ECE 215 Spring 2025

Objective 3.3:

Antennas

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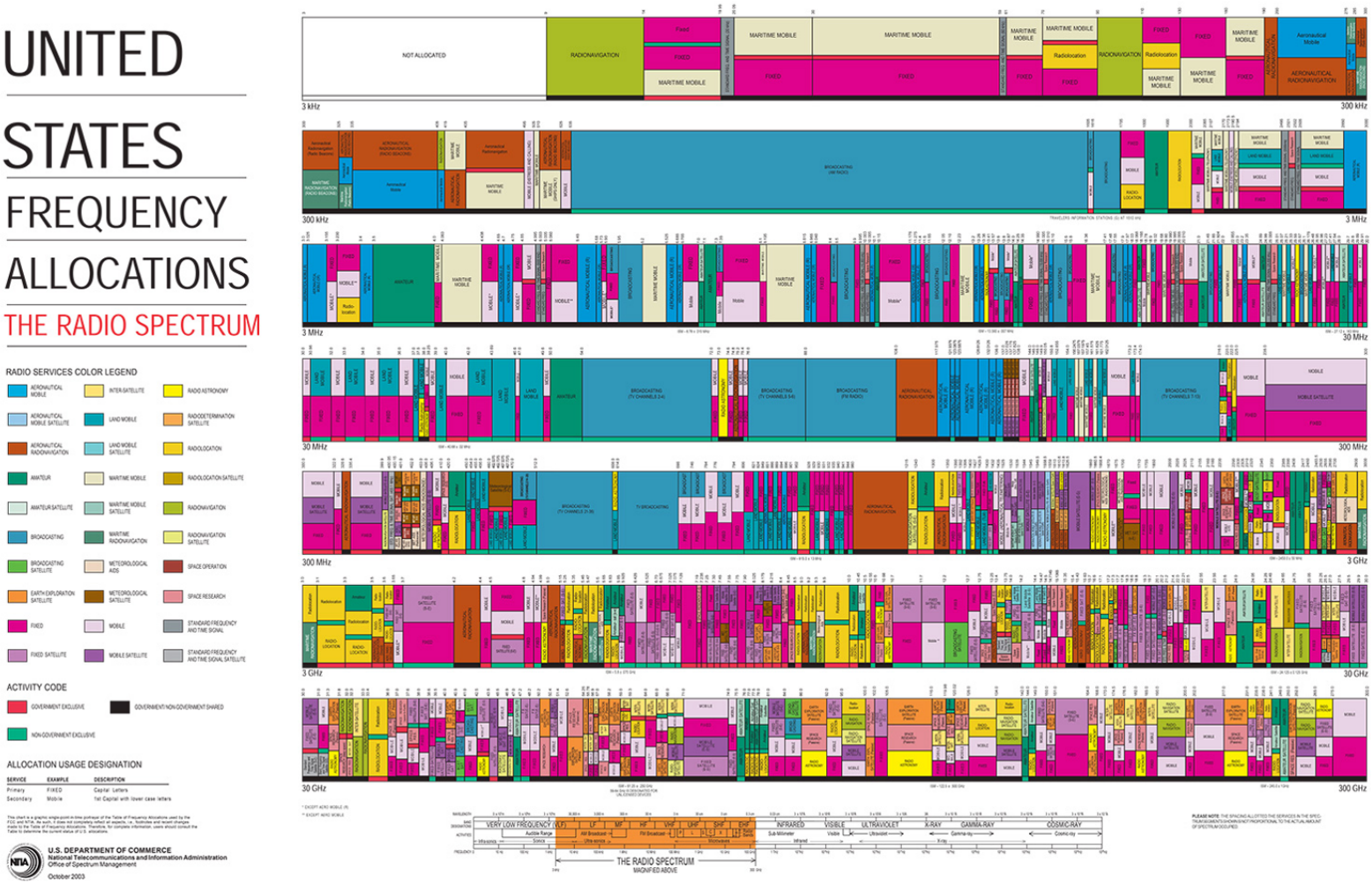
I can calculate the signal wavelength, antenna size, max antenna gain, and basic gain pattern for dipole, monopole, and parabolic dish antennas.

