Antenna Characteristics

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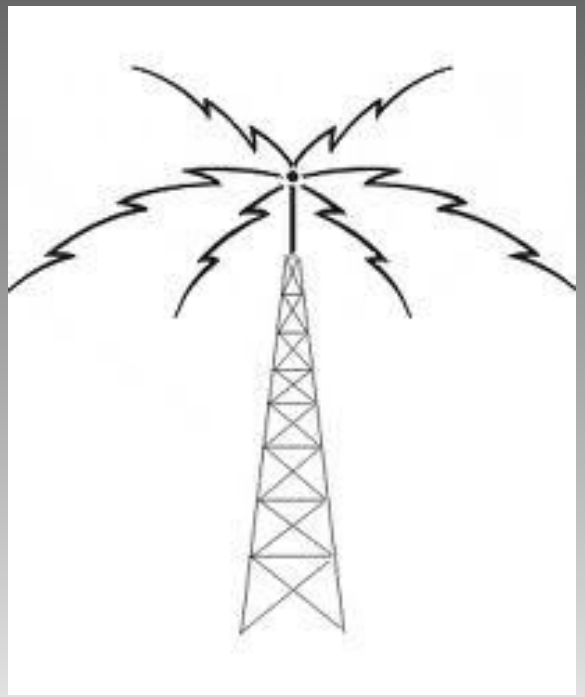
Outline

- Introduction
- Characteristics
- Methodology
- Observations
- Inferences

Antenna

- An antenna is a device designed to radiate and/or receive electromagnetic waves in a prescribed manner.

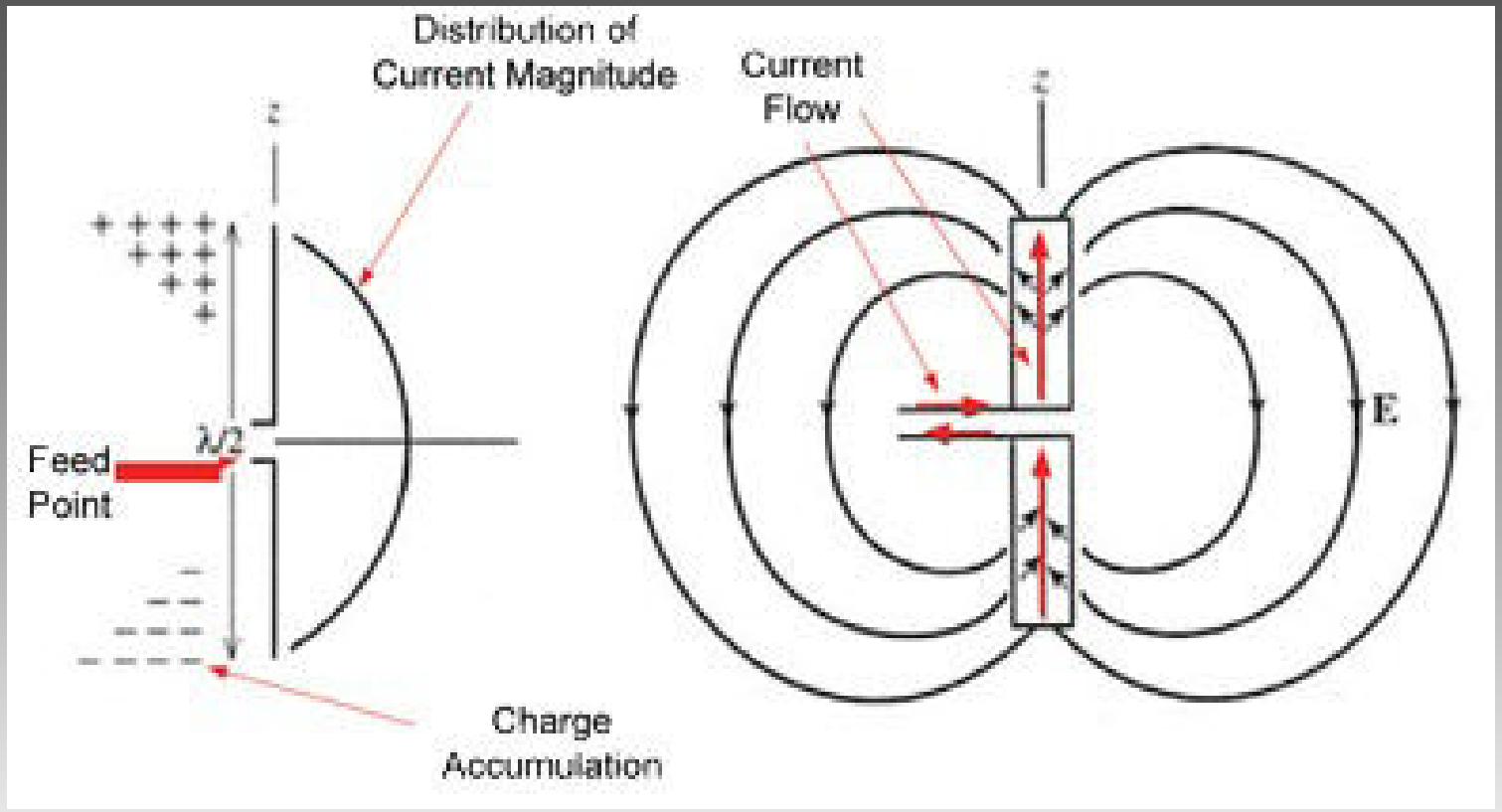
A Yagi Uda antenna meant for home use



Schematic diagram of a antenna

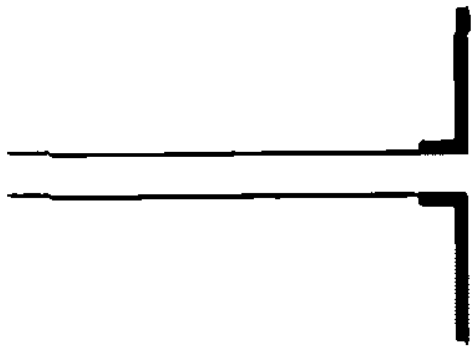
The current distributions on the antennas produce the radiation.

