Some Antenna Theory

Just a little to get us going

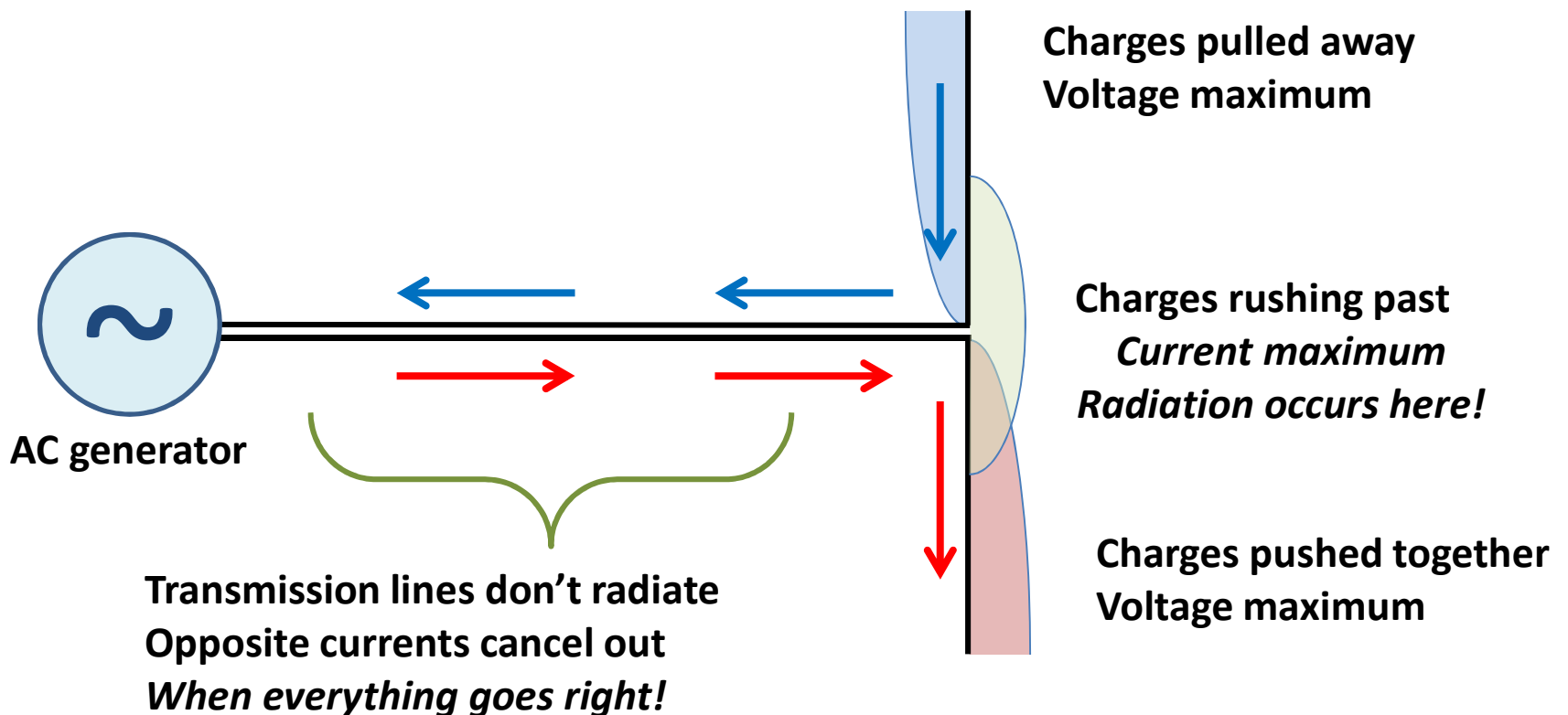# What is electromagnetic radiation?