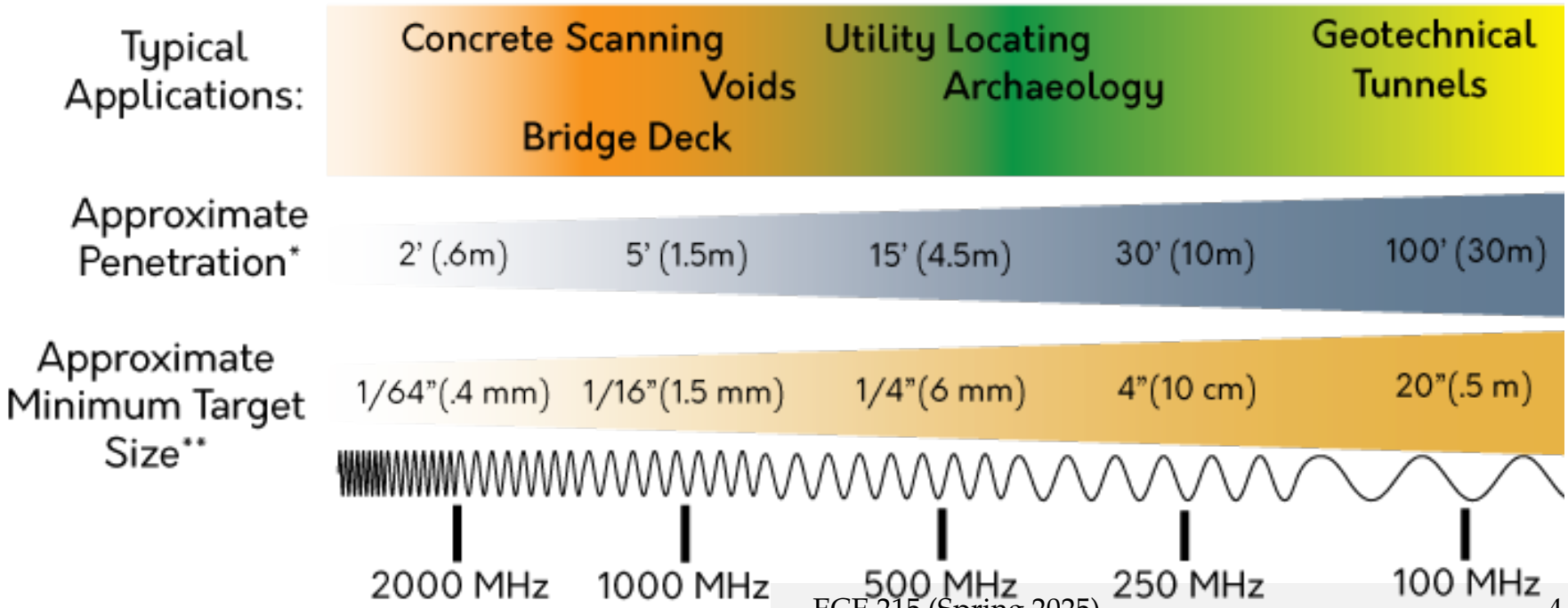
RF Spectrum Bands



RF Spectrum Bands

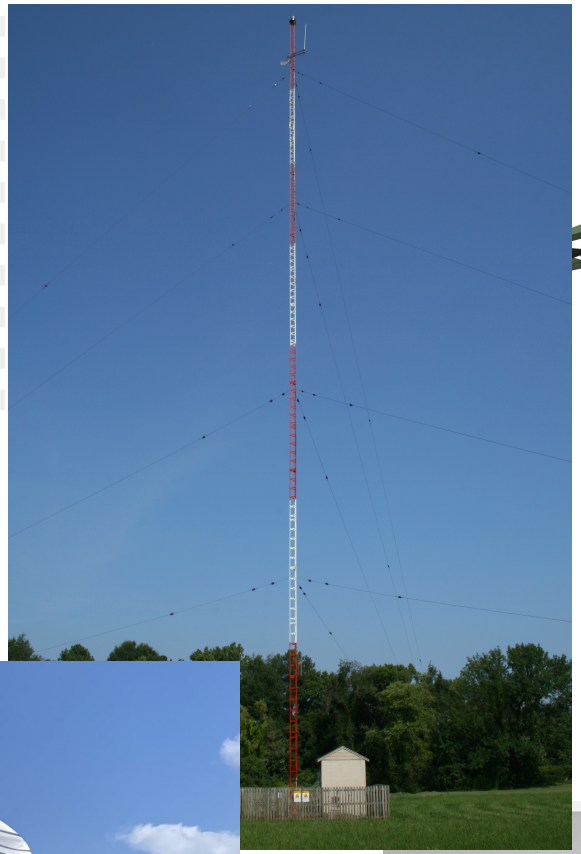
3 kHz	30 kHz	300 kHz	3 MHz	30 MHz	300 MHz	3 GHz	30 GHz	300 GHz
VLF	LF	MF	HF	VHF	UHF	SHF	EHF	

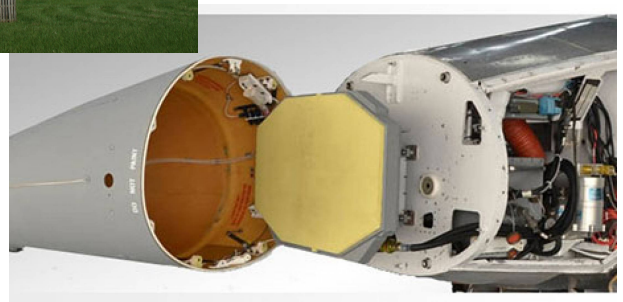
Example: Ground Penetrating Radar (GPR)



