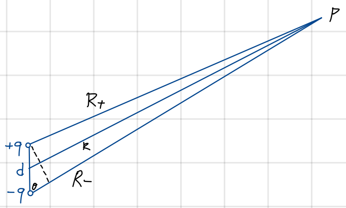


$$V = V_{+q} - V_{-q} = \frac{q}{4\pi\varepsilon_0 R_+} - \frac{q}{4\pi\varepsilon_0 R_-}$$

$$R_+ = R - \frac{d}{2}\cos\theta$$

$$R_- = R + \frac{d}{2}\cos\theta$$

$$\frac{1}{R_+} - \frac{1}{R_-} = R^{-1}\left(1+\frac{d}{2R}\cos\theta\right) - R^{-1}\left(1-\frac{d}{2R}\cos\theta\right)$$

$$= R^{-1}\left(\frac{d}{R}\cos\theta\right)$$

$$= \frac{d}{R^2}\cos\theta$$

$$V = \frac{q}{4\pi\varepsilon_0} \cdot \frac{d}{R^2}\cos\theta$$

$$= \frac{qd\cos\theta}{4\pi\varepsilon_0 R^2}$$

$$R = \sqrt{\frac{qd\cos\theta}{4\pi\varepsilon_0 V}} = C_V\sqrt{\cos\theta}\ , \ C_V \text{ is constant}$$

電場線的斜率代表此處電場方向

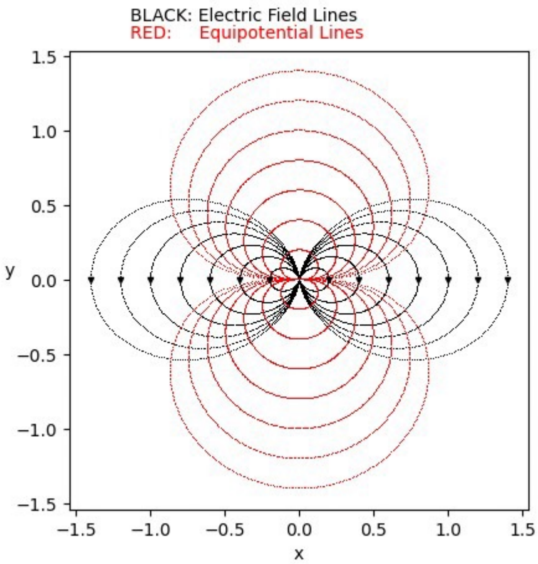
$$\therefore d\ell = c \cdot E\ , \ c \text{ is constant}$$

轉換成球座標

$$\Rightarrow a_R\, dR + a_\theta R\, d\theta + a_\phi R\sin\theta\, d\phi = c\cdot(a_R E_R + a_\theta E_\theta + a_\phi E_\phi)$$

$$\therefore C = \frac{dR}{E_R} = \frac{R\,d\theta}{E_\theta} = \frac{R\sin\theta\, d\phi}{E_\phi} \quad (\text{which } E_\phi \text{ is not exist})$$

$$\Rightarrow \frac{dR}{2\cos\theta} = \frac{R\,d\theta}{\sin\theta} \Rightarrow R^{-1} dR = \frac{2d(\sin\theta)}{\sin\theta} \Rightarrow R = C_E \sin^2\theta\ , \ C_E \text{ is constant}$$



My code and image file
https://github.com/charlie-ww/Antennas.git