Alternating current
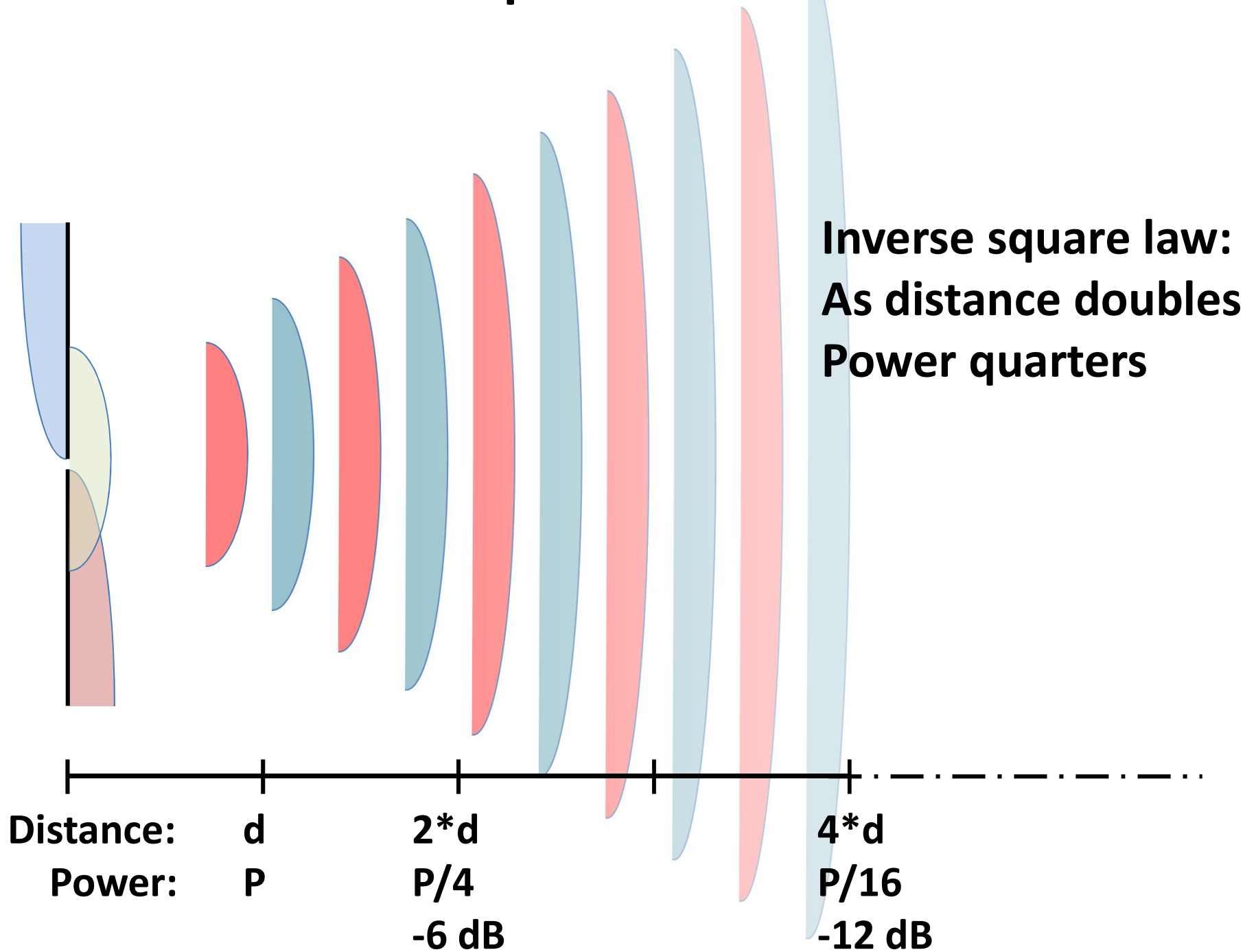Charges (electrons) wiggle back and forth in a wire
The *continuous change* in current produces electromagnetic waves
Waves radiate into the universe forever

Eventually encounter another wire & cause those electrons to wiggle

**Charges pulled away
Voltage maximum**

**Charges rushing past
Current maximum
*Radiation occurs here!***

AC generator

**Charges pushed together
Voltage maximum**

**Transmission lines don't radiate
Opposite currents cancel out
*When everything goes right!***

Free Space Path Loss

Inverse square law:
As distance doubles
Power quarters

Distance: d   2*d   4*d

Power: P   P/4   P/16

                              -6 dB   -12 dB

Measuring Gain & Loss:

Decibels (dB) are used to *compare* two power levels

-10 dB	1/10 the power	10%
-3 dB	Half the power	50%
0 dB	Identical power	100%
+3 dB	Double the power	200%
+7 dB	5x the power	500%
+10 dB	10x the power	1,000%
+20 dB	100x the power	10,000%
+30 dB	1000x the power	100,000%

dB is only meaningful if you know the point of comparison!

