NEVER GONNA GIVE

ECE 490-ST
Wireless Computing

Lesson 9 :: A brief insection of antennas

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SJT

Lesson Objectives

- Give a definition of an antenna
- Describe the characteristics of an antenna such as gain, impedance, radiation resistance, temperature.
- Design a basic antenna

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After this lesson …

- You will not be an expert on antennas.
- This is a HUGE field, and there is extreme depth that we could go.
- This lecture gives just an overview to know the basics and understand the purpose of an antenna.

- Two places to start are the PDF’s posted to Bb. I highly recommend reading through these resources

What is an antenna?

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What is an antenna?

- EVERYTHING!

What is an antenna?

- EVERYTHING! (everything conductive, that is)

What is an antenna?

- EVERYTHING! (everything conductive, that is)
- Radiation of EM wave is produced from accelerated (and decelerated) charge

$$\boxed{\dot{I}L = Q\dot{v} \qquad (\mathrm{A\ m\ s^{-1}})\ \ \textbf{\textit{Basic radiation equation}}} \qquad (1)$$

where

$\dot{I}$ = time-changing current, $\mathrm{A\ s^{-1}}$

L = length of current element, m

Q = charge, C

$\dot{v}$ = time change of velocity which equals the acceleration of the charge, $\mathrm{m\ s^{-2}}$

L = length of current element, m

A better question

WHAT DOES AN ANTENNA DO?

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- An antenna is a structure associated with a region of transition between a guided wave (on a transmission line) and free-space or vice-versa

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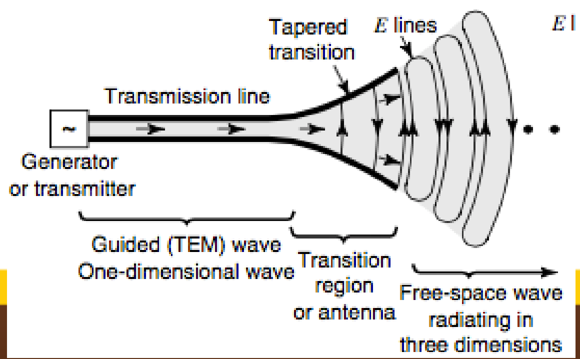
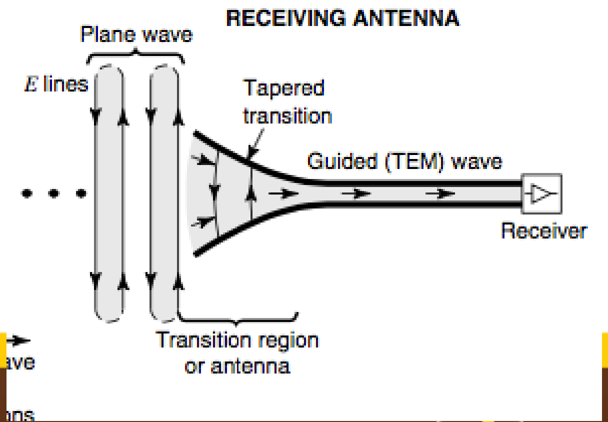
WHAT DOES AN ANTENNA DO?

- An antenna is a structure associated with a region of transition between a guided wave (on a transmission line) and free-space or vice-versa
- In other word: An antenna is converts the RF (ac) signal you send down your transmission line to something that radiates out into the air.
- A SIGNAL CONVERTER!

Circuit perspective

- To the transmission line, antenna appears as an resistance (radiation resistance) not related to an actual resistance, but to the antenna’s coupling with the rest of the world.
- For reception, distant objects make the antennas heat increase. It is technically a distant/remote heat sensor.



