Phys 3330 Electricity & Magnetism II
Spring 2019
Assignment #11 - due Monday April 22nd 2019

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1. Two observers are tracking the motion of a third object. The stationary observer measure the components of the third object's velocity as (u_x,u_y,u_z). Given the transformation relationships between (x,y,z,t) and (x',y',z',t') calculate the velocity components as measured by the moving observer (u'_x,u'_y,u'_z).

2. Given the relationships
   a $x = r \sin\theta \cos\varphi$
   b $y = r \sin\theta \sin\varphi$
   c $z = r \cos\theta$
   Calculate the Jacobian

$$\begin{vmatrix} \frac{\partial x}{\partial r} & \frac{\partial x}{\partial \theta} & \frac{\partial x}{\partial \phi} \\ \frac{\partial y}{\partial r} & \frac{\partial y}{\partial \theta} & \frac{\partial y}{\partial \phi} \\ \frac{\partial z}{\partial r} & \frac{\partial z}{\partial \theta} & \frac{\partial z}{\partial \phi} \end{vmatrix}$$

   to show that $dv = dx\,dy\,dz$ in Cartesian coordinates is equal to $r^2 \sin\theta\, dr\, d\theta\, d\varphi$ in spherical polar coordinates.

3. An atom at rest emits a photon of frequency f. What is the frequency that is detected if the atom is moving with a speed v tangential to the line of sight. (This is known as the transverse Doppler effect.) Compare the frequency shifts for the transverse and longitudinal (along the line of sight) Doppler Effects for the case when $v = 0.1c$ and $f = 5 \times 10^{14}$ Hz.