# QFT Spring2025

# HW5

## Q1 Form Factors

Consider the classical electrostatic potential $A^0$:

$$A^0(\vec{x}) = \int d^3y\, V(\vec{x}-\vec{y})\, \rho(\vec{y})$$

where $V$ is the Coulomb potential and $\rho$ is the distribution of electric charges.

a) Show that The Fourier transform of $A^0$, $\tilde{A}^0(\vec{q})$ is given by the product of the Fourier transform of $V$ and $\rho$, i.e.

$$\tilde{A}^0(\vec{q}) = \tilde{V}(\vec{q})\tilde{\rho}(\vec{q}).$$

b) Form factors are just $\tilde{\rho}(\vec{q})$.

For a point-like charge $(Ze)$, $\tilde{\rho} = Ze$. (no $q$ dependence). Compute analytic expressions of form factors for

b1) Gaussian distribution

$$\rho(\vec{y}) = \rho_0\, e^{-a^2\vec{y}^2}.$$

b2) Homogeneous sphere

$$\rho(r < R) = \frac{Ze\,3}{4\pi R^3}$$

and zero otherwise.

## Q2 Schwinger Dyson Equation for $\lambda\phi^4$ theory.

Derive the Schwinger Dyson Equation for the connected 2-point function. Identify the sunset diagram contribution.