Antennas in the Wild

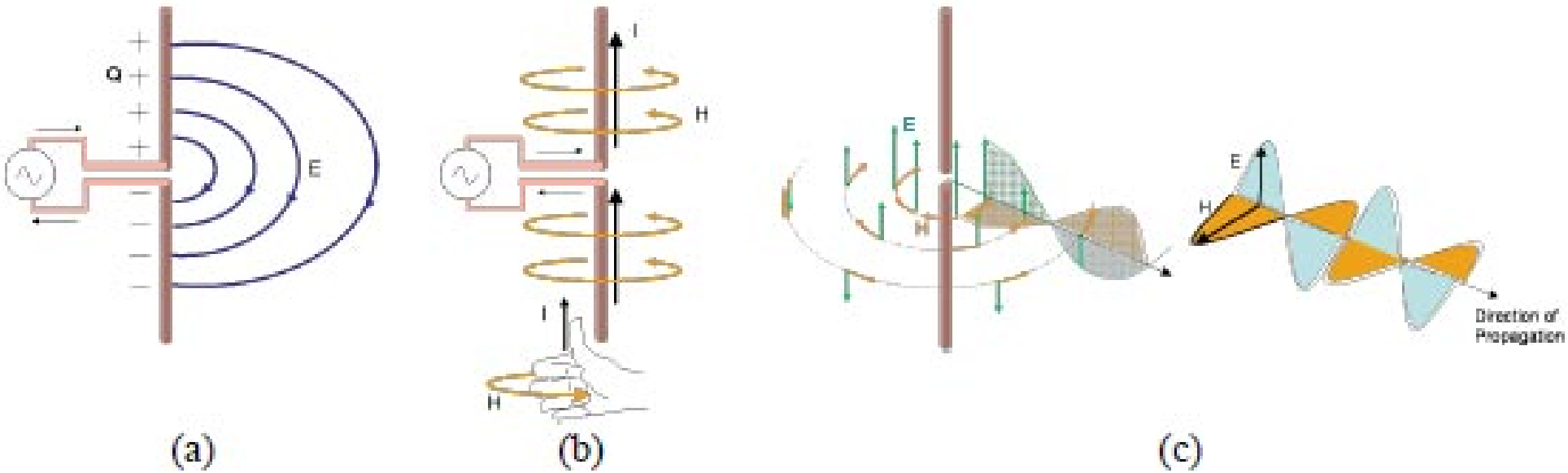
- Monopole
- Dipole
- Parabolic/Spherical
- AESA





How Antennas Work

- Separation of charge (a) creates an electric field (E-field)
- Moving charge (b) creates a magnetic field (H-field)
- The Poynting Vector predicts the electromagnetic wave direction of propagation: $\vec{S} = \vec{E} \times \vec{H}$



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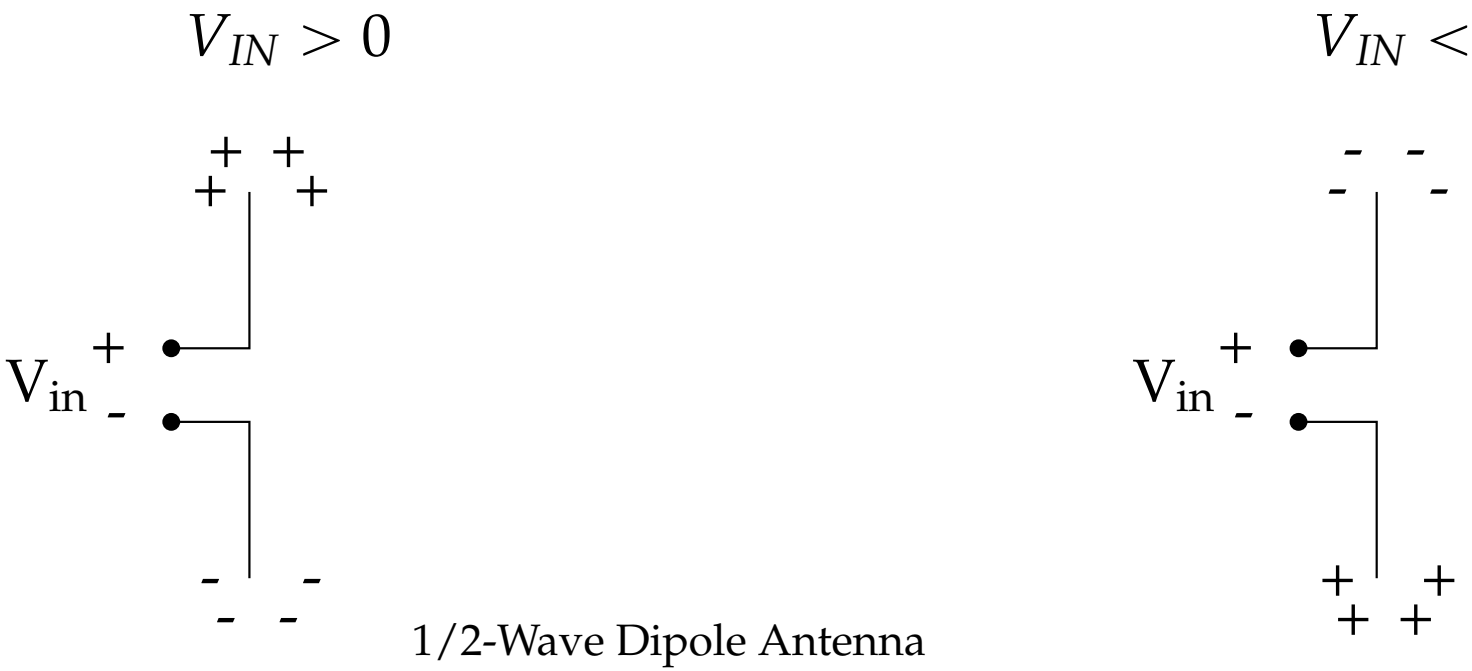


