

DARA Unit 1 - Star & Planet Formation

Workshop 2 - Questions

1) Jets from young stars

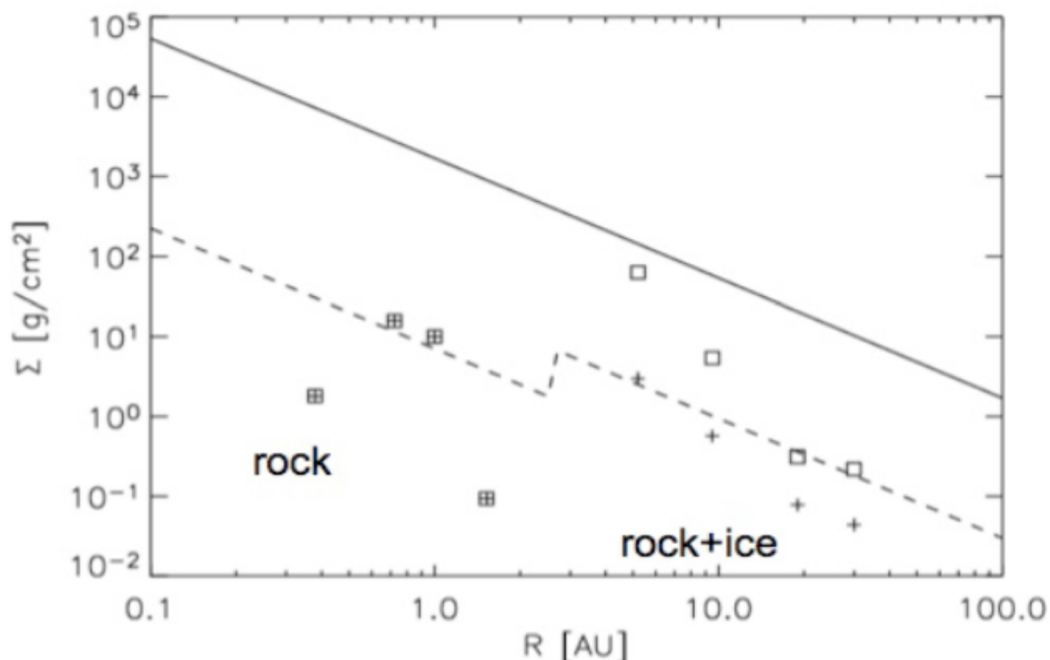
Demonstrate that the jets that are generated by young stars must be launched very close to the star.

Hint: use the expression for escape velocity provided in lecture 1.

2) The minimum mass solar nebula (MMSN)

The MMSN describes the mass distribution of the gas and solids needed in the disk around the young Sun to form the planets in the Solar System.

The figure shows the surface density (mass per unit area) of the MMSN and compares it with approximate values of the material from which the Solar System planets were built.



a) Where is the location of the snowline in this plot?

- b) What do the different lines (solid and dashed) and symbols (squares and crosses) mean?

The MMSN is described by the following equations:

$$\Sigma_{\text{gas}} = 1700 \left(\frac{r}{\text{au}} \right)^{-3/2} \text{ g cm}^{-2}$$

$$\Sigma_{\text{solid}} = 7.1 F_{\text{snow}} \left(\frac{r}{\text{au}} \right)^{-3/2} \text{ g cm}^{-2}$$

where

$$F_{\text{snow}} = \begin{cases} 1.0 & r < r_{\text{snow}} \\ 4.1 & r \geq r_{\text{snow}} \end{cases}$$

- c) Using these equations, calculate the solid-to-gas mass ratio in the disk (i) within the snowline, and (ii) beyond the snowline.
- d) Bearing in mind the answer to part c) explain why gas- and ice-giant planets are found only beyond the snowline.

3) Planets around other stars

An astronomer uses a large telescope equipped with a coronagraph (that blocks the star light) to detect light directly from a gas-giant planet orbiting a nearby sun-like star. The astronomer was able to determine that the planet orbits its star at a distance of 10 au, that it has a mass and a radius similar to Jupiter, and a luminosity equal to 10^{-7} times that of the host star.

- a) Demonstrate that the light detected from the planet is not due to reflection alone.
- b) Bearing in mind your answer in part a) what does this tell us about the planet?

Hint: we discussed the relationship between planet and star luminosity for directly imaged planets in lecture 2.