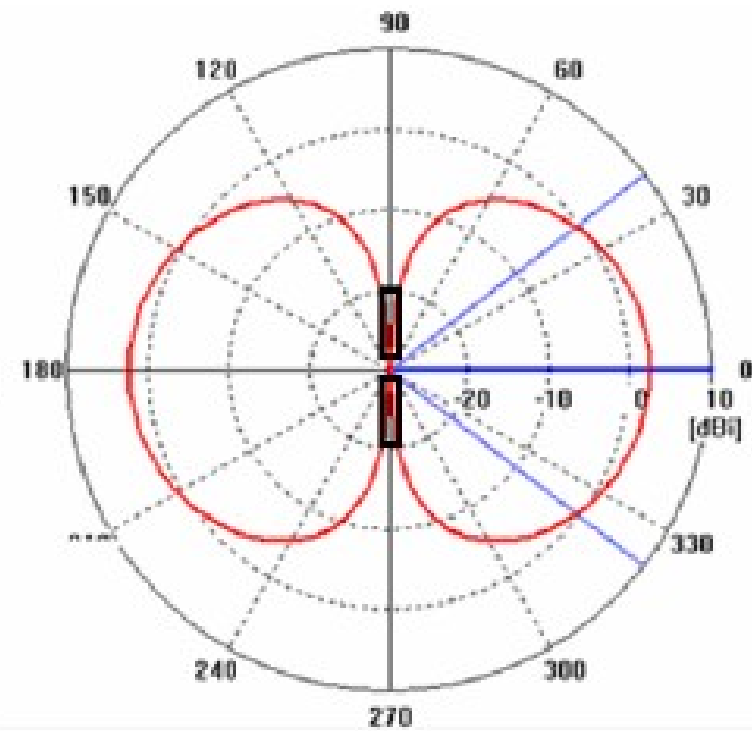**+3 dBi means double the power relative to *isotropic***
+3 dBd means double the power relative to *dipole*

Decibels are confusing at first but have advantages:
Big numbers & small numbers in the same conversation
Math is much easier (trust me)
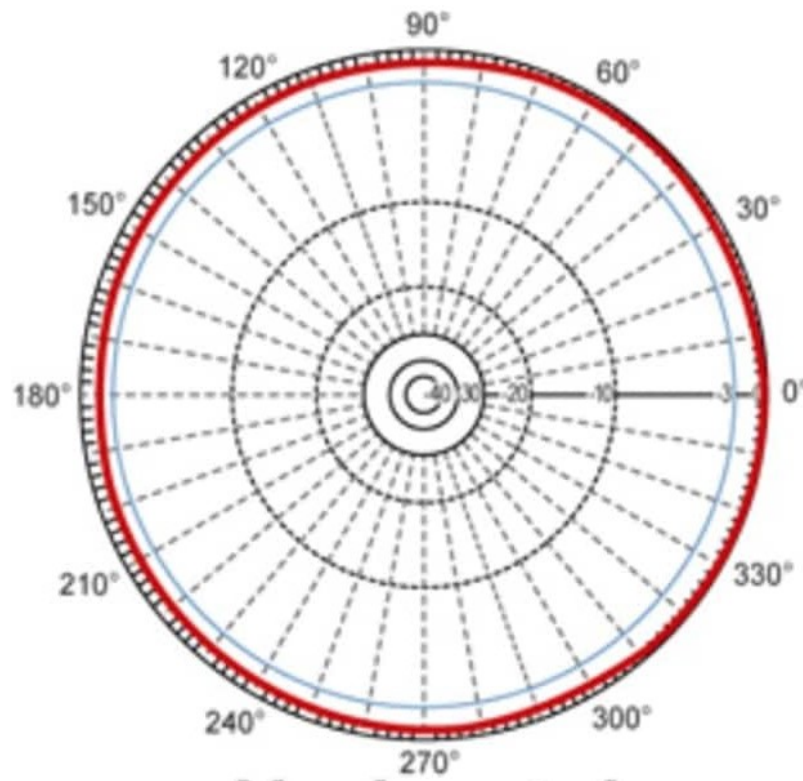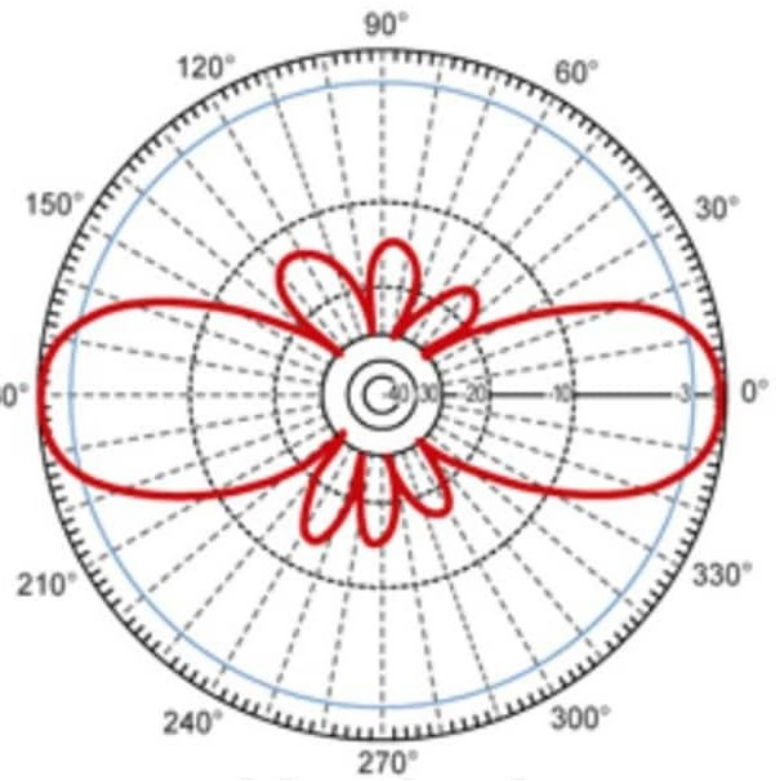
Gain & Pattern of a dipole antenna