1/2-Wave Dipole Antenna

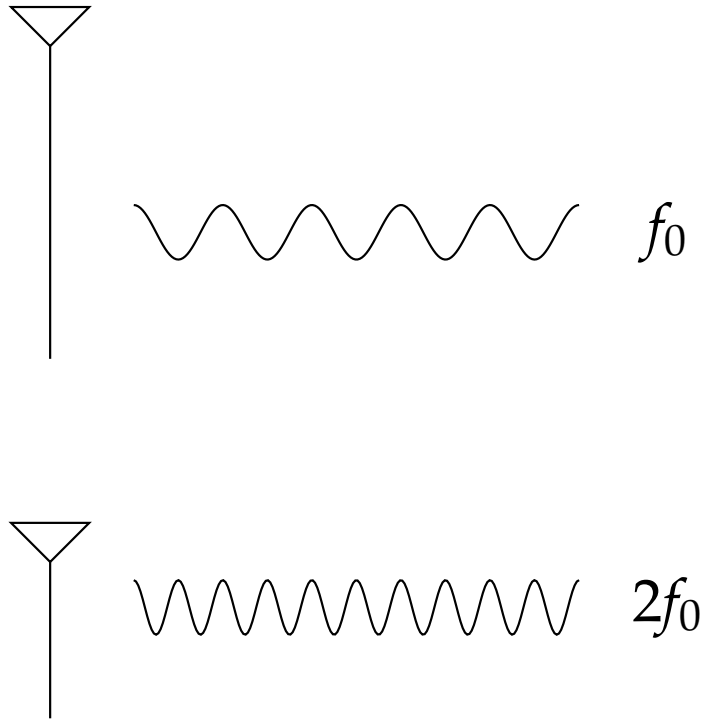
Important Quantities

Wavelength and frequency

Radiation Pattern

Antenna Gain

$$\lambda = \frac{c}{f}$$

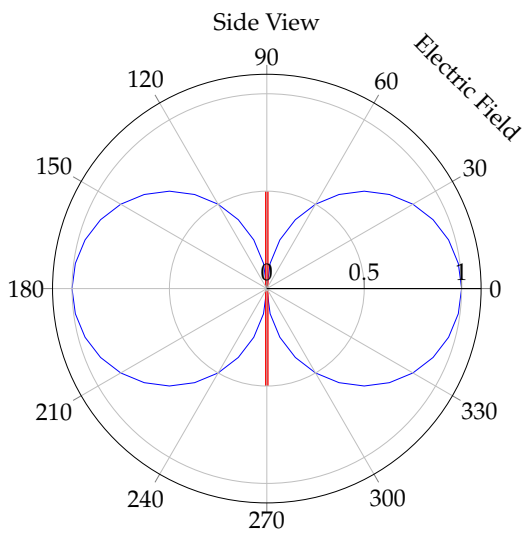