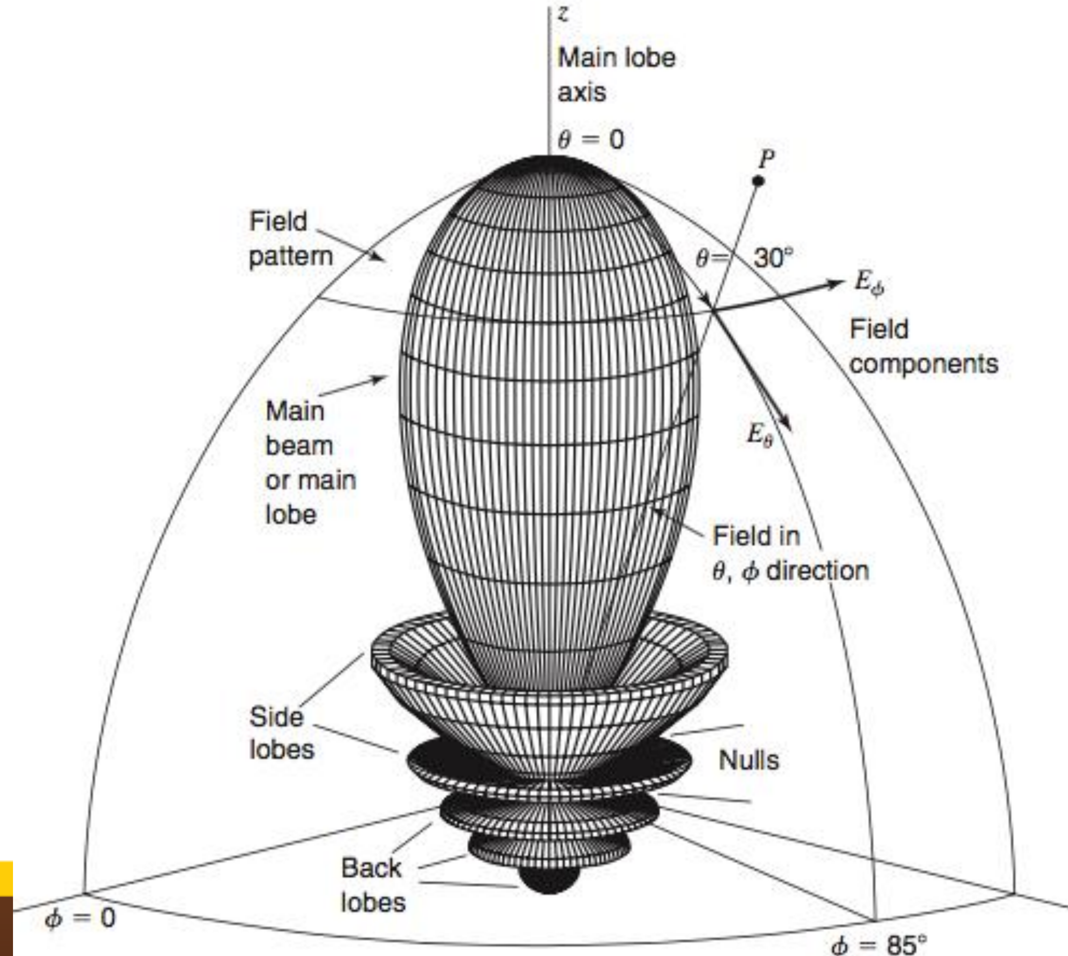


Pattern

Shows direction that fields radiate

Main “chunk” of pattern is the main lobe.