Usually, these current distributions are excited by transmission lines or waveguides.

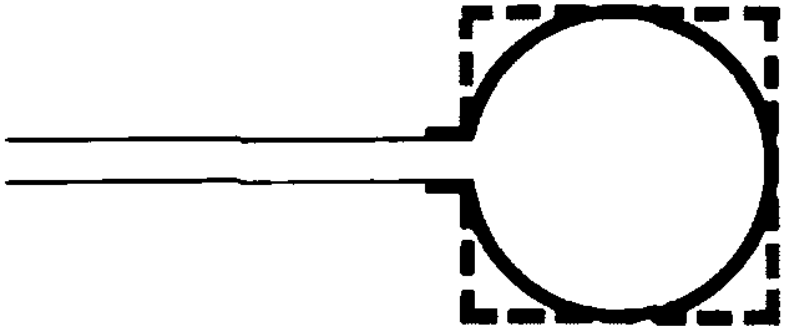


Types Of Antennas

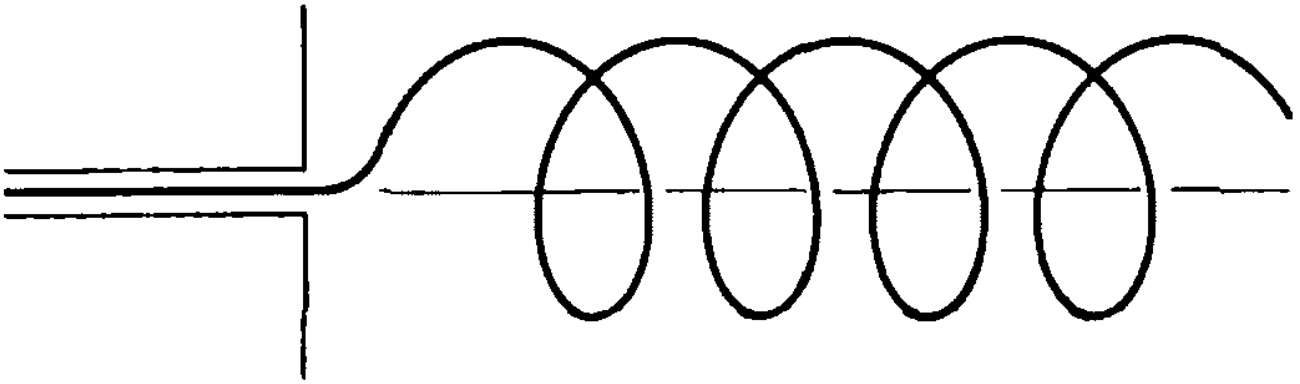
Wire Antennas



(a) Dipole

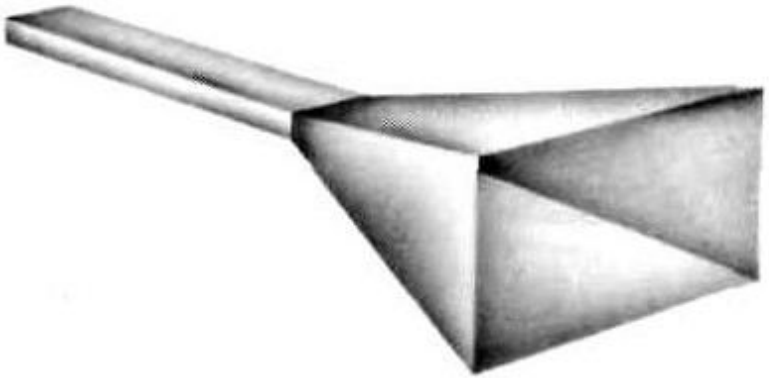


(b) Circular (square) loop



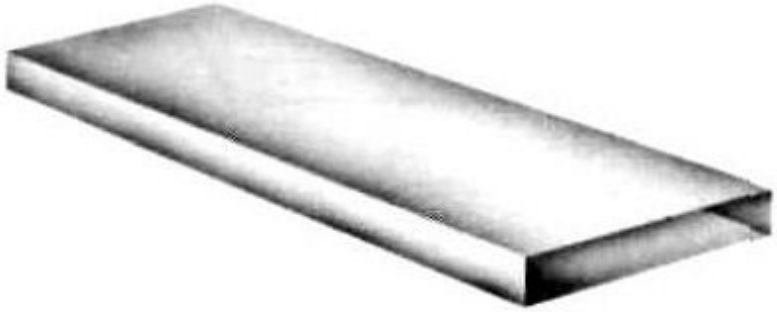