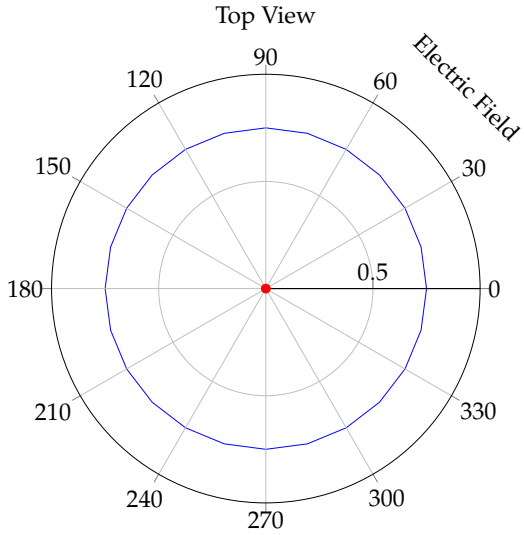
Important Quantities

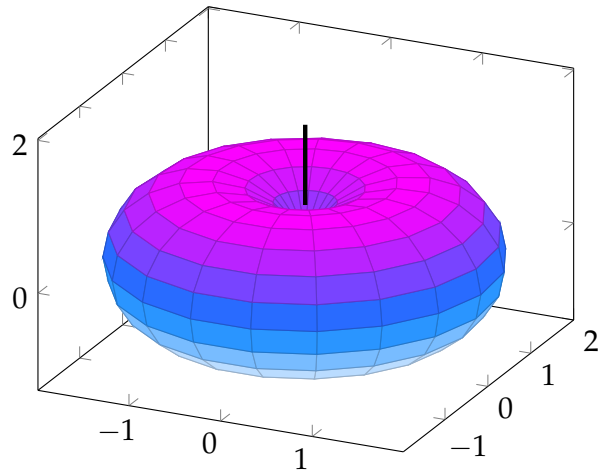
Wavelength and frequency

Radiation Pattern

Antenna Gain







Important Quantities