Gain shows pattern but shows ratio of peak direction power to average power



ure 2-3

All about antennas at a glance

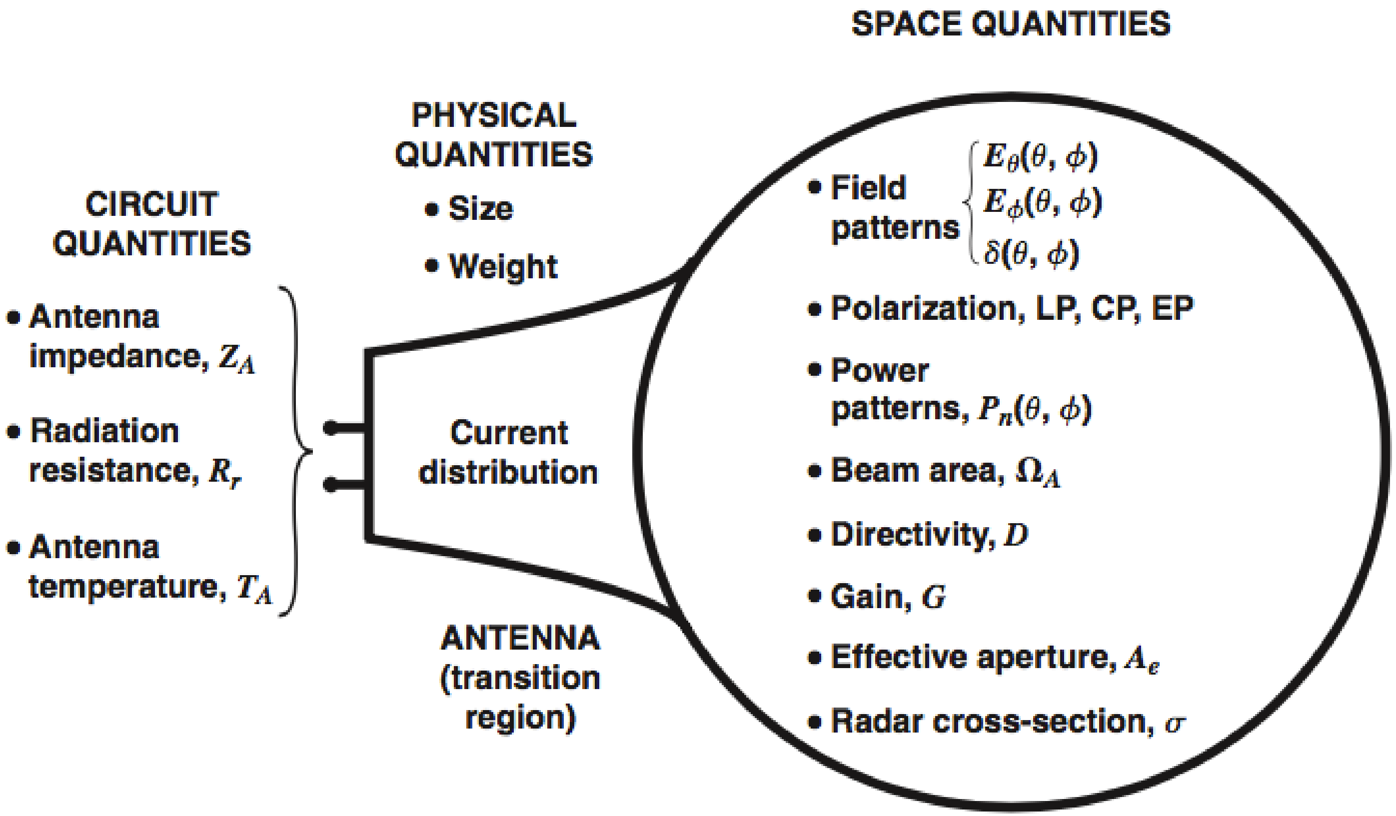


Figure 2-10

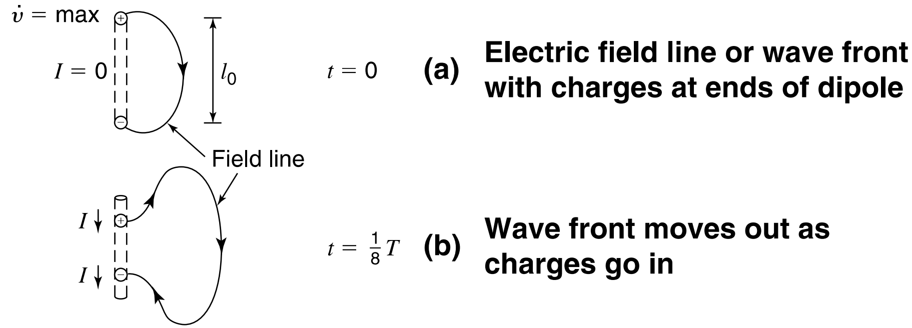
The half-wave Dipole

¼ wavelength per leg … Why?

The Dipole

¼ wavelength per leg … Why?

When driven,



The Dipole

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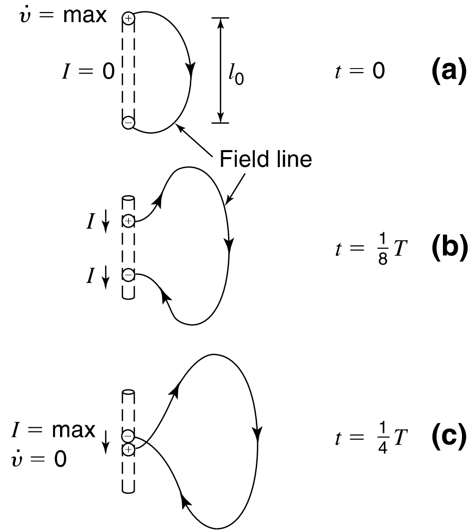


