Spacecraft Thermal Analysis II
January 24, 2001

Mark Campbell
Charlie Vaughan (Primex)

AA420 Space Design

Review

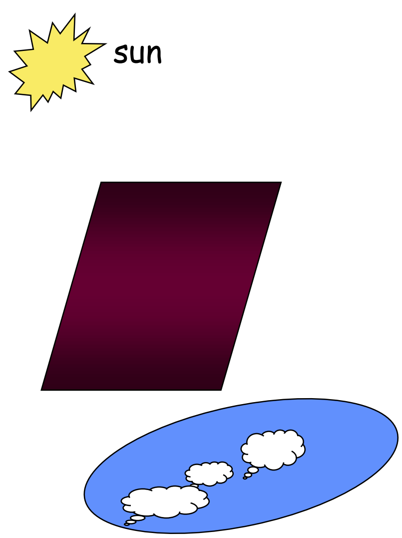
- Last time we went over the basic heat balance of objects in space.
- We showed how absorptivity and emissivity dominate heat transfer.
- We started into examples of simple passive heat transfer
- Homework added conduction and orbital environments as influences
  - Any questions regarding the homework?

Outline for Today

- A couple of additional simple objects - solar panels
- Add radiation between walls
- Set up another problem set with radiation, dissipation, and conductance

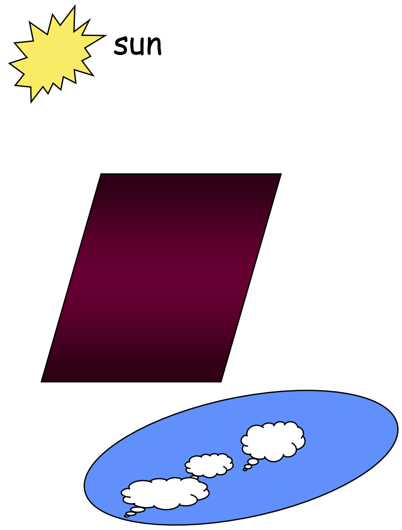
Solar Panel Examples

- An aluminum substrate solar panel is perpendicular to a vector to the center of the sun, at 1 AU. The other side is nadir pointing to a full visual field earth.
- 10 cm x 10 cm, thin
- 3 K space in the sun direction
- top: α = 0.805, ε = 0.825
- btm: α = 0.379, ε = 0.0346
- Q_s = 1400 W/m^2
- Q_e = 240 W/m^2 + 420 W/m^2 solar reflection (albedo 0.3)
- T_e = 291 K (per UW School of Oceanography)
- Calculate T_{top}, T_{bottom}



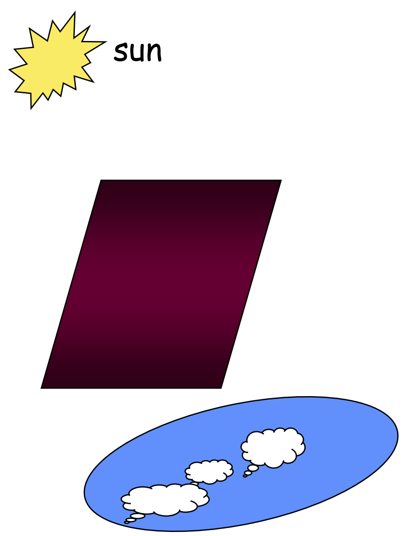
Paint the Earth Side White!

- An aluminum substrate solar panel is perpendicular to a vector to the center of the sun, at 1 AU. The other side is nadir pointing to a full visual field earth.
- 10 cm x 10 cm, thin
- 3 K space in the sun direction
- top: α = 0.805, ε = 0.825
- btm: α = 0.225, ε = 0.825
- Q_s = 1400 W/m^2
- Q_e = 240 W/m^2 + 420 W/m^2 solar reflection (albedo 0.3)
- T_e = 291 K
- Calculate T_{top}, T_{bottom}



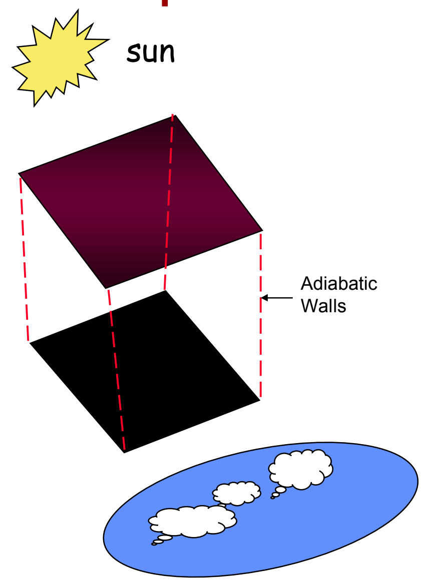
Kapton Substrate

- An Kapton blanket solar panel is perpendicular to a vector to the center of the sun, at 1 AU. The bare Kapton is nadir pointing to a full visual field earth.
- 100 cm x 100 cm, 0.01 mm Kapton
- 3 K space in the sun direction
- top: α = 0.805, ε = 0.825
- btm: α = 0.41, ε = 0.86
  Note: translucency makes these values vary greatly!!!
- Q_s = 1400 W/m^2
- Q_e = 240 W/m^2 + 420 W/m^2 solar reflection (albedo 0.3)
- T_e = 291 K
- Calculate T_{top}, T_{bottom}



An Example More Like a Spacecraft

- **A solar panel is perpendicular to a vector to the center of the sun, at 1 AU. The other side is white painted, nadir pointing to a full visual field earth. Inside surfaces are painted black.**
- **10 cm x 10 cm, thin aluminum**
- **3 K space in the sun direction**
- **top: $\alpha = 0.805$, $\varepsilon = 0.825$**
- **inside: $\alpha = 0.95$, $\varepsilon = 0.9$**
- **btm: $\alpha = 0.225$, $\varepsilon = 0.825$**
- **$Q_s = 1400\ W/m^2$**
- **$Q_e = 240\ W/m^2 + 420\ W/m^2$ solar reflection (albedo 0.3)**
- **$T_e = 291$ K**
- **Calculate inside surface T_{top}, T_{bottom}**



Homework

1. Same as before but add Al conduction of the side walls
   4 each, 0.1 cm x 10 cm x 10 cm
   Calculate inside surface T_{top}, T_{bottom}

2. Recalculate adding a 5 W heat dissipation on the earth facing plate to 1.

3. Calculate the same inside temperatures as 2. for eclipse