Wavelength and frequency

Radiation Pattern

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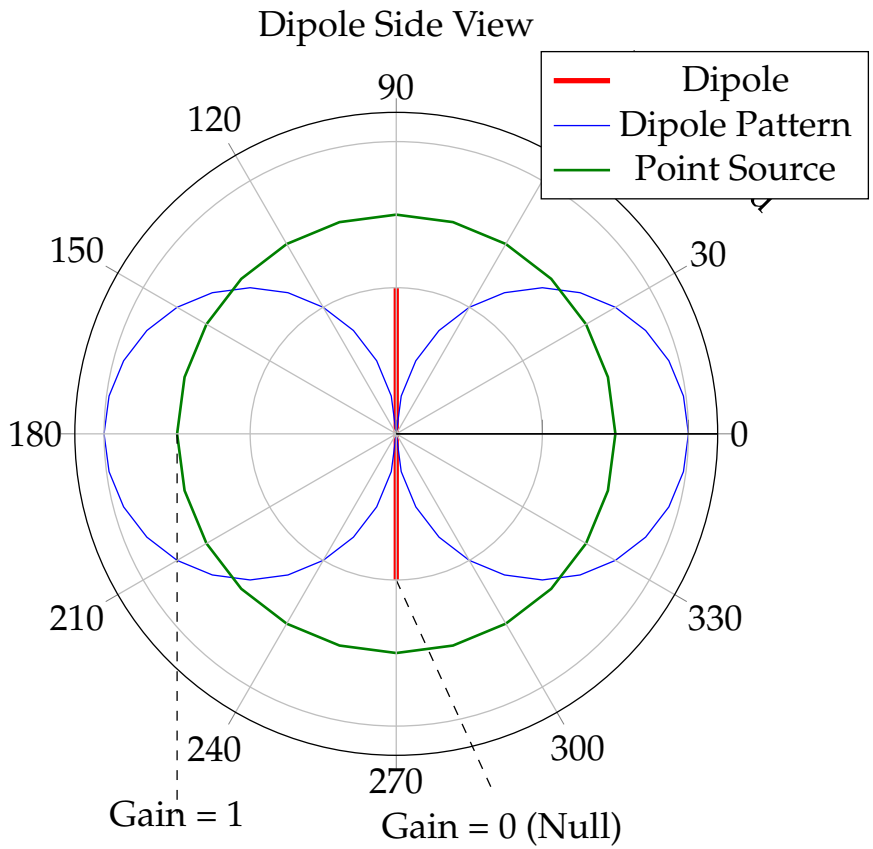
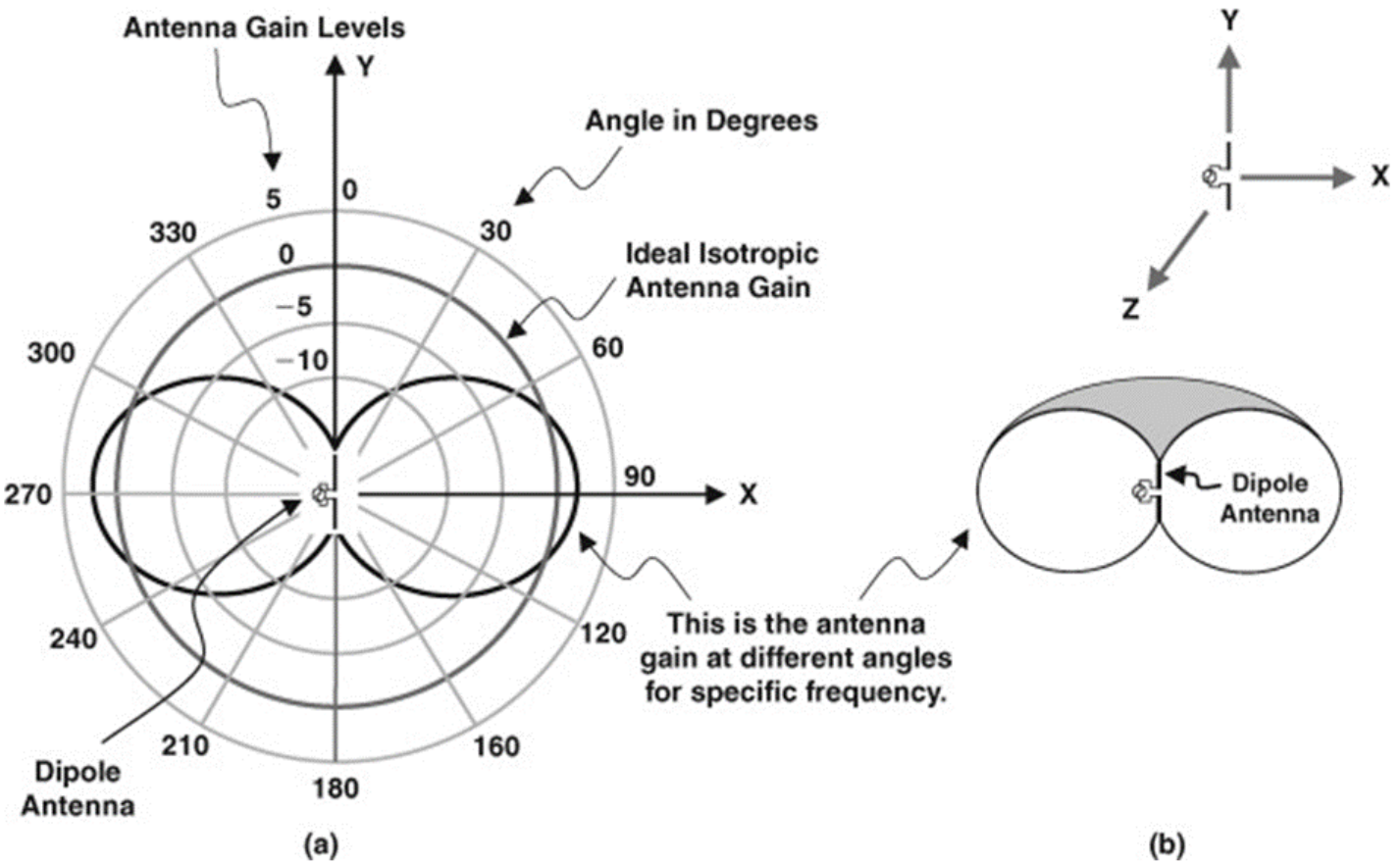
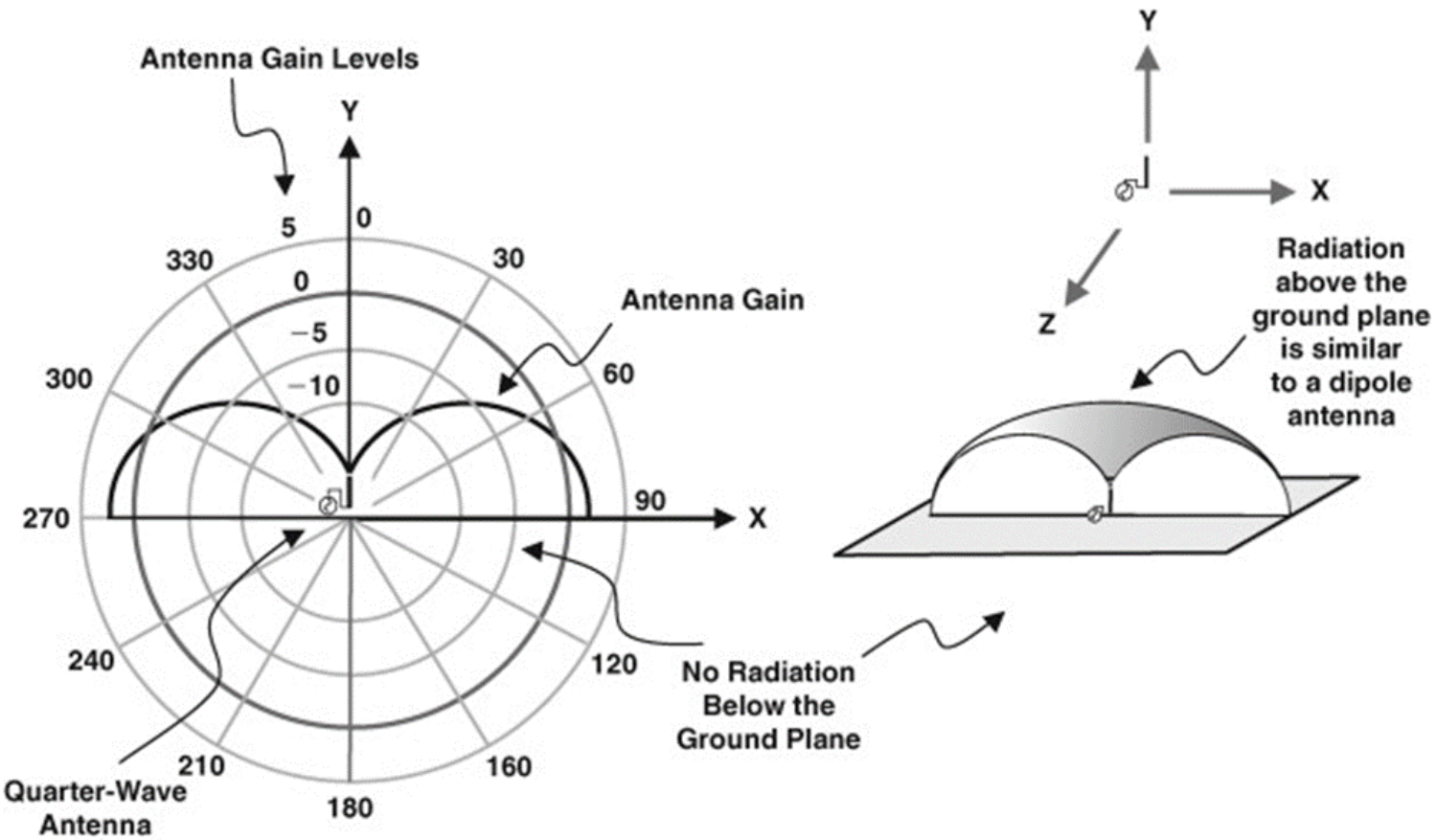