Azimuth

Elevation

E. S. Pires et al
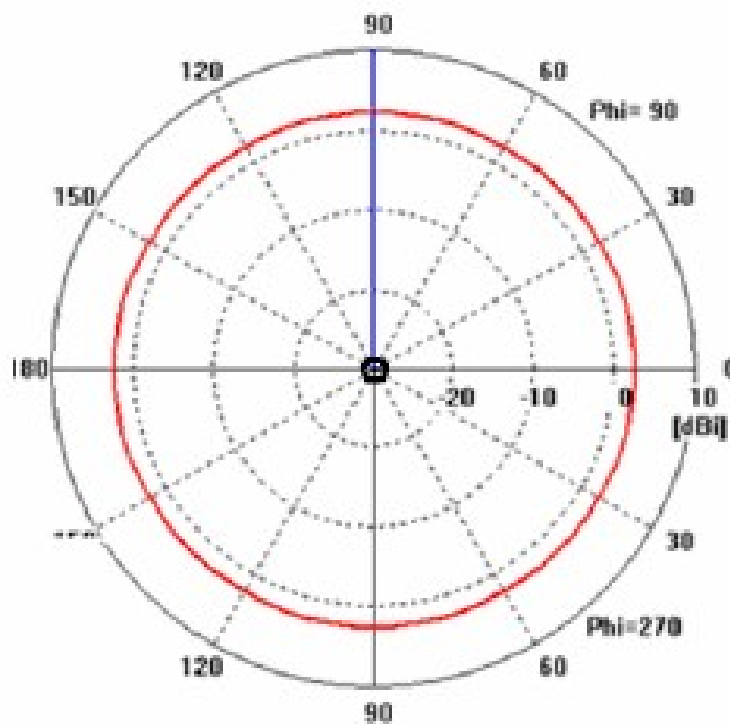
Gain & Pattern of a collinear antenna
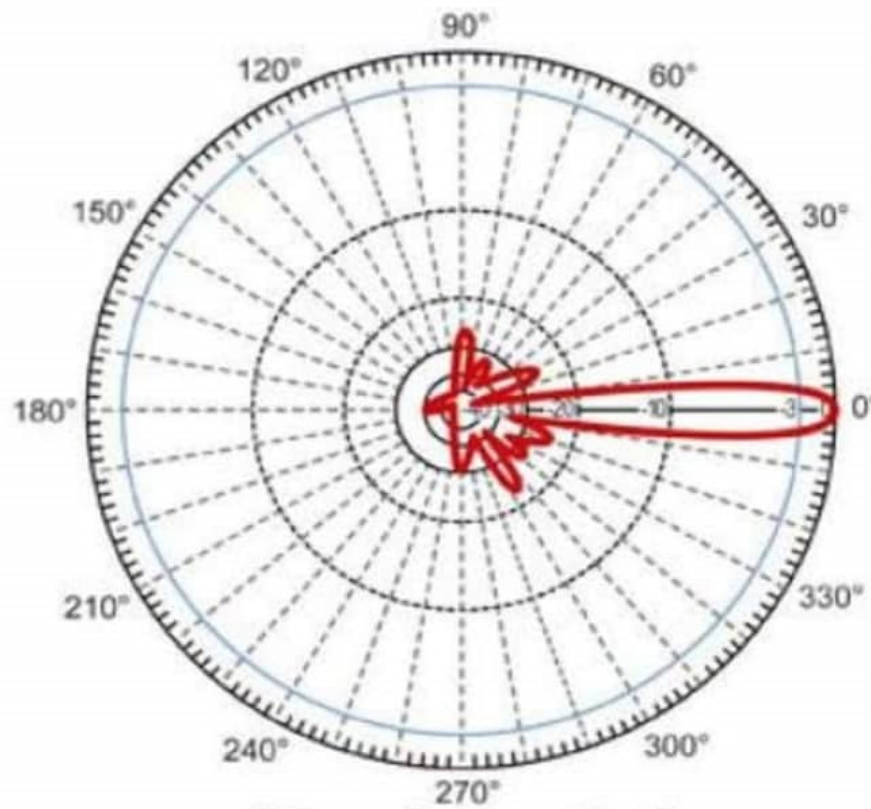