Electric field line or wave front with charges at ends of dipole

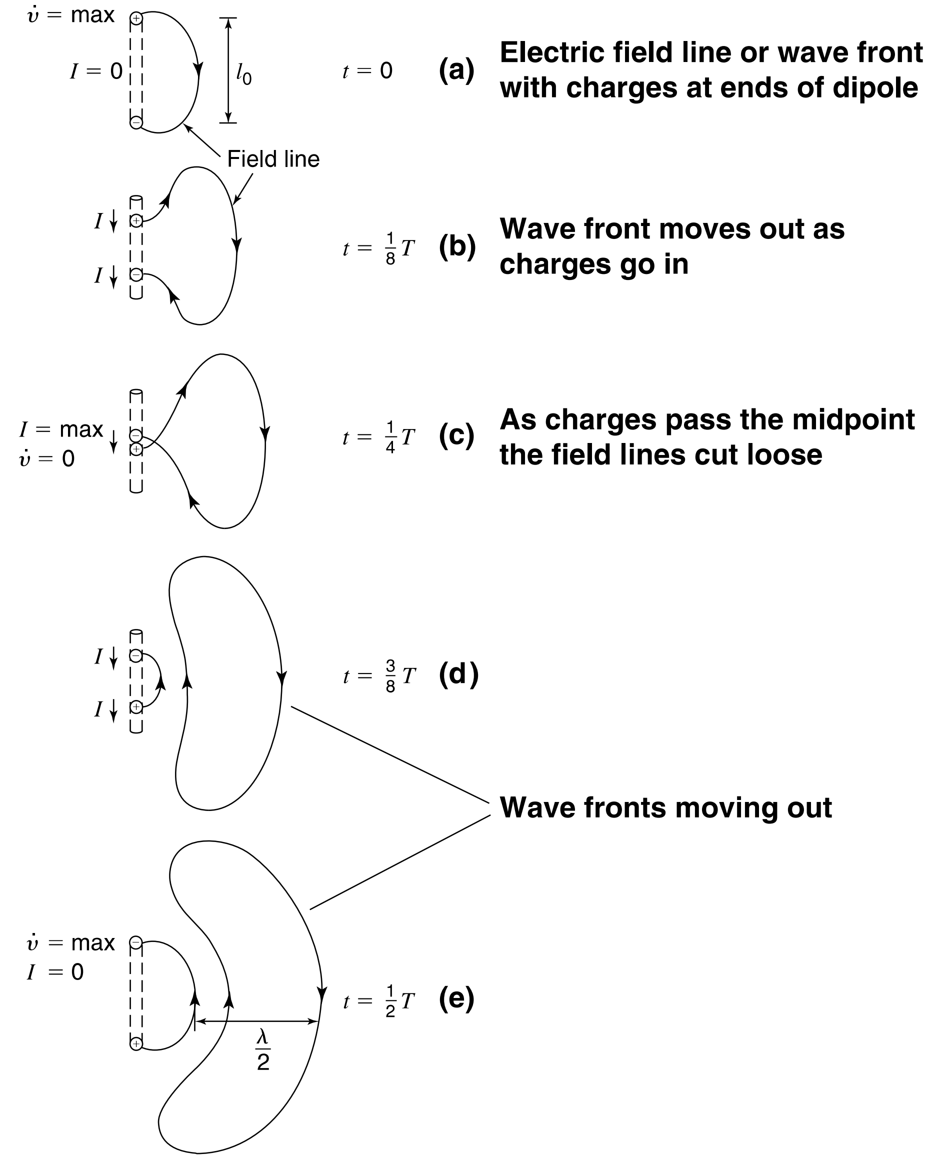
Wave front moves out as charges go in

As charges pass the midpoint the field lines cut loose

The Dipole

¼ wavelength per leg … Why?

