

ASTR 5820: Problem Set #1
(due Tuesday 2nd September)

1. The IAU definition of a Solar System 'planet' includes the requirement that a planet be massive enough that gravity forces the body to adopt a 'near-spherical' shape. Consider a rocky body that has a mean density ρ and a yield strength P_{yield} (the yield strength can be considered to be the maximum pressure that the rock can resist due to its internal strength before it deforms). By dimensional consideration of the hydrostatic equilibrium equation (or otherwise) determine an expression for the minimum radius of a body that would be expected to be roughly spherical.

For a density of 3.5 g cm^{-3} and a yield strength of $2 \times 10^9 \text{ dynes cm}^{-2}$ what is the minimum radius? Is this consistent with observations of Solar System objects?

2. A giant planet such as Jupiter can derive energy from solar irradiation and from other sources, such as gravitational contraction. Estimate the luminosity that would result from contraction of the planet at a rate dR_j/dt . How fast would Jupiter need to contract for this luminosity source to match that due to Solar irradiation?