Azimuth | **Elevation**

Augustine Nguyen, Mouser.com

Gain & Pattern of a directional antenna

Azimuth

Elevation

AE5IT 2025

Augustine Nguyen, Mouser.com
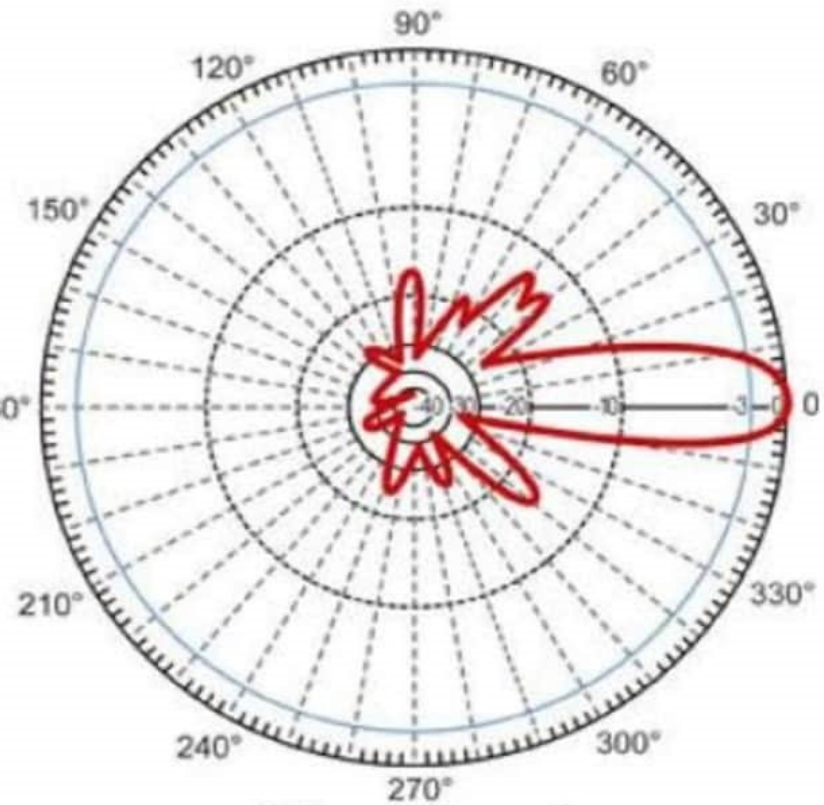
Impedance
Ratio of Voltage : Current

