Earth's center

Prove this Statement

"The energy needed to achieve low Earth orbit is roughly half of the total energy to reach anywhere in the Solar System."

$$\frac{1}{2} m v_{esc}^2 = \frac{1}{2} m(\sqrt{2} v_c)^2$$
$$\frac{1}{2} m v_{esc}^2 = m(v_c)^2$$

$$KE_{esc} = 2\ KE_C$$
$$\frac{1}{2} KE_{esc} = KE_C$$

Justifies the need for an orbital "waystation."

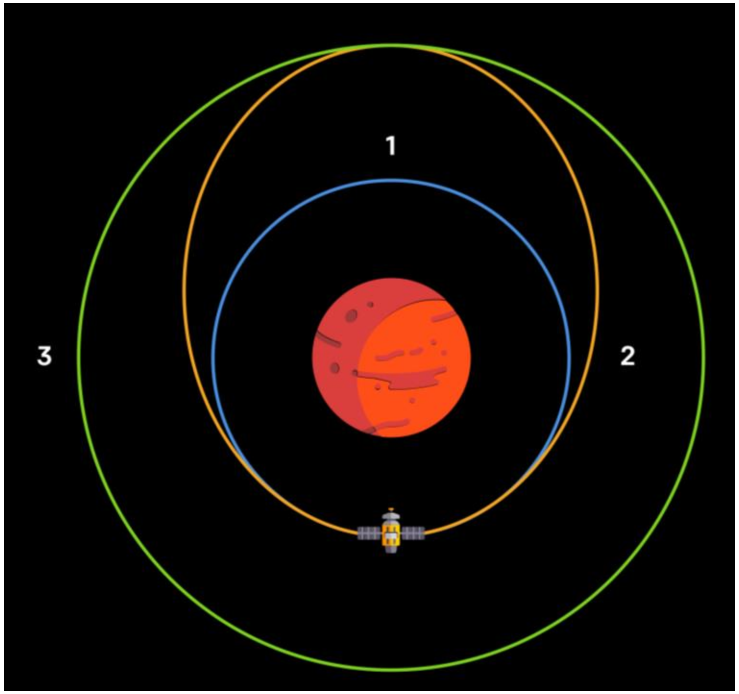
Vis-Viva Equation

speed at any point in an orbit
equation 3.67

$$v^2 = G(M+m)(\frac{2}{r} - \frac{1}{a})$$

What is v_{esc} from Earth to leave Solar System?

True or false:
"It's much more difficult to reach the Sun than it is to leave the Solar System altogether."



Hohmann transfer orbit

Hohmann Transfer Orbit
minimum energy usage => maximize payload

- **Shown: Earth-Mars**
  - **9 month travel time**
  - **“windows” open every 26 months**

- **Parker Solar Probe**
  - **ExCr: Calculate energy required to reach 0.04 AU vs to Mars**
  - **Using textbook, I got 60x more energy required!**