# AST 250 – Spring 2018
## <u>Homework Due: Friday March 30</u>

29. Measurements of Jupiter indicate that it radiates in the infrared with a total flux of 14.1 W/m$^2$. In this problem, you will explore the origin of this emission. Some physical variables you will need: $R_{Jup}$ = 6.99 x 10$^7$ m, a = 5.2 AU, $M_{Jup}$ = 1.9 x 10$^{27}$ kg ~ 318 $M_{Earth}$.

(a) What is the total rate of energy emitted by Jupiter in the infrared? Give your answer in Watts.

(b) What is the rate of energy absorbed by Jupiter from solar radiation? Assume Jupiter has an albedo of A = 0.343. Give your answer in Watts.

(c) Calculate the excess $(dE/dt)_{internal}$ emitted by Jupiter?

(d) One possibility is that radioactive decay of elements may account for this excess energy. Using the Earth as an analogue, radioactive decay of long-lived radioactive isotopes (such as $^{40}$K, $^{238}$U etc.) account for ~ 2 x 10$^{13}$ W in the Earth. Assuming Jupiter has the same mass fraction of radioactive elements as the Earth, what would be the radioactive heating rate for Jupiter?

(e) Since the radioactive heating rate is far too small to account for the difference, what about gravitational contraction (dU/dt)? Assume Jupiter is a **uniform density sphere** contracting at a rate dR/dt. What contraction rate (dR/dt give as km/Gyrs) could account for the excess energy? Hint: Differentiate U and set dU/dt = excess energy emitted.

(f) Assuming dR/dt has been the same over 4.6 Gyrs, What fraction of Jupiter's present radius has it contracted?