High voltage, low current
High impedance

Typically many thousand ohms

Low voltage, high current
Low impedance

Typically about 72 ohms
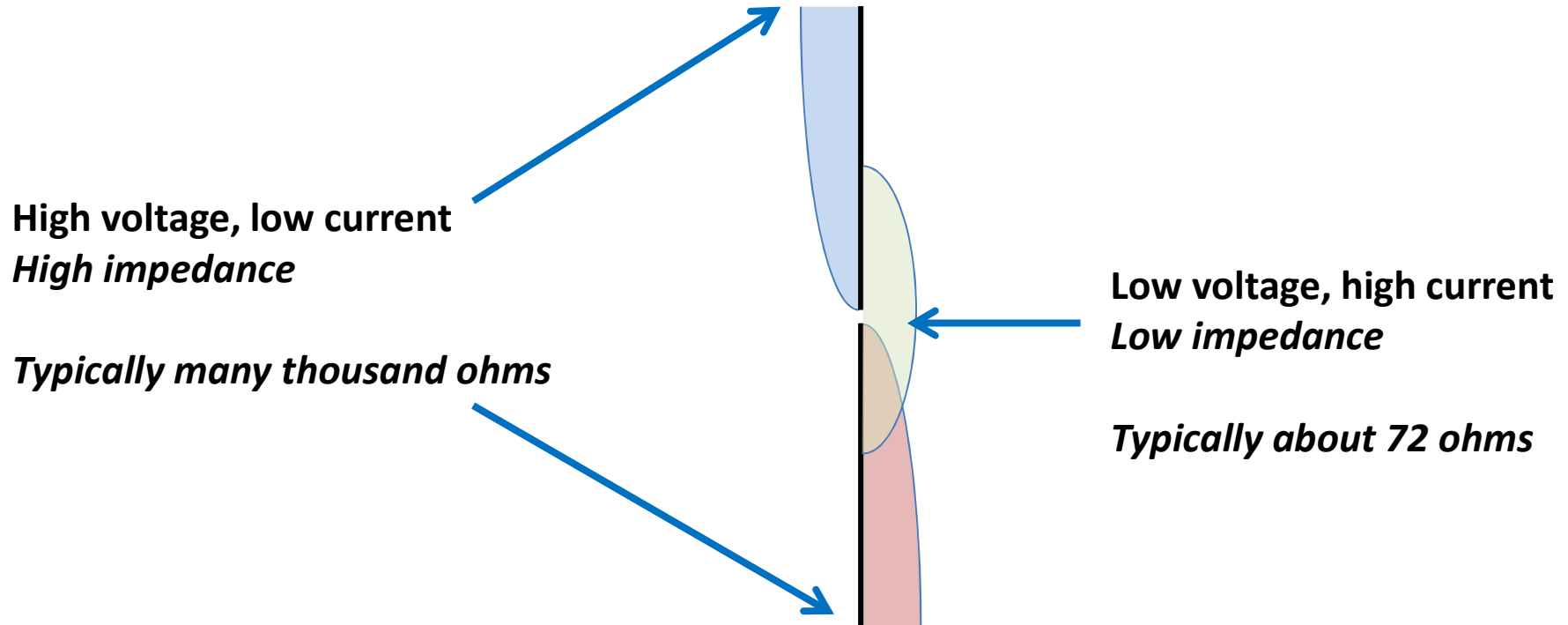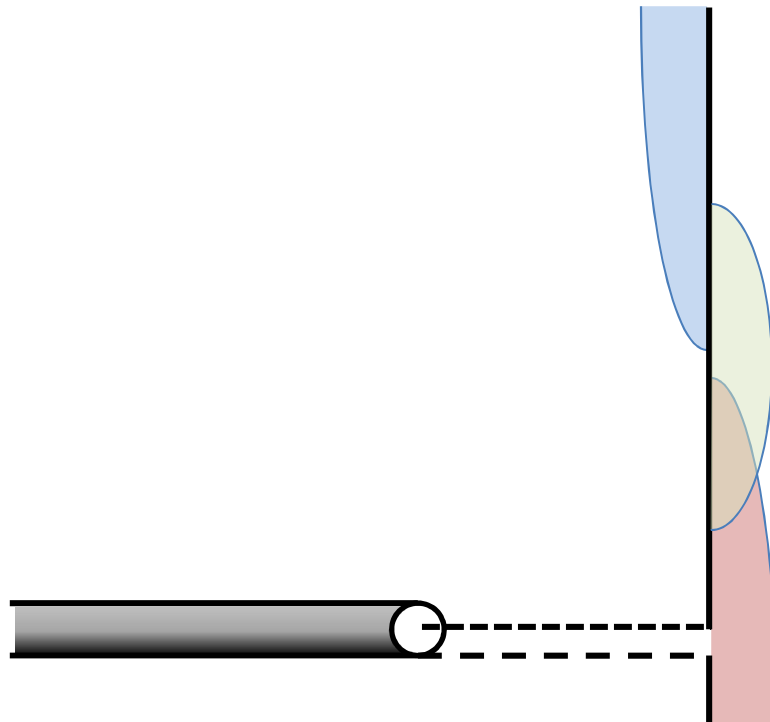
Impedance Matching

Characteristic impedance: the ratio of voltage & current where a *feedline* is happiest
Depends on material, size, shape of feedline