(c) Helix

Aperture antennas



(a) Pyramidal horn

(b) Conical horn



(c) Rectangular waveguide

Micro strip Antennas

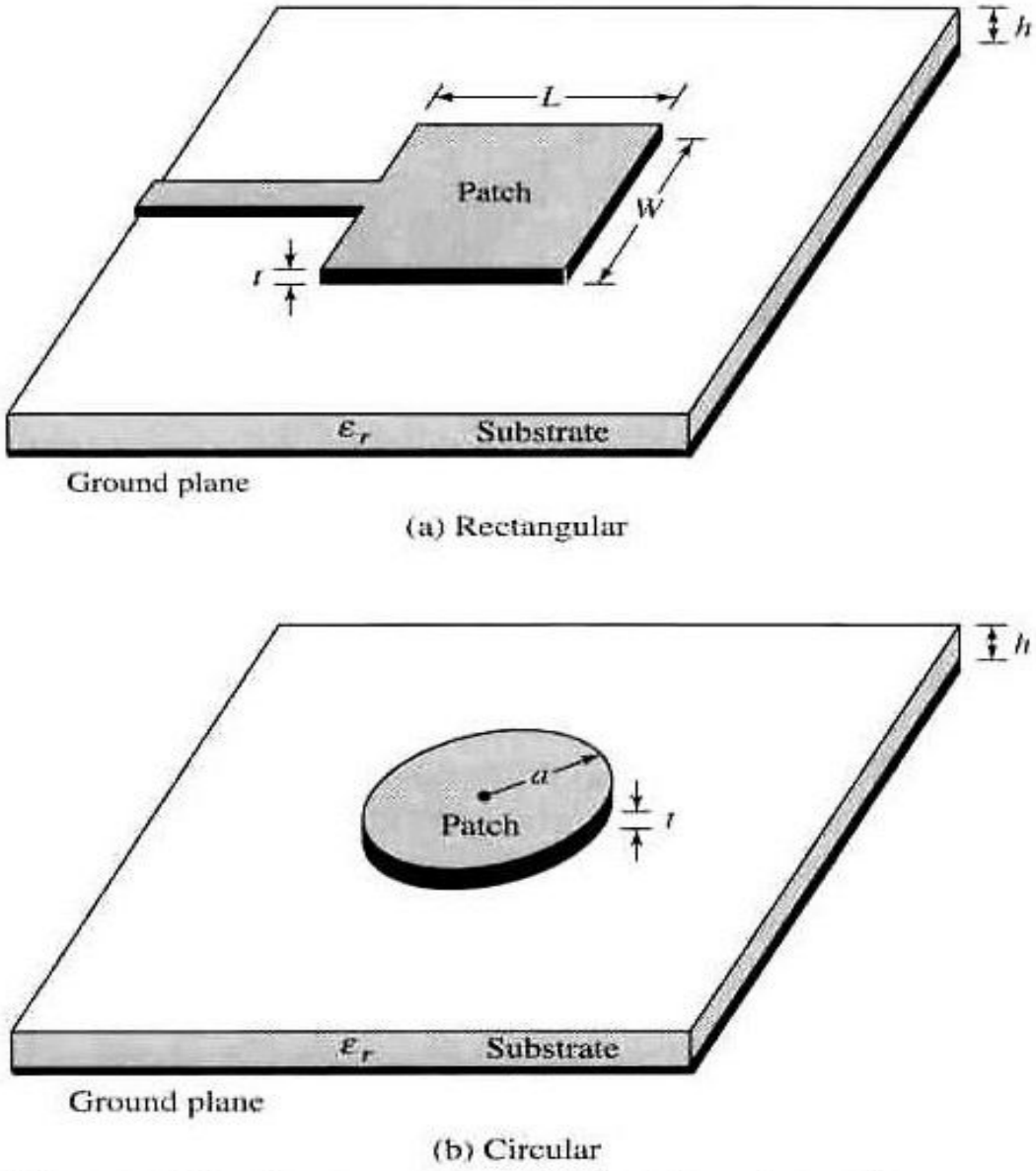
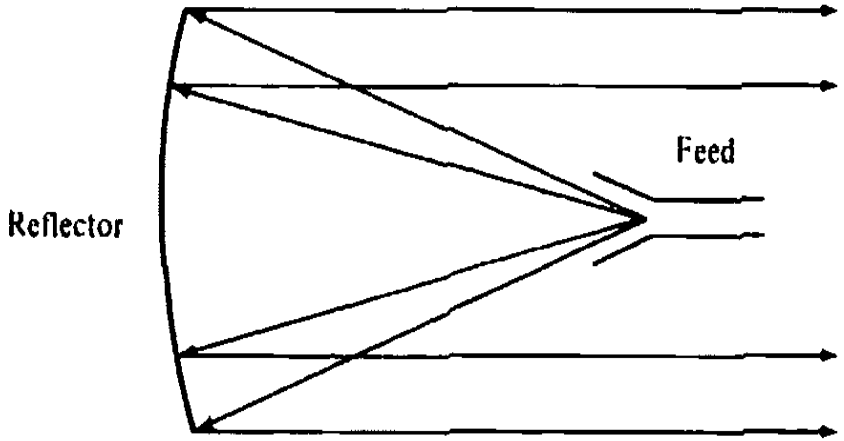
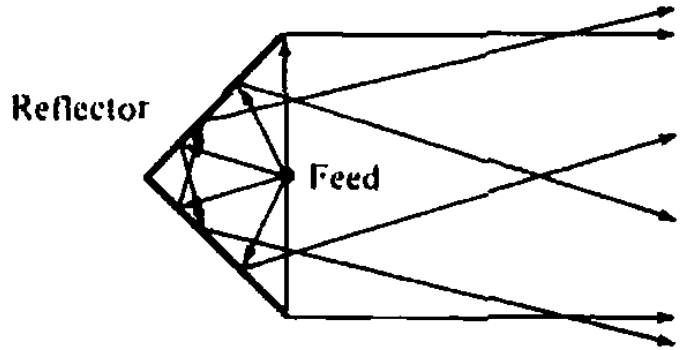


Figure 1.5 Rectangular and circular microstrip (patch) antennas.

