Physics 109: Homework #11 Solutions

11.1 All are large satellites that revolve around Jupiter in prograde orbits as a sort of miniature planetary system. They differ in density (Io and Europa are the most dense while Ganymede and Callisto are the least dense) and in the amount of tectonic and volcanic activity that they have experienced. The similarities are due to the way the Galilean satellites formed, while the differences are largely due to varying amounts of internal heating from tides raised by Jupiter.

11.2 Icy satellites contain a smaller quantity of radioactive isotopes than rocky ones do, so they should have less internal heating. Because of their relatively small size, it was believed that these satellites would have cooled enough by now that geological activity was impossible.

11.3 The tidal bulge of the Earth precedes the Moon as it orbits and consequently the gravitational effect of the bulge is to speed-up the Moon in its orbit, which makes it spiral outward. Because of Triton's retrograde orbit, the tidal bulge of Neptune lags behind Triton, which has the effect of slowing down the satellite, causing it to spiral inward.

11.4 Radioactive dating and the presence and number of cosmic ray tracks are the techniques used for determining the ages of meteorites. Radioactive dating indicates that the parent bodies of meteorites solidified 4.55 to 4.65 billion years ago. On the other hand, the cosmic ray exposure ages of meteorites are typically only tens of millions of years which indicates that the parent bodies fragmented very recently.

11.5 Gravity, radiation pressure from sunlight, and electrical interactions with the solar wind are the forces that act on a comet's tail. Comets have dust and plasma tails. The plasma tail consists of electrically charged ions that are swept away from the nucleus in the direction opposite to the Sun. They tend to be quite straight. Dust tails are made of dust that gets pushed away from the nucleus by the force of radiation pressure of sunlight. The individual dust particles continue to orbit the Sun as they stream away from the nucleus, but since they are further from the Sun (than the nucleus) they move more slowly and thus curve out in an arc away from the nucleus.