When driven,



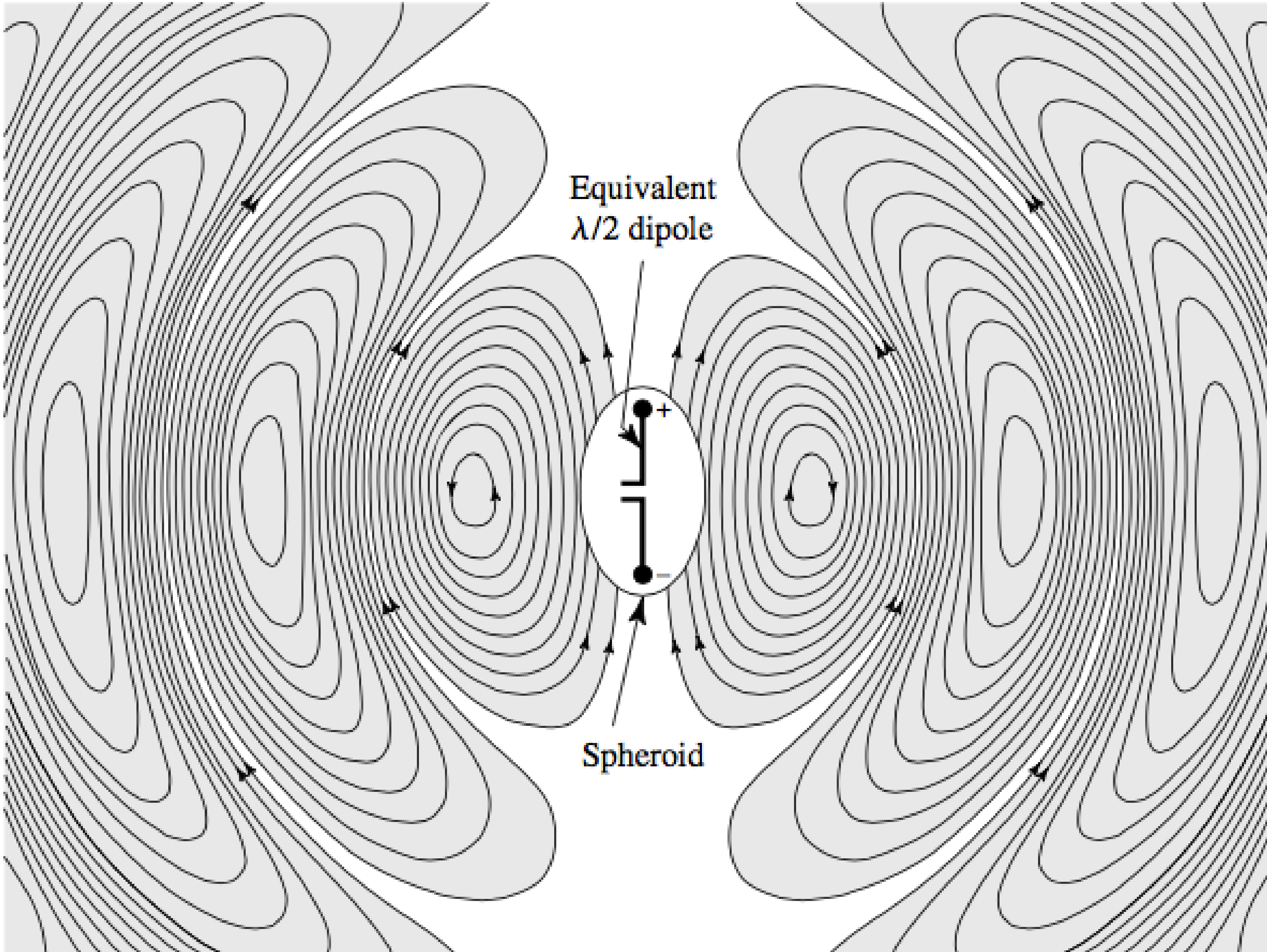
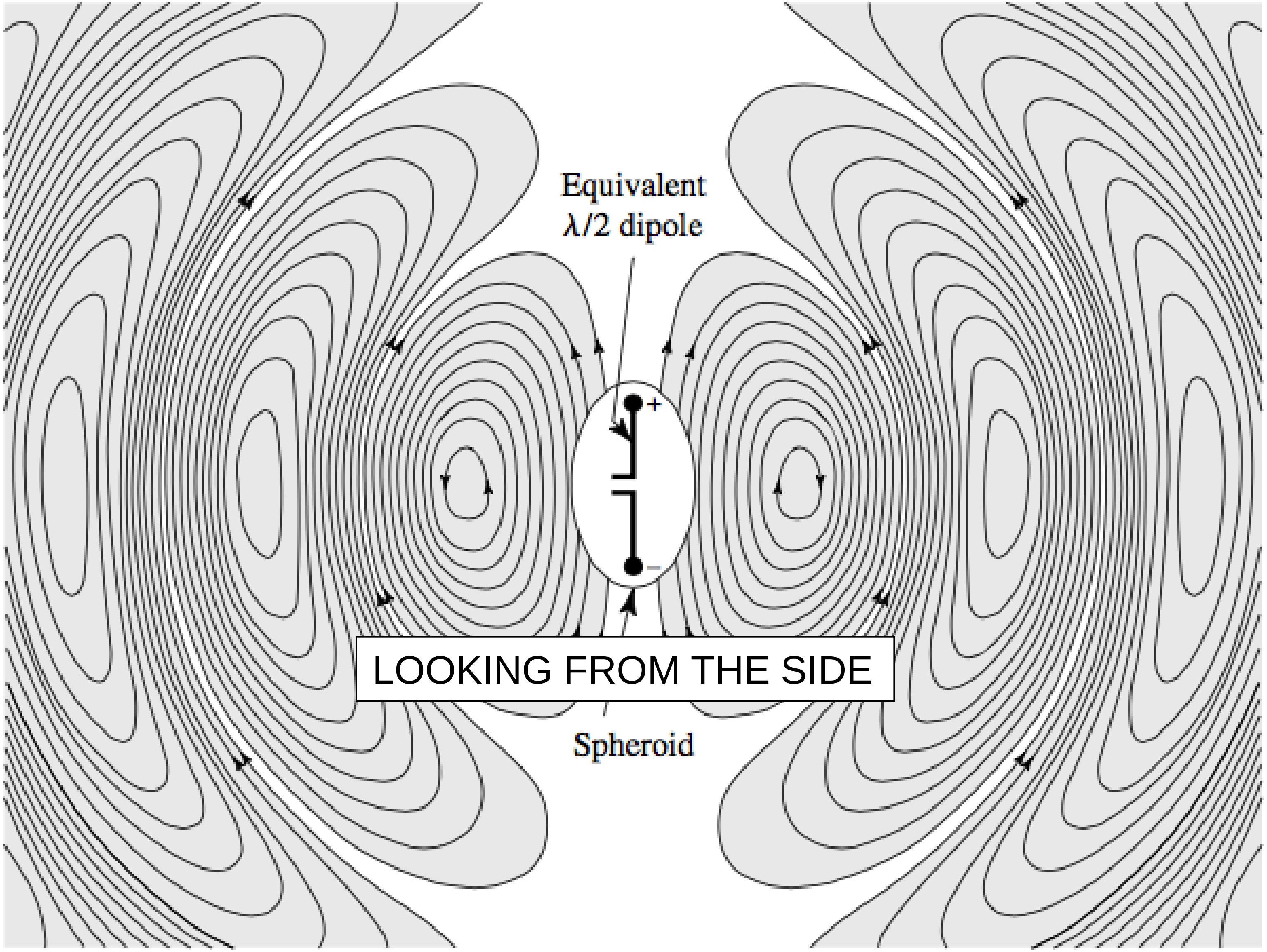