Reflector antennas



(a) Parabolic reflector with front feed



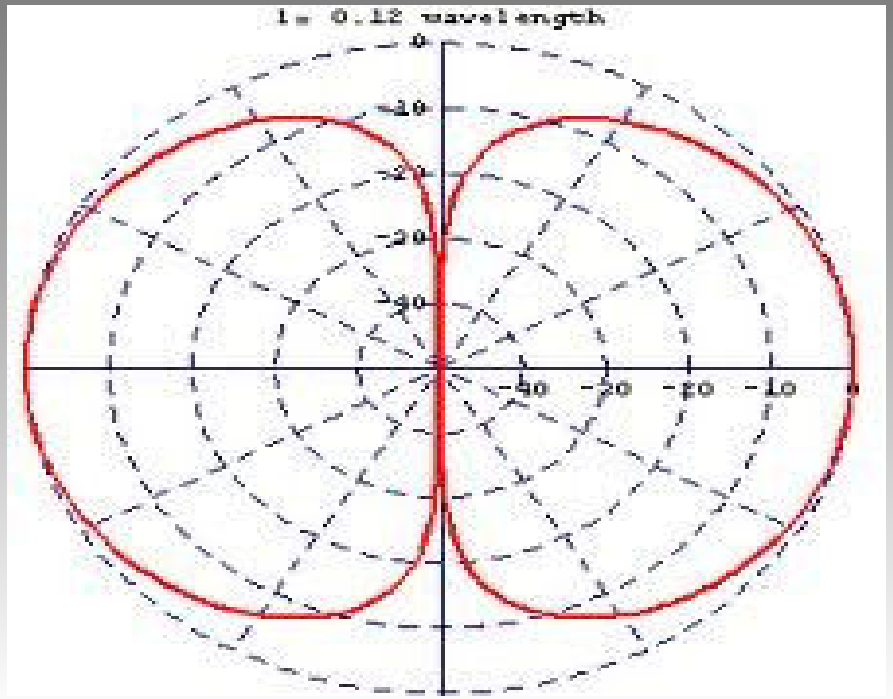
(c) Corner reflector

Figure 1.7 Typical reflector configurations.

Antenna Basics

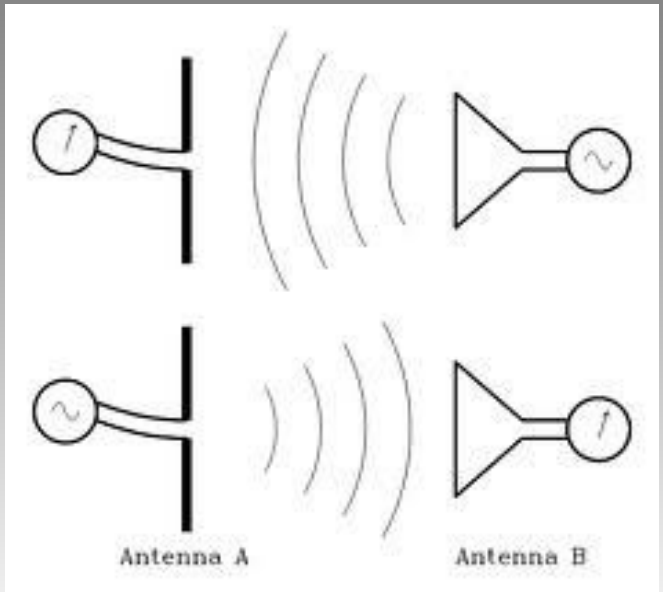
Radiation Pattern

- The distribution of radiated energy from an antenna over a surface of constant radius centered upon the antenna as a function of directional angles from antenna



