Astronomy 1102/1104 **Name: ______________________________________**

Spring 2016 - Problem Set 9 **Section # ____________**

Due in section the week of April 25th
Problems are based off lecture and readings - Show all work - Don't forget units - 10pts total

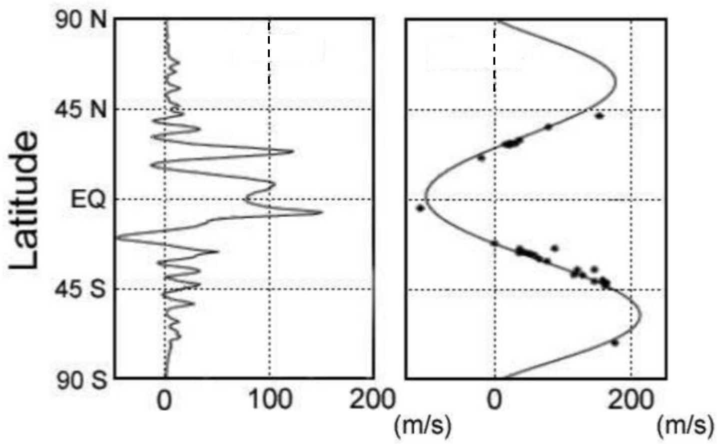
1) Mission Planning: While the Galileo spacecraft revealed much about Jupiter, several issues led to the mission losing out on potential data. Let us now imagine we are planning a successor to Galileo.

a) For this mission we want to obtain high resolution images of the 4 Galilean satellites. Due to radiation generated by Jupiter's very strong magnetic field, with a magnetic moment of $\mu = 1.56\times10^{20}$ **T*m^3,** we cannot venture to close to Jupiter. Since the radiation is generated by the magnetic field, the radiation and the magnetic field from Jupiter drops off as **$1/r^3$.** Calculate the strength of the magnetic field for **Io (Distance from Jupiter = 4.21×10^5 km), Europa (6.71×10^5 km), Ganymede (10.7×10^5 km), and Callisto (18.83×10^5 km).** <u>Give your answer in units of teslas (T).</u> **(2 pts)**

b) We can design our spacecraft to reliably operate at radiation levels where Jupiter magnetic field strength is **1×10^{-6} T**. Relative to the moons, how close can our spacecraft get to Jupiter? **(1 pts)**

c) For this mission to be a true successor we will want to include an atmospheric probe. With our advancements in communication and materials since 1989, we can expect to reach a depth of **200 km.** Given that the pressure of the atmosphere is **$P = \rho gh$**, calculate the pressure our probe must survive if Jupiter's atmosphere has a density of **$\rho = 1326$ kg/m^3** and where **$M_J = 1.9\times10^{27}$ kg** and **$R_J = 69{,}911$ km**. Assume g is constant at all depths. <u>Give your answer in units of pascals (Pa)</u>. **(2 pts)**

2) Giant Wind Speeds: Because the Gas and Ice Giants do not have "solid surfaces", as they rotate, different latitudes in the atmosphere will rotate at different speeds. We see these differences as variations in wind speed with latitude, and these varying wind speeds give rise to beautiful bands and vortices the giant planets are known for. Since there is no solid surface as on the Earth, we define a "day" on these bodies by measuring the rotation period of the body's magnetic field via its emitted radio waves; this is called the "radio period". Given below are the wind speed profiles for Jupiter and Uranus at varying latitudes. Zero on these profiles is given by the radio period. Positive numbers imply the wind is moving faster than the radio period, while negative numbers imply the wind is moving slower than the radio period.



a) Based on the shapes of these profiles, which profile do you think goes with which planet? Why? <u>Give your answer in clear, concise, and complete sentences.</u> **(1 pts)**

b) Given that the equatorial radius for Jupiter is $\mathbf{R_J = 7\times10^7}$ **m**, and Uranus is $\mathbf{R_U = 2.5\times10^7}$ **m**, and the radio period of $\mathbf{P_J = 35700}$ **s** for Jupiter and of $\mathbf{P_U = 62000}$ **s** for Uranus, calculate the total length of day at the equator for each planet using the profiles above. <u>Give your answers in units of seconds (s).</u> **(2 pts)**

3) Astrobiology: Throughout this course we have talked many times about the search for life in our solar system. **Other than the Earth, Mars, or anything related to humans,** where in the solar system would you look for life? Why? <u>Give your answer in 2-3 clear, concise, and complete sentences.</u> (Hint: There is no wrong *place* so long as you can logically explain your answer) **(2 pts)**