DUE: THURSDAY, FEBRUARY 23, 2017

MIDTERM ALERT: The midterm exam will be handed out in class on Thursday February 23 and will be due at the end of the day on Friday February 24. Completed exams should be placed in my physics department mailbox. (Please see me if you have a time conflict. I will then arrange to have you work on the exam during a 24 hour period of your choosing during the weekend and return it to my mailbox on Monday February 27.)

While working on the exam, you may refer to Jackson’s text and any second electromagnetic textbook of your choosing. (If you do consult a second text, please indicate which one you used.) Any reference for integrals or other mathematical facts, and any personal handwritten notes are also OK. You are also free to consult any of the class handouts, including the solution sets. However, you may not collaborate with anyone else. The exam will cover material from Chapters 7, 9 and 11 of Jackson (and the first three problem sets of this course).

1. Jackson, problem 9.2

HINT: Show that the time-dependent quadrupole tensor can be written as the real part of a complex tensor of the form $Q_{ij}(t) = Q_{ij} e^{-2i\omega t}$, where $Q_{ij}$ is a complex matrix that depends on $a$ and $q$. Note the factor of 2 in the exponent. How does this affect the application of the formulas for $dP/d\Omega$ and $P$ given in section 9.3 of Jackson?

2. Jackson, problem 9.8


HINT: The charge density can be expressed as $\rho(\vec{x}, t) = \rho_0 \Theta(R(\theta) - r)$, where the step function $\Theta(x) = 1$ for $x > 0$ and $\Theta(x) = 0$ for $x < 0$. The constant $\rho_0$ can be determined in terms of the total charge $Q$ which is conserved and hence time-independent. Find the relation between $\rho_0$ and $Q$ assuming that $\beta \ll 1$. Then writing $\beta = \beta_0 e^{-i\omega t}$, expand the expression for $\rho(\vec{x}, t)$ to linear order in $\beta_0$. You can now use this expression to evaluate the electric multipole moments. You can also evaluate the current density $\vec{J}(\vec{x}, t)$ by making use of the continuity equation. This will be needed to evaluate the magnetic multipole moments.

4. Jackson, problem 9.16

NOTE: Do not employ any approximations associated with the multipole expansion in this problem.

5. Jackson, problem 9.17