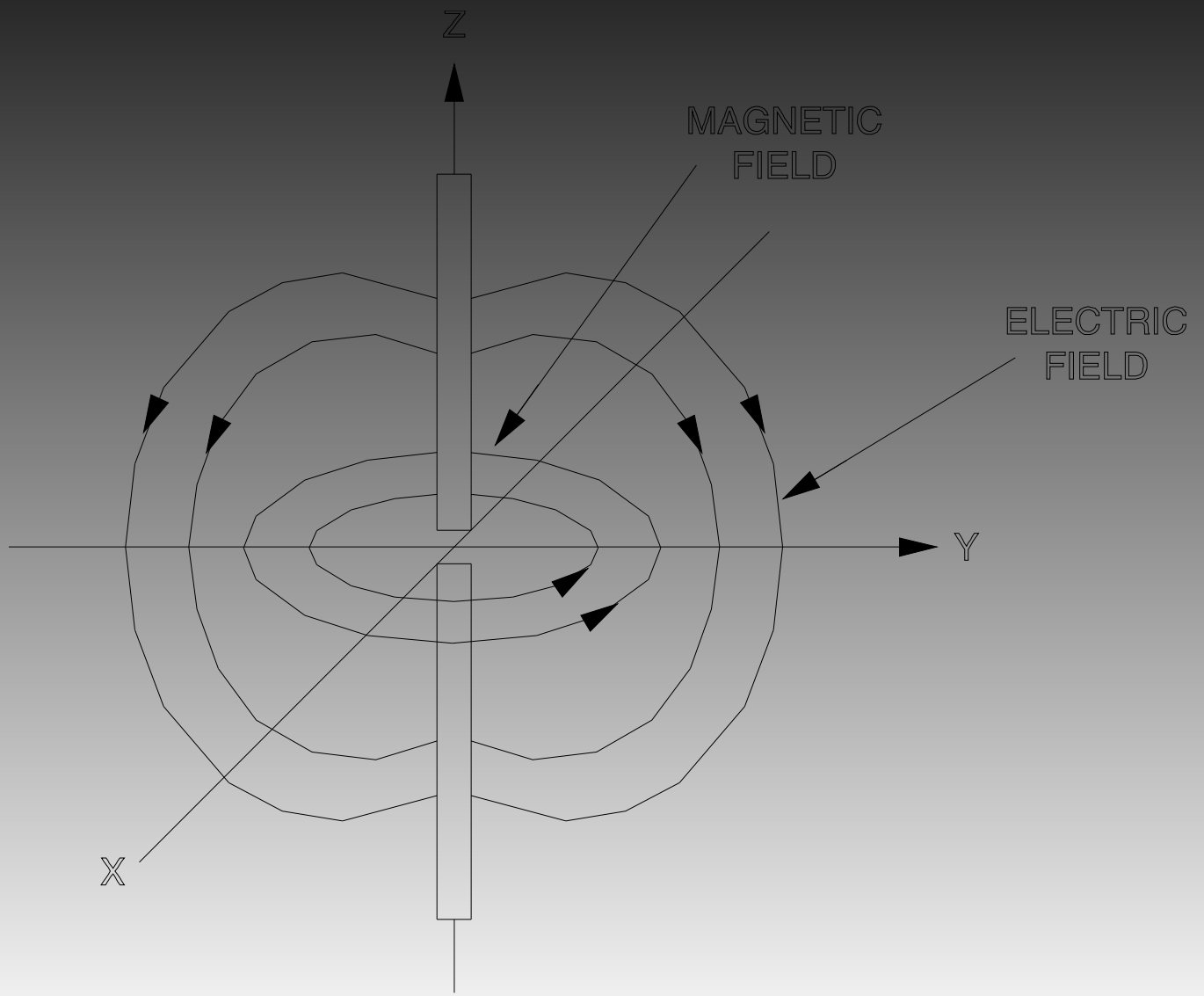
Reciprocity Theorem

- The reception pattern of an antenna is identical to its radiation (transmission) pattern. This is a general rule, known as the reciprocity theorem.



- A complete radiation pattern is three dimensional function.
- a pair of two-dimensional patterns are usually sufficient to characterize the directional properties of an antenna.
- In most cases, the two radiation patterns are measured in planes which are perpendicular to each other.
- A plane parallel to the electric field is chosen as one plane and the plane parallel to the magnetic field as the other. The two planes are called the **E-plane** and the **H-plane**, respectively.

E-plane (y-z or θ) and H-plane (x-y or φ) of a Dipole



Antenna Gain

- Some antennas are highly directional
- ***Directional antenna*** is an antenna, which radiates (or receives) much more power in (or from) some directions than in (or from) others.
- The ratio between the amount of energy propagated in these directions compared to the energy that would be propagated if the antenna were not directional (Isotropic Radiation) is known as its gain.

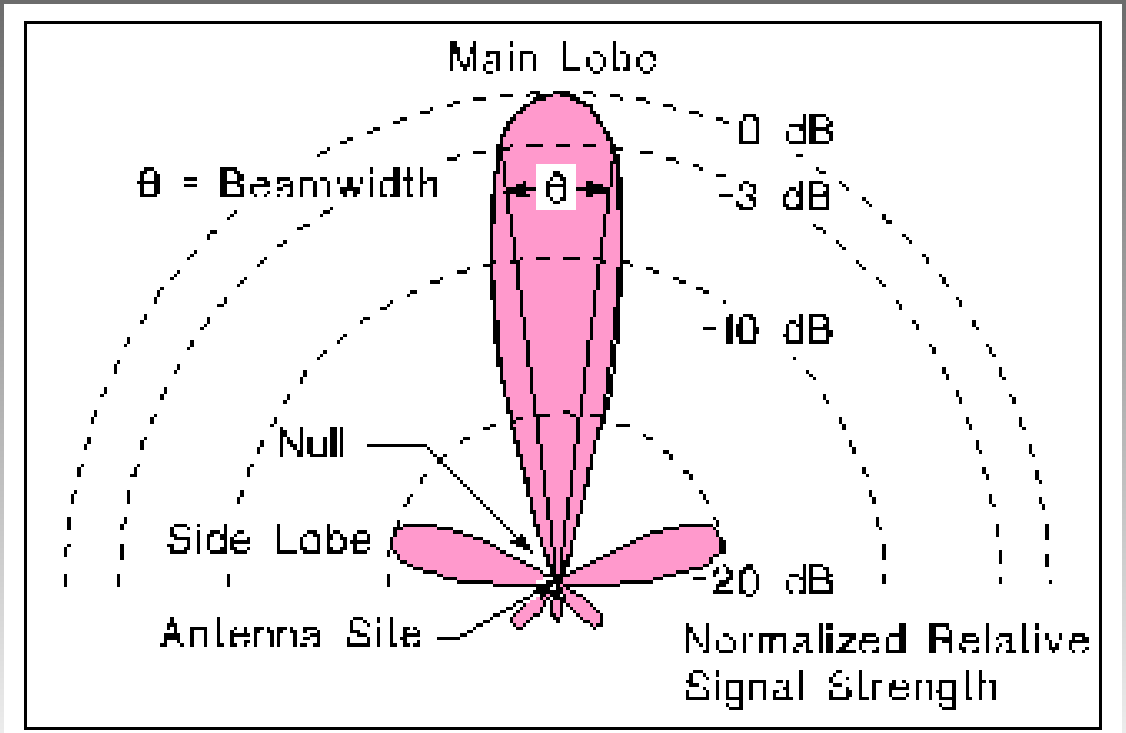
Aperture

- Area of the receiver that captures energy from a passing radio wave.
- Relation between gain and effective aperture is