Figure 2.16


Equivalent
λ/2 dipole
+
−
Spheroid
LOOKING FROM THE SIDE

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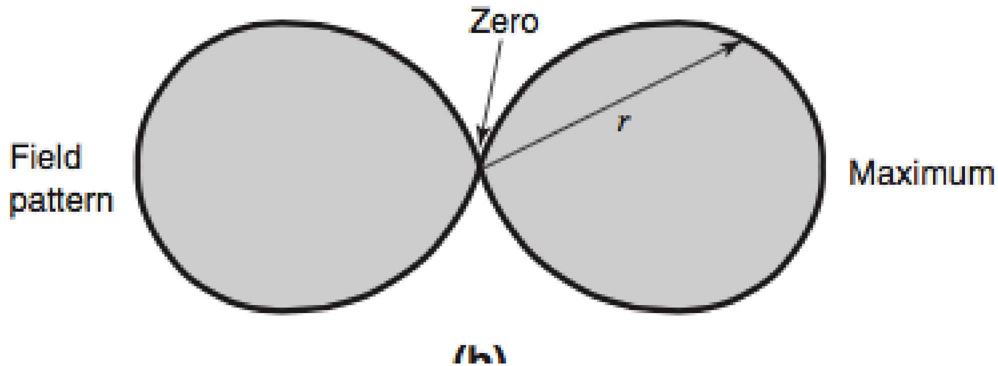
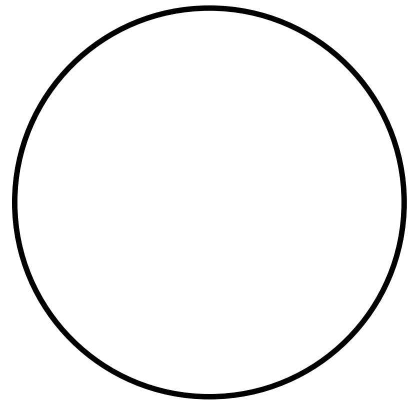


