Arizona State University, Physics 311
Problem Set #4, Rev. A, due Wednesday, 2014-02-12

1. a) An amount of charge Q is uniformly distributed over a spherical shell of radius r'. Integrate Coulomb's law over this charge distribution to calculate the electric field $\boldsymbol{E}(r)$ everywhere (both inside and outside the shell).

b) Compare part b) with the field of the same spherical charge distribution, this time calculated using Gauss' law.

c) Given a spherically symmetric charge distribution $\rho(r) = \rho_0(3 - 2r^2/r_0^2)e^{-r^2/r_0^2}$, where ρ_0 and r_0 are constants, plot $\rho(r)$ and show that the total charge everywhere is zero. Bonus: what is the total positive charge?

d) Explain why the charge in a shell of radius r' and thickness dr' is $đq = \rho(r')4\pi r'^2 dr'$. Calculate the electric field of the charge distribution in part c) by substituting $đq$ for Q in part a) and integrating over r'.

e) Calculate the divergence of the electric field $\boldsymbol{E}(r)$ of part d) and compare your answer with c).

f) Show that the impostor field $\boldsymbol{E}'(r) = \rho_0/\epsilon_0\,[\hat{\boldsymbol{x}}(x-y) + \hat{\boldsymbol{y}}(x+y) + \hat{\boldsymbol{z}}z]\,e^{-r^2/r_0^2}$ has the same divergence, but calculate $\boldsymbol{\nabla} \times \boldsymbol{E}'$ to show that is cannot be the electric field for $\rho(r)$.

Also, Griffiths 3ed[same in 4ed] Ch. 2, #4, 5, 6, 9, 16, 18.