$$G = \frac{4\pi}{\lambda^2} A_e$$

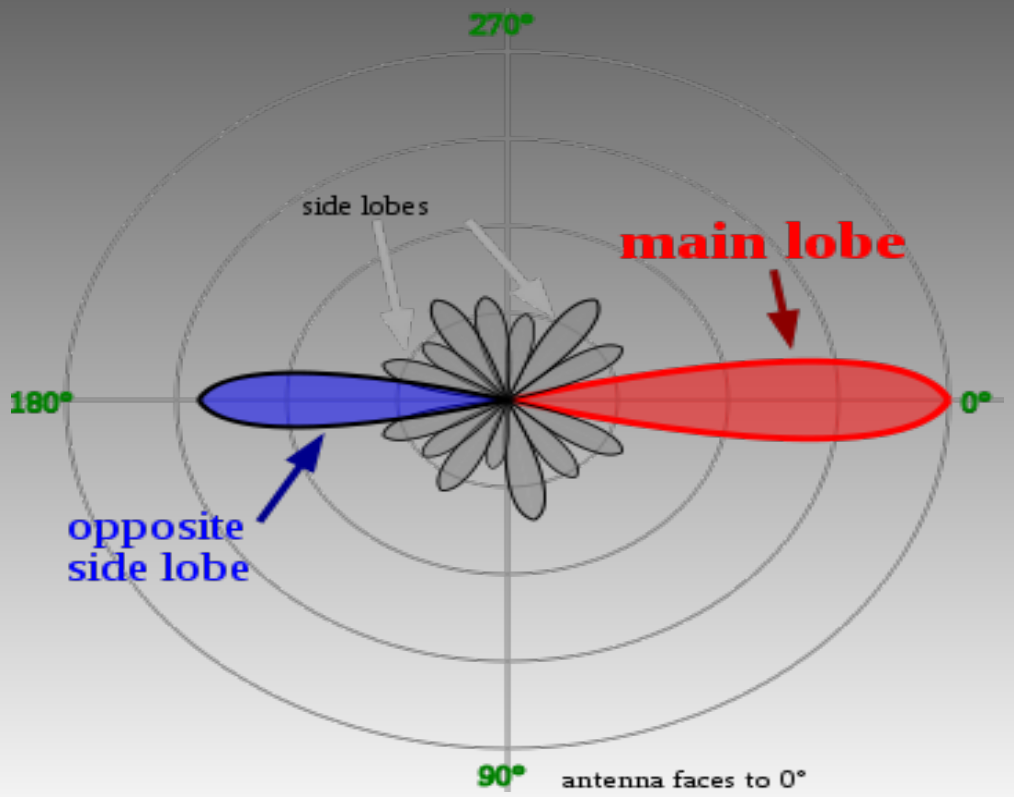
Half Power Beam Width

- It is the angular range in which the antenna at least radiates/receives half of the maximum power.
- It is bordered by points intersecting at -3dB

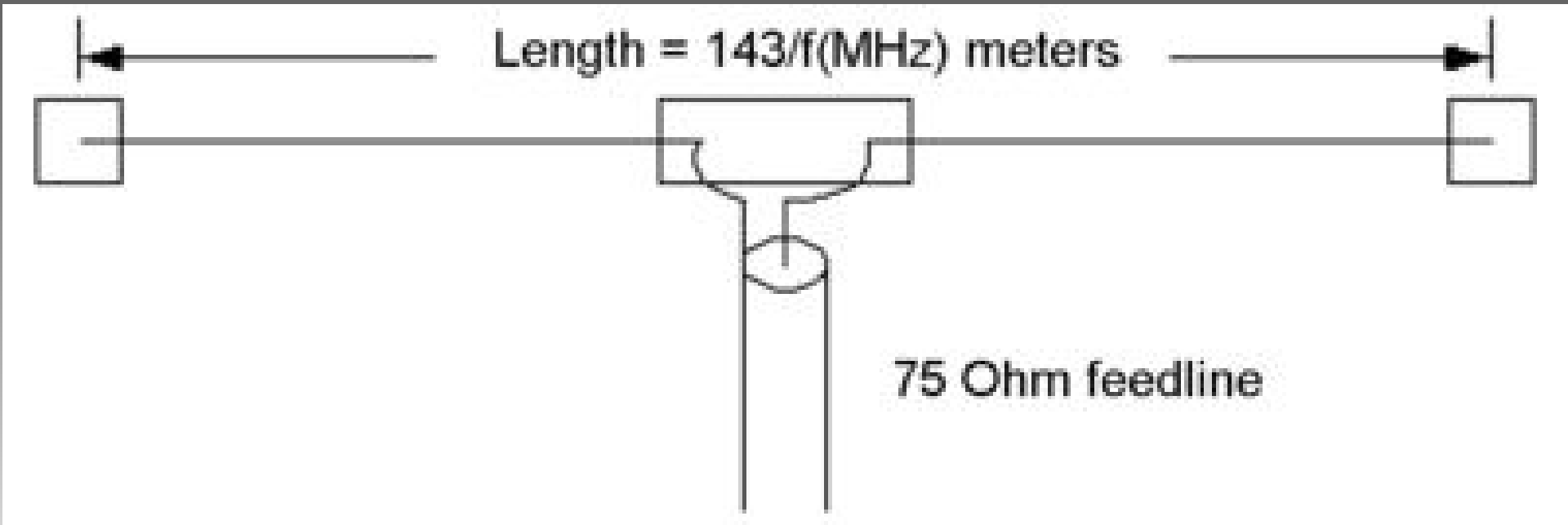


Major and Minor Lobes

- In radiation pattern we observe many lobes. Strongest one is referred as major lobe and other lobes are called minor lobes.