$\frac{\lambda}{2}$-Dipole Antenna

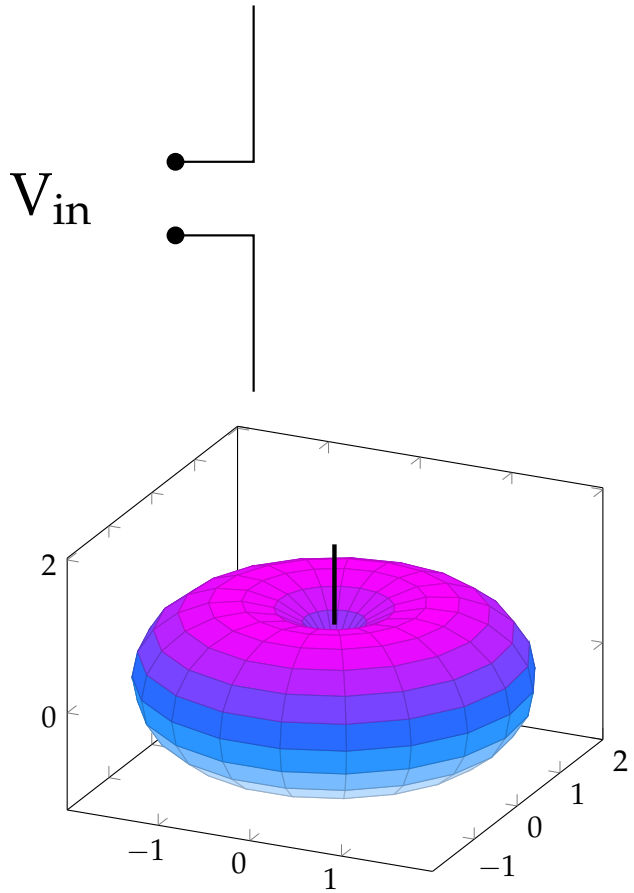


$\frac{\lambda}{4}$-Monopole Antenna

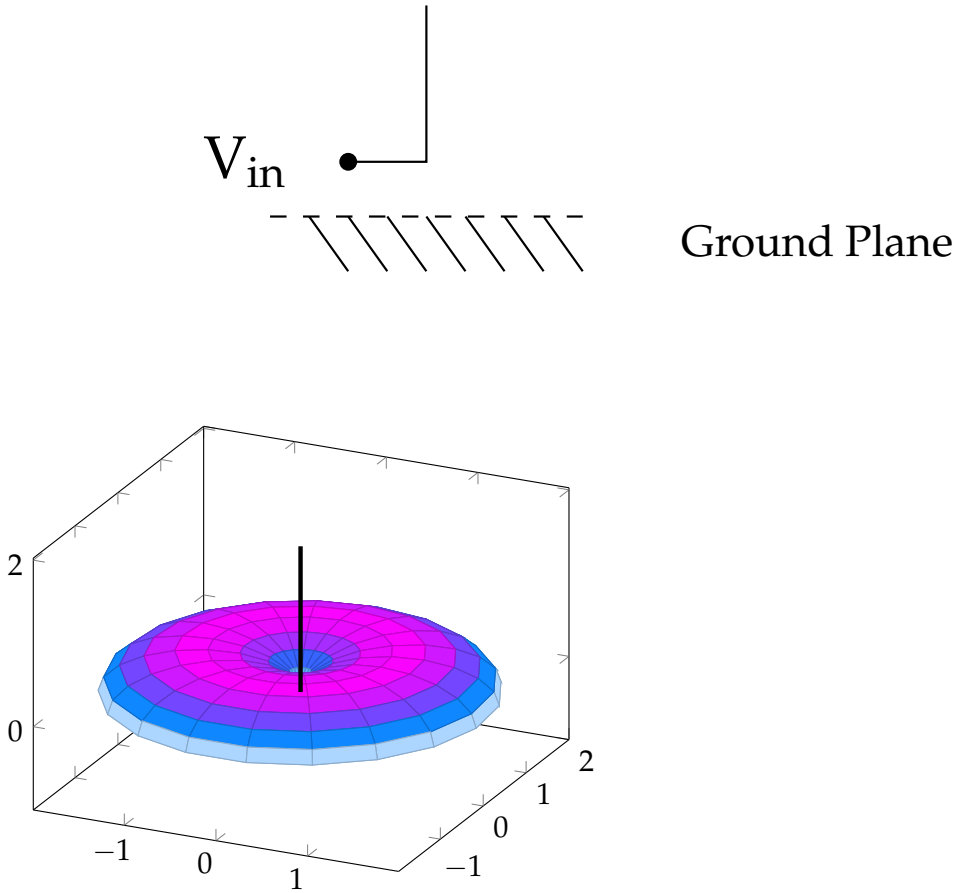


Dipole/Monopole Antennas

$\frac{\lambda}{2}$ Dipole (Gain = 1.64)



$\frac{\lambda}{4}$ Monopole (Gain = 3.28)



Dipole/Monopole Examples

- Calculate the required length of a $\frac{\lambda}{2}$ dipole designed for a 144MHz radio

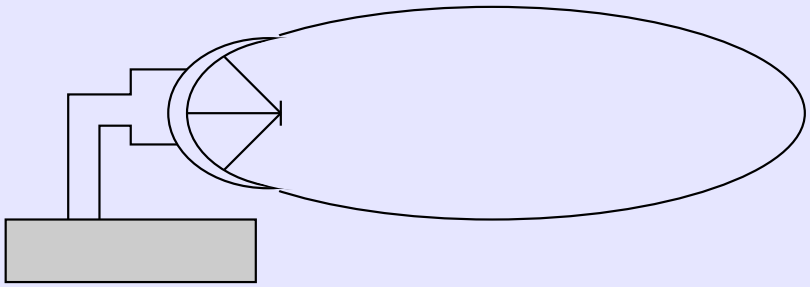
- Calculate the required length of a $\frac{\lambda}{4}$ monopole designed for a 800 kHz AM radio

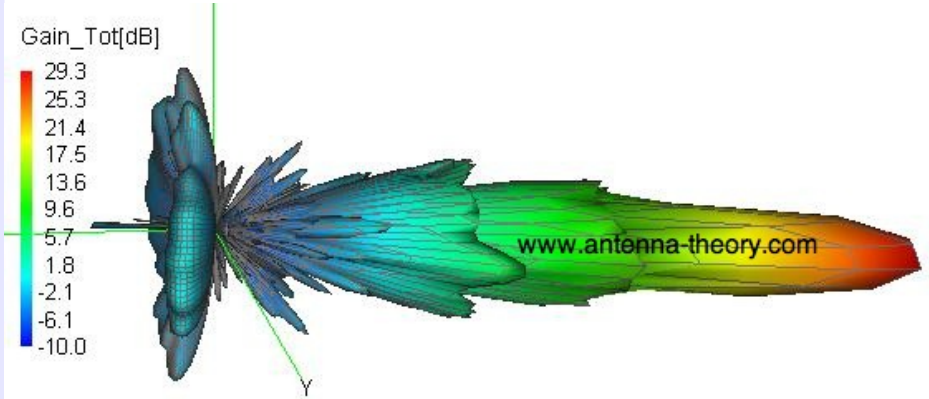
Antenna Size

	3 kHz – 30 kHz	30 kHz – 300 kHz	300 kHz – 3 MHz	3 MHz – 30 MHz	30 MHz – 300 MHz	300 MHz – 3 GHz	3 GHz – 30 GHz	30 GHz – 300 GHz