**Coaxial cable
50 or 75 ohms**

***Reasonably good* match
to 72 ohm feedpoint**
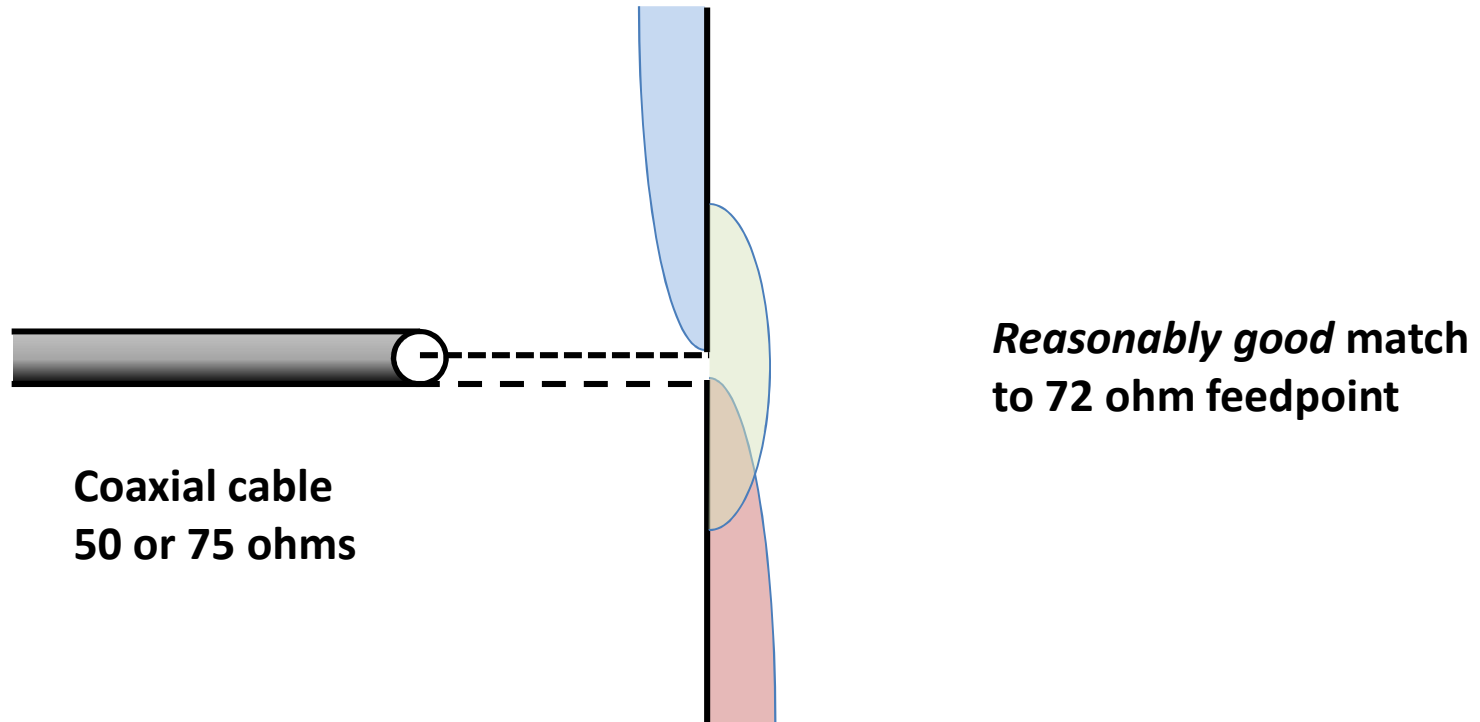
This may be mechanically *inconvenient*

