The Antenna Dipole

The dipole antenna ⇒ The simplest antenna design.

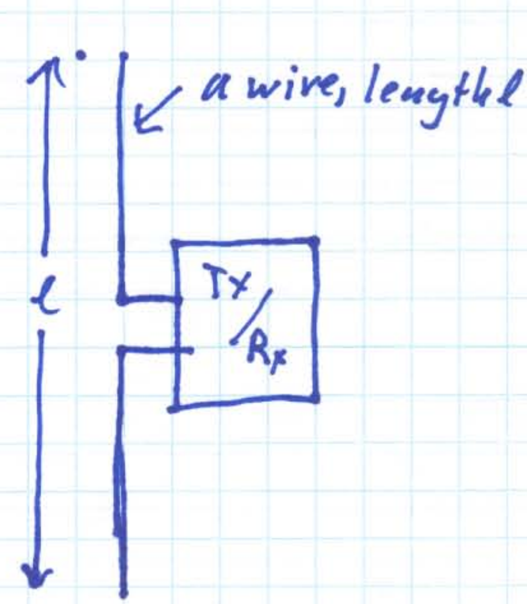
Also, one of the most frequently used!

Q: Why ??

A: Several reasons!

Reason #1: Its cheap!

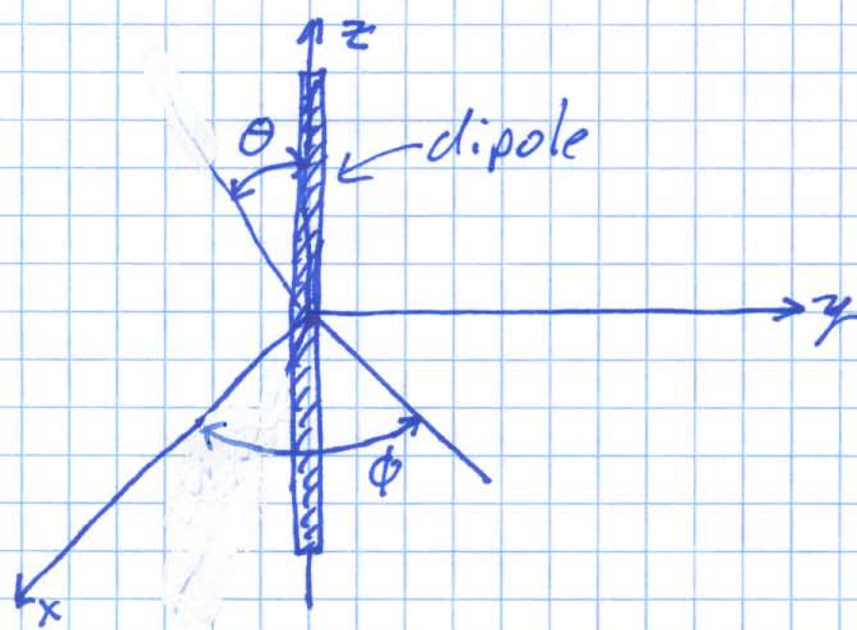
The dipole antenna is a wire antenna. It is simply a straight piece of wire, connected at the middle!



Reason #2 ⇒ It has a wide beamwidth!

This should be obvious!

Say we orient the dipole such that it lies on the z-axis:



Consider then the antenna pattern as a function ϕ (i.e., azimuth) when $\theta = 90°$ (i.e., elevation angle = 90°).