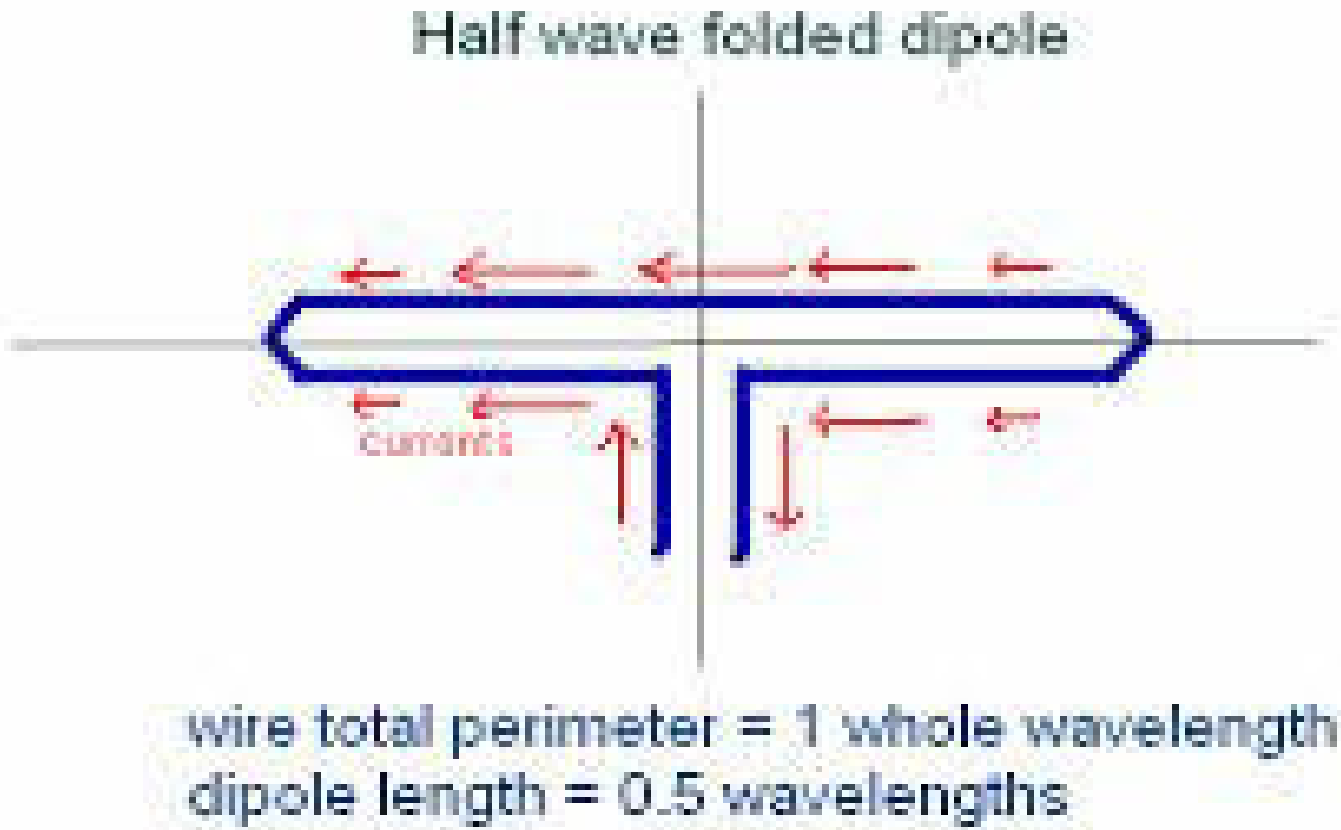
Single Dipole Antenna



Single Dipole Antenna

- The dipole antenna is made of two poles into which radio frequency current flows.
- A dipole is usually an antenna that uses a resonant length of conductor.
- The antenna is an electrical half wavelength, or multiple of half wavelengths.