LOOKING FROM THE SIDE



LOOKING FROM THE TOP

Polarization

Linear Polarization

Horizontal or Vertical

Circular Polarization

Elliptical Polarization

- A changing E-field induces an H-field.
- A Changing H-field induces an E-field.
- … See line 1.
- The fields are orthogonal.
- So you need to align the E-fields.

- BUT, some E-fields rotate during each cycle of the RF signal.
- This makes the entire wave rotate with Circular polarization.

And most important … Reciprocity!

- An EM theorem for antennas states that:
  - “What goes in, must come out” --

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And most important … Reciprocity!

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And most important … Reciprocity!

- An EM theorem for antennas states that:
  - "What goes in, must come out"

Or better: "An antenna will retain its characteristics whether its receiving or transmitting."

So if we characterize an antenna for transmitting, then we have also characterized an antenna for receiving.

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When designing an antenna

- The most important aspect is resonant frequency or band of frequencies of interest.
- Just as different frequencies have different wavelengths, the antennas will need to be different wavelengths as well.

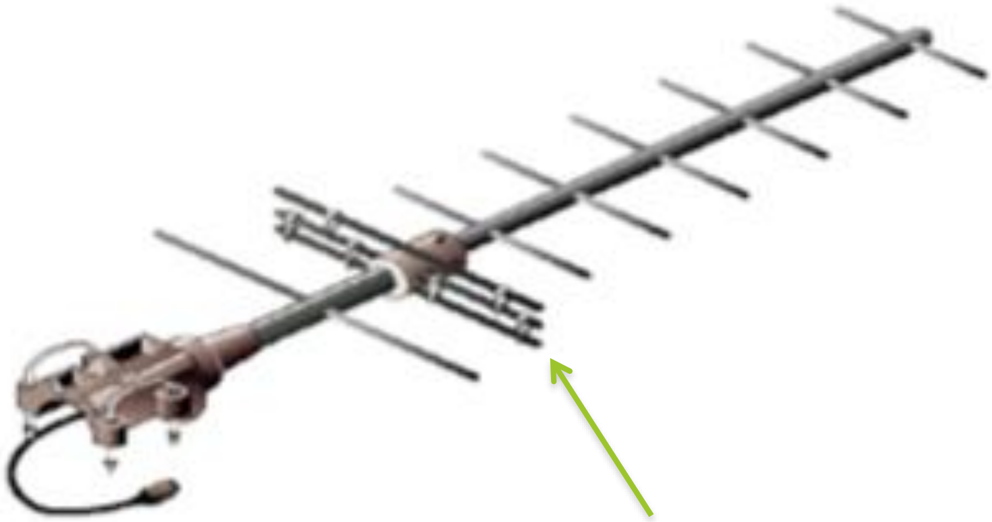
- There are many (MANY) different types of antennas.
- You will be designing a planar antenna using corrugated fiberboard and copper tape.

