Thursday Reading Assessment: Unit 0, Electric Fields

Prof. Jordan C. Hanson

January 25, 2024

1 Memory Bank

- $\vec{E} = \frac{kQ}{r^2}\hat{r}$ ... Coulomb field of a charge Q.
- $k = 8.99 \times 10^9$ N C^{-2} m^2 ... Constant of proportionality for Coulomb field.

2 Electric Fields

1. Consider Fig. 1 below. A ring of charge with radius R is situated in the xy-plane. The charge is positive, and it is distributed evenly across the ring. We write $\Delta q = \lambda R \Delta\theta$, to mean that there are λ Coulombs per meter along an angle $\Delta\theta$. If $\Delta\theta$ were to extend to 2π (all the way around the circle), then the total charge is $Q = \lambda(2\pi R)$. (a) By *symmetry*, where should the electric field be zero? (b) Where would the electric field be infinite?

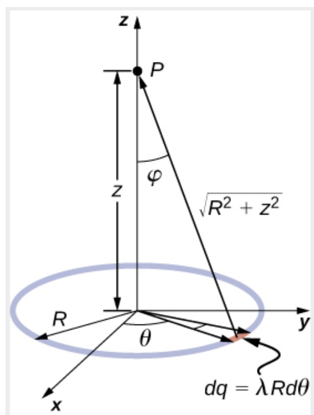

Figure 1: A ring of charge situated in the xy-plane.

2. Consider again Fig. 1. As $z \rightarrow \infty$, what happens to the field?
   - A: The field-strength increases.
   - B: The field-strength remains constant.
   - C: The field-strength decreases.
   - D: The field-strength is exactly zero.
3. Suppose the actual function for the E-field $\vec{E}(z)$ is

$$\vec{E}(z) = \frac{1}{4\pi\epsilon_0}\frac{qz}{\left(z^2+R^2\right)^{3/2}}\hat{z} \tag{1}$$

   To see what happens when z is much larger than R, try setting $R = 0$. What is the result in Eq. 1 if $R = 0$?

4. Do you recognize the expression? What does the ring resemble if $R \approx 0$?