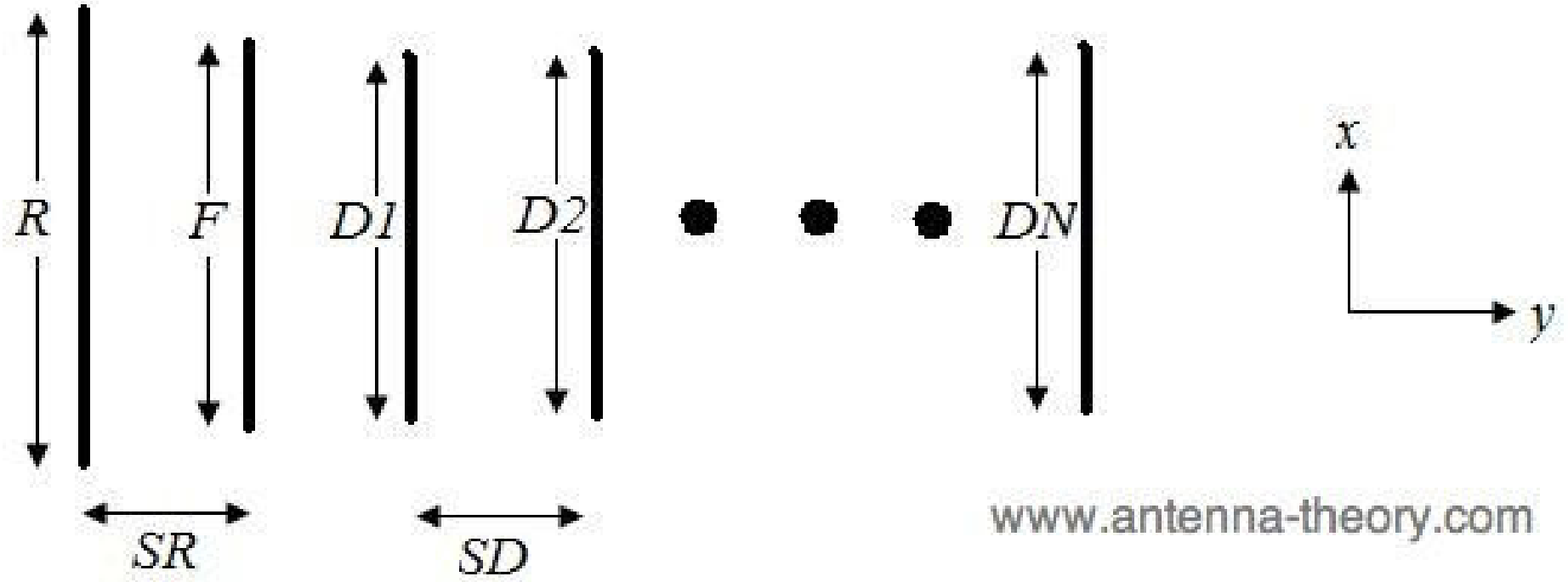
Folded Dipole Antenna



Folded Dipole Antenna

- A folded dipole is a half-wave dipole with an additional wire connecting its two ends.
- The antenna comprises one entire wavelength.
- The resulting far-field emission pattern is nearly identical to the one for the single-wire dipole, however, at resonance its input impedance is four times the radiation resistance of single dipole.

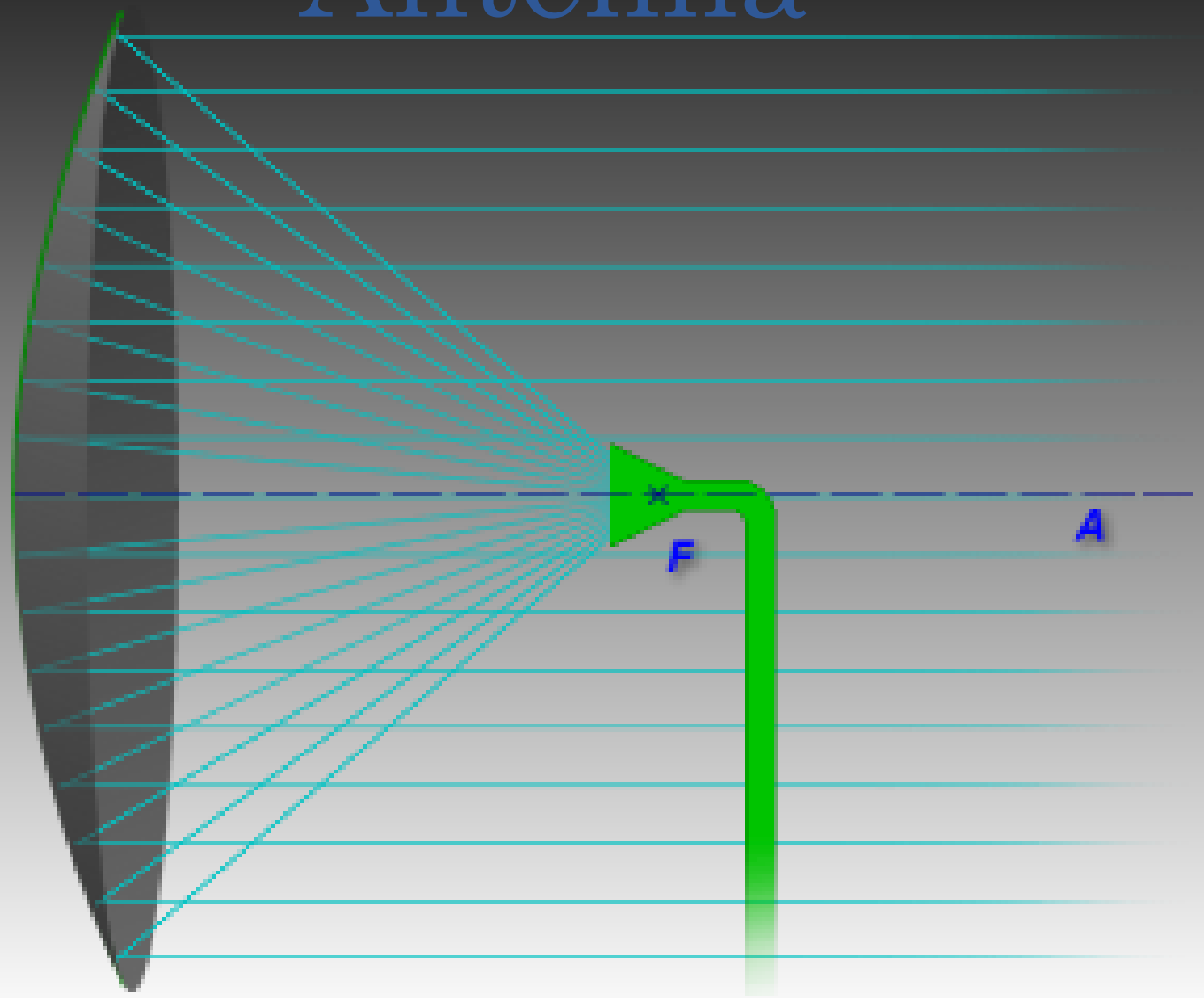
Yagi-Uda Antenna



Yagi-Uda Antenna

- It is a directional antenna consisting of a driven element and an additional *reflector* and one or more *directors*.
- Spacing b/ elements ~ 1/3 of a wavelength.
- The effects of the spacing and the progressive current phase shifts result in the contributions of the current in the various elements to the radiated fields adding up in phase.

Parabolic Reflector Antenna



Parabolic Reflector Antenna

- The theory of operation for parabolic antenna is that a point source of radio waves at the focal point in front of a parabolic reflector will be reflected into a collimated plane wave beam along the axis of the reflector.
- These can have extremely high gain.
- The distribution of the field on the focal plane will be in phase and traveling in the same direction resulting in highly directional radiation pattern