¼ Ground Plane

Yagi-Uda

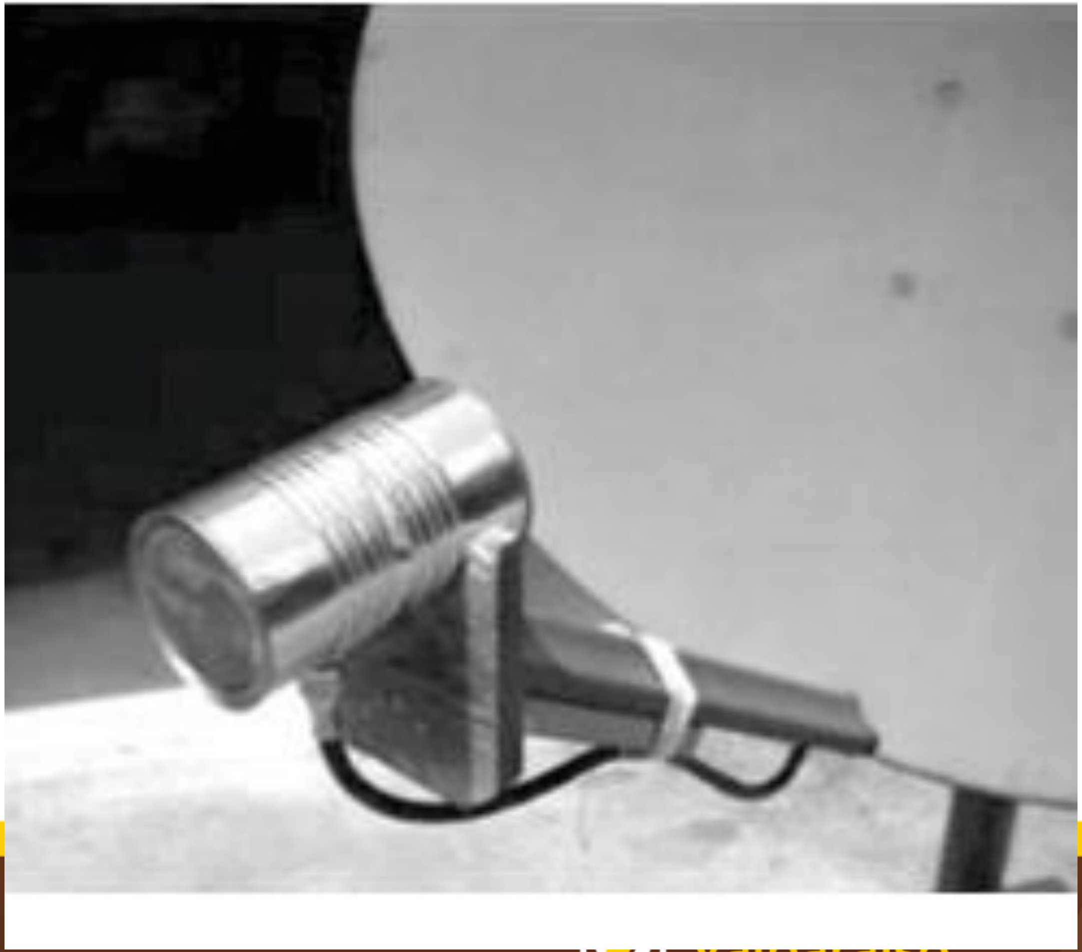
Driven element (see arrow) is a dipole.

All reflectors (extra wires) make the antenna VERY directional



Horn

This is a horn (made from a tin can) that transmits signals to a parabolic dish which reflects the signals back out.

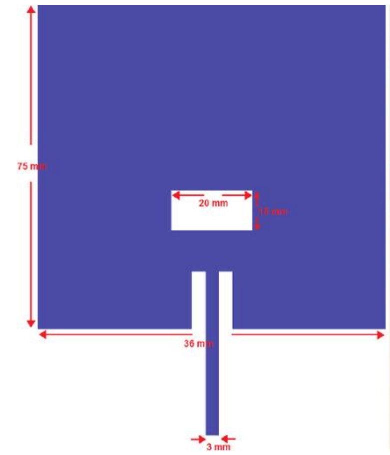


BiQuad

Made from two squares of a quarter wavelength, and a big metal back plane

Patch Antenna

Its just a flat piece of metal, with a feedline (50-Ω transmission line) terminated in the middle of the copper. These can have fairly high gains of 8 dBi (or more).



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Lesson Objectives

- An antenna is a device that converts a signal from a guided wave in a transmission line to a radiating wave in freespace
- An antenna has several characteristics that describe how it functions. Resistance relates to the coupling between the antenna and the outside world, the radiation pattern represents in what 3D direction an antenna will send most of its energy.
- To design a basic antenna, you need to know what frequency will be needed, and find the corresponding wavelength, and test out some designs.

Before next class

- Find 3 examples of planar antennas. You can look through the tag antenna chapter in our book, use google, or any other resource. Examples are: flat patch antenna, F antenna, inverted F antenna, yagi, folded dipole.
- Be ready to build one of your designs using copper tape and corrugated fiberboard