

Electric dipole radiation:

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$$\begin{aligned} r_+ &= \sqrt{\left(r \cos \Theta - \frac{d}{2}\right)^2 + (r \sin \Theta)^2} \\ &= \sqrt{r^2 \cos^2 \Theta + \frac{d^2}{4} - 2r \cos \Theta \frac{d}{2} + r^2 \sin^2 \Theta} \\ &= \sqrt{r^2 (\cos^2 \Theta + \sin^2 \Theta) + \frac{d^2}{4} - rd \cos \Theta} \\ &= \sqrt{r^2 + \frac{d^2}{4} - rd \cos \Theta} \end{aligned}$$

$$\begin{aligned} r_- &= \sqrt{(r \sin \Theta)^2 + \left[d + \left(r \cos \Theta - \frac{d}{2}\right)\right]^2} \\ &= \sqrt{r^2 \sin^2 \Theta + \left[\frac{d}{2} + r \cos \Theta\right]^2} \\ &= \sqrt{r^2 \sin^2 \Theta + \frac{d^2}{4} + r^2 \cos^2 \Theta + 2 \frac{d}{2} r \cos \Theta} \\ &= \sqrt{r^2 (\sin^2 \Theta + \cos^2 \Theta) + \frac{d^2}{4} + dr \cos \Theta} \\ &= \sqrt{r^2 + \frac{d^2}{4} + rd \cos \Theta} \end{aligned}$$