	VLF	LF	MF	HF	VHF	UHF	SHF	EHF
Wavelength (m)	100k	10k	1k	100	10	1	0.1	0.01	0.001
$\lambda/2$ dipole	50k	5k	500	50	5	0.5	0.05	0.005	0.0005
$\lambda/4$ monopole	25k	2.5k	250	25	2.5	0.25	0.025	0.0025	0.00025

Dish Antennas

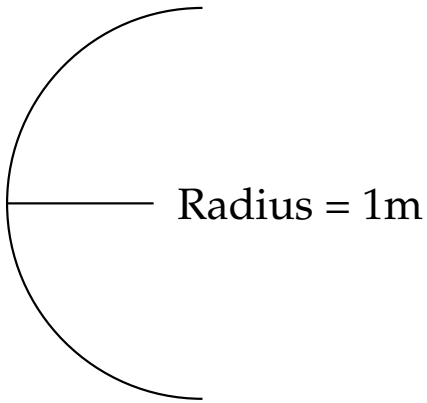
- Focuses beam in a particular direction
- Gain given by: $G = \frac{(2\pi r)^2}{\lambda^2} * \eta$
- Where have you seen these?





Parabolic Example

What frequency is the following antenna designed for? Assume $\eta = 91\%$ and $G = 300$.



Phased Arrays

- Array of antenna elements
- Each element is delayed in phase (time) from the one before it
- "Wave front" is the sum of the peaks
- Beam propagates at an angle, determined by phase delay