

ASTR 321-Fall 2009

Problem set #4

Due- thurs oct 29

- 1) Estimate the accretion time of the Earth. Assume that the surface density (mass of solids in the nebula per unit area) of the solid particles in the Earth's feeding zone is equal to two times the Earth's mass uniformly spread over an annular ring that fills the space half way from Earth to Mars and half way from Earth to Venus. You can also assume that planetesimals approach the growing Earth at a speed equal to a third of the escape speed from the surface of the growing planet.
- 2) If a uniform density cloud of a large number of rocks approaches both the Earth and Moon at an initial speed (V_{∞}) of 5 km/s. What is the ratio of the impact rate per unit area on the Moon compared to Earth?
- 3) One model for the formation of Saturn is that it first formed a core of rock and ice that was about 10 times the mass of Earth. Assume that the surface density of solids in the solar nebula varied as $r^{-3/2}$ and estimate the ratio of the formation time of Saturn's core to the accretion time of Earth. Also assume that Saturn formed at 10AU and Earth formed at 1AU.
- 4) When a body is deflected by a planetary encounter (a hyperbolic trajectory) it leaves the planet at the same speed as its approach speed but at a different angle. Objects deflected by Jupiter can efficiently leave on paths that collide with Mars (at 1.5AU) but are less effective hitting Earth because if they approach Jupiter at high enough speed to be deflected to Earth, they will also have a reasonable probability of being ejected from the solar system. Show why this is so by comparing the speed needed to escape the solar system from the distance of Jupiter's orbit with the differences between the orbital speed of Jupiter and A) the aphelion speed of a body on a minimum energy orbit between Mars and Jupiter and B) the aphelion speed of a body on a minimum energy orbit between Earth and Jupiter. This effect may have discouraged the formation of Mars (a puny planet) and a planet in the asteroid belt.