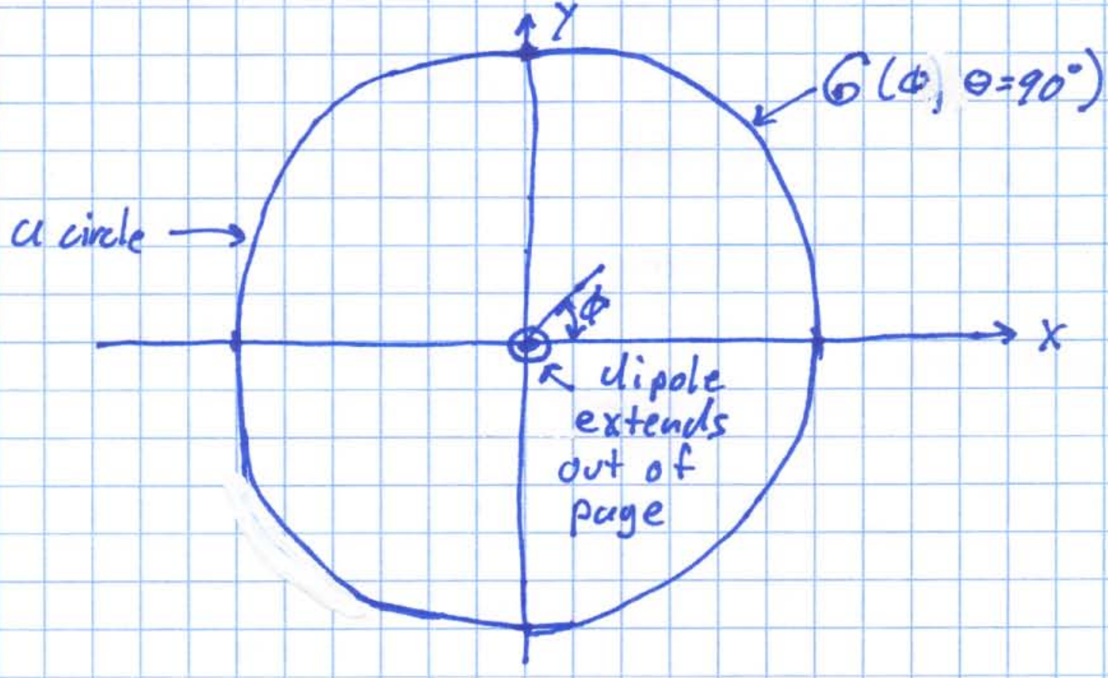
∴ We are considering the antenna pattern in different directions (ϕ) on the x-y plane.

This geometry is said to be <u>azimuthally</u> <u>symmetric</u>!

$\Rightarrow$ In other words, if we rotate the anttena azimuthally, we do not change the physical geometry at all.

$\therefore$ The gain of the antenna is the same for <u>all</u> ϕ !!

i.e.,



Note this in <u>not</u> true for elevation angle θ (Do you see why??.

$\therefore$ G_{dipole} has form $G(\theta)$ $\Leftarrow$ independent of ϕ

So, a vertically oriented dipole radiates (receives) equally in all azimuthal (i.e. ϕ) directions.

Q: Is this a <u>good</u> thing?!

A: It depends on the application!

For example, if you do not know where the receiver (transmitter) you are transmitting to (receiving from) is <u>located</u>. You will want to "<u>broadcast</u>" (receive) in all directions!!

⇒ ∴ Dipole is good for <u>mobile</u> and/or <u>consumer</u> devices.
e.g. car radio, mobile phones, TV, stereo, etc.

If you <u>know</u> where the Tx or Rx is, do <u>not</u> use a dipole ⇒ You're wasting power!

Q: What is $G(\theta)$ with respect to θ??

A: It depends on the length ℓ of the dipole!

Specifically, the length of the dipole in terms of wave length λ.

For example, if the frequency of the signal is $f = 600$ MHz, then the wavelength of the wave is:

$$\lambda = \frac{c}{f} = 0.5 \text{ meter}$$

So a dipole 1 meter long would have a length $\ell = 2\lambda$, whereas a dipole 0.5 meters long would have a length $\ell = \lambda$, or a dipole 0.25 meters long would have a length of $\ell = 0.5\lambda$.

The antenna pattern depends on the length of the antenna in wavelengths:

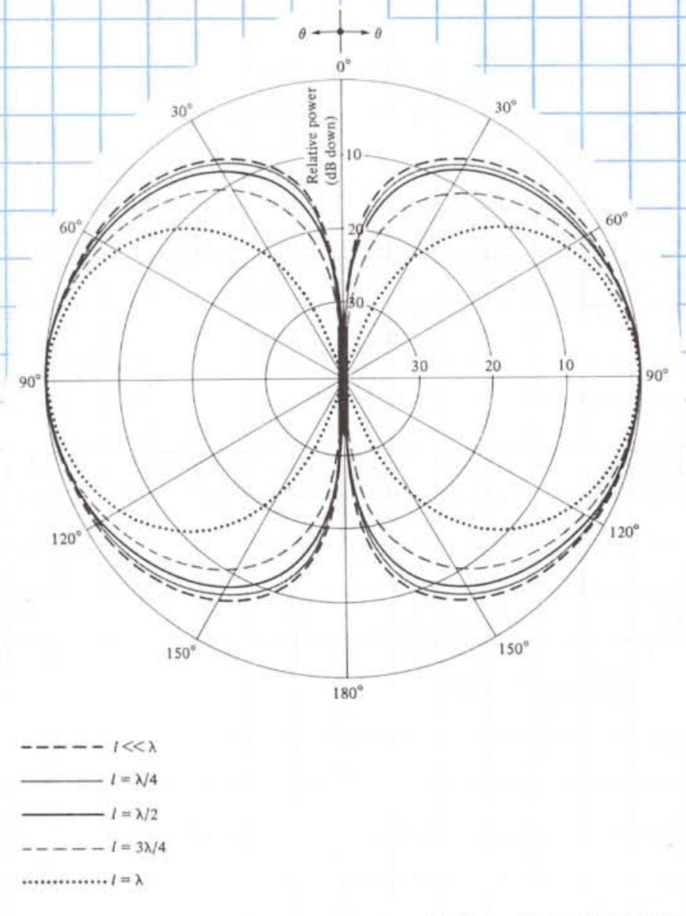


Figure 4.5 Elevation plane amplitude patterns for a thin dipole with sinusoidal current distribution ($l = \lambda/4, \lambda/2, 3\lambda/4, \lambda$).

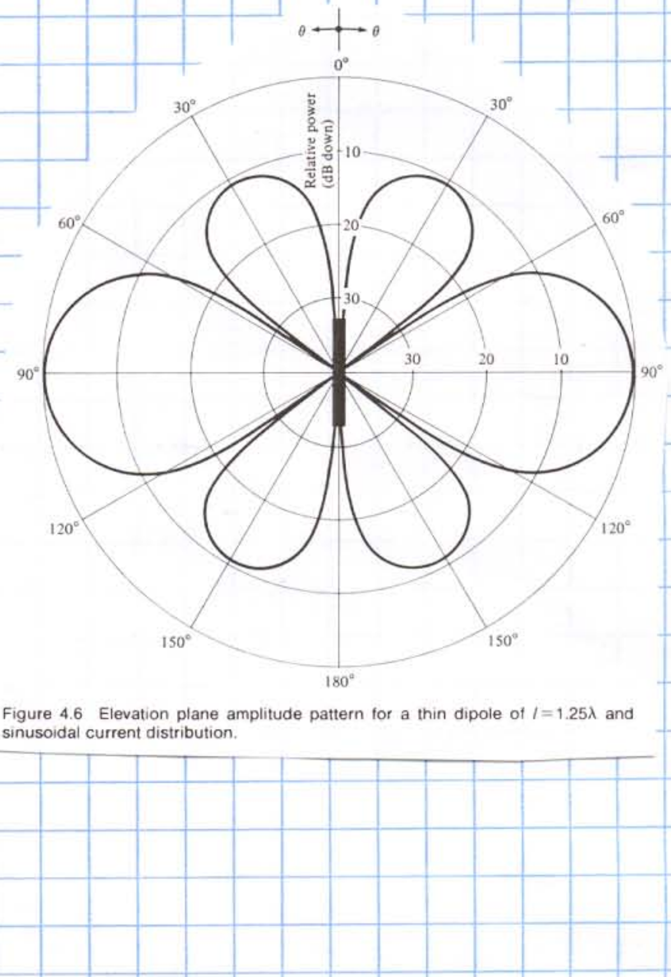


Figure 4.6 Elevation plane amplitude pattern for a thin dipole of $l = 1.25\lambda$ and sinusoidal current distribution.

Q: So what *should* the length of a dipole be ??

A: This leads us to the *third* reason!

Reason #3 - Antenna Impedance Z_A

The input impedance of a $\frac{\lambda}{2}$ dipole (i.e., $\ell = \lambda/2$) turns out to be:

$$\boxed{Z_A = 73\ \Omega}$$

i.e., $R_A = 73\ \Omega$ and $X_A \approx 0.0$

∴ We can connect a transmission line with Z_0 *directly* to the $\lambda/2$-dipole, and *all* transmitter power will be delivered to the load.