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EE 106 – Planetary Exploration

Problem Set VI
The Giant Planets

Problem 10.13 – Internal Heat Sources for Jupiter and Saturn

Much of the heat emanating from Jupiter and Saturn remains from the primordial formation of the two planets, processes that required and left a lot of heat. For one, the shaping of these two planets potentially involved the melting and collapse of external materials around the central core, leading to gargantuan energy transfers that never completely escaped the body. As a result, some of that primordial heat persists today, particularly for Jupiter.

Although it possesses much less primordial heat than the gargantuan Jupiter, Saturn's interior features continual differentiation, with heavier helium drops sinking toward the core and separating from lighter hydrogen; this ongoing chemical process – differentiation – provides consistent gravitational potential energy from within Saturn.

Finally, the gradual contraction of Jupiter and Saturn under their enormous gravitational field also generates a considerable amount of energy, since even small contractions of such large bodies releases billions of chemical bonds and therefore excess energy.

Despite the excess energy generated from within, Jupiter and Saturn *could* but *should not* be considered stars, because their energy and brightness still do not compare with that generated by the much more gigantic Sun. Furthermore, though several moons orbit both gas giants, neither serves as the center of an intricate network of planetary bodies like the Sun, and, unlike other stars, neither features nuclear fusion as an internal energy source.

Problem 10.15 – Wind Speeds at Jupiter's Great Red Spot

Jupiter's Great Red Spot rotates in T = 6 days = 144 hours = 518,400 seconds and possesses a circumference equivalent to a circle with radius 10,000 km = 10^7 m. The winds at the outer edge of the Great Red Spot must therefore travel a full circumference of $C = 2\pi R$ during a full period. Hence, the average wind speed must be approximately the distance traveled during one period divided by the time:

$$v_{wind} = \frac{2\pi R}{T}$$

$$v_{wind} = \frac{2\pi(10^7 m)}{(518{,}400 \text{ sec})}$$

$$\boxed{\boldsymbol{v_{wind} \approx 121.20342 \frac{m}{sec}}}$$

$$\boxed{\boldsymbol{v_{wind} \approx 436.33231 \frac{km}{hr}}}$$

$$\boxed{\boldsymbol{v_{wind} \approx 271.12433 \frac{miles}{hour}}}$$