Impedance Matching

**Move feedpoint for construction convenience – but feeding becomes a new challenge**

Very bad mismatch
Thousands of ohms

Big reflections - High SWR
Coax loss becomes significant

Transmitter may shut down to avoid damage

Coaxial cable
50 or 75 ohms

AE5IT 2025

Impedance Matching

Insert Antenna Tuner or other transformer system between low-impedance coax and high-impedance antenna feedpoint
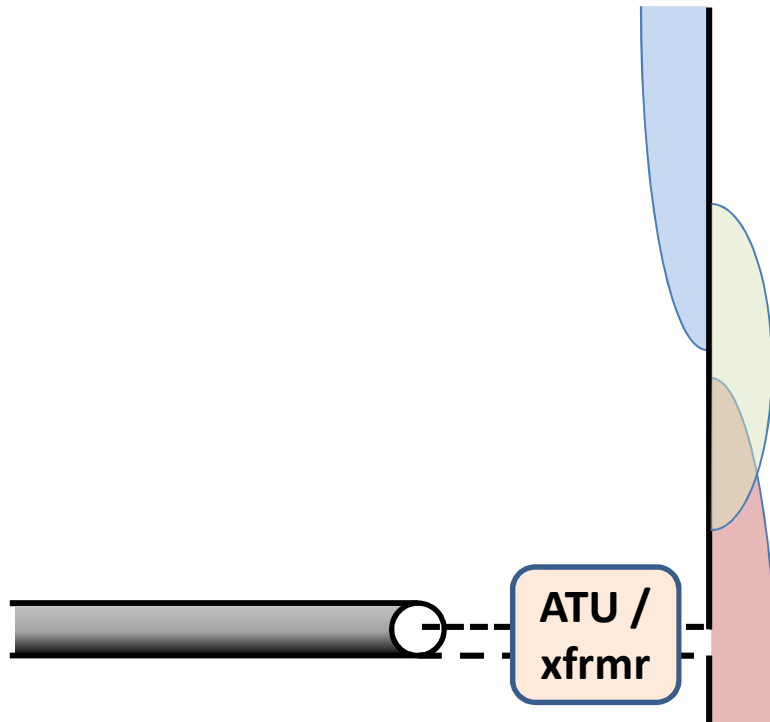
This can work well!

But details matter a lot

ATU / xfrmr

Resonance

Antenna length and frequency are perfectly matched
impedance is purely resistive ← **Mostly don't worry about this today**

Resonance is not necessary for good performance.
Lots of good non-resonant antenna designs.
EFRW, 43' vertical, multiband doublet, etc
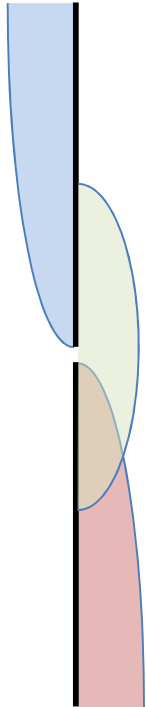
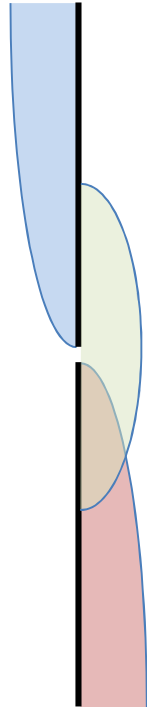Resonance is *mostly not* related to SWR

BUT

Resonant antennas are:
- Predictable (usually)
- Simple to build (usually)
- Simple to feed (usually)
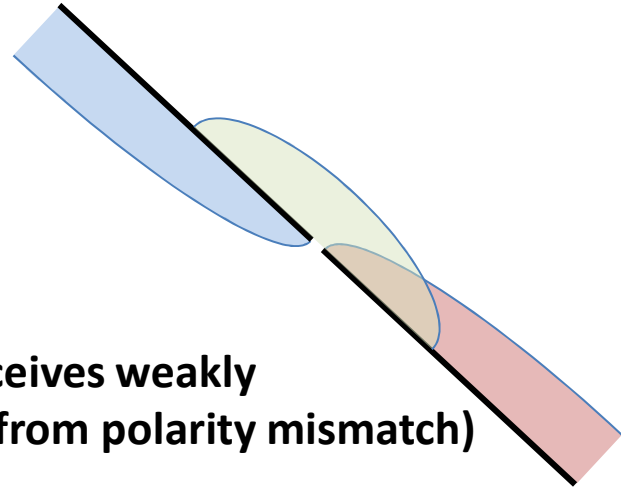- A pretty good place to start learning

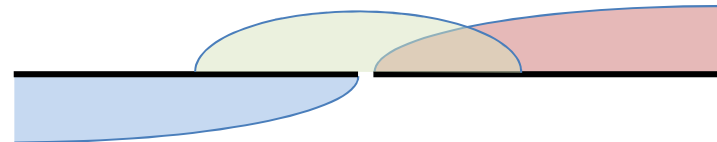AE5IT 2025

Polarization

Which way did the electrons wiggle?

**Charlie receives weakly
(3 dB loss from polarity mismatch)**

Alice transmits

Bob receives OK

**Dan receives very weakly or not at all
(20 dB loss from severe polarity mismatch)**

BUT! Polarization matters less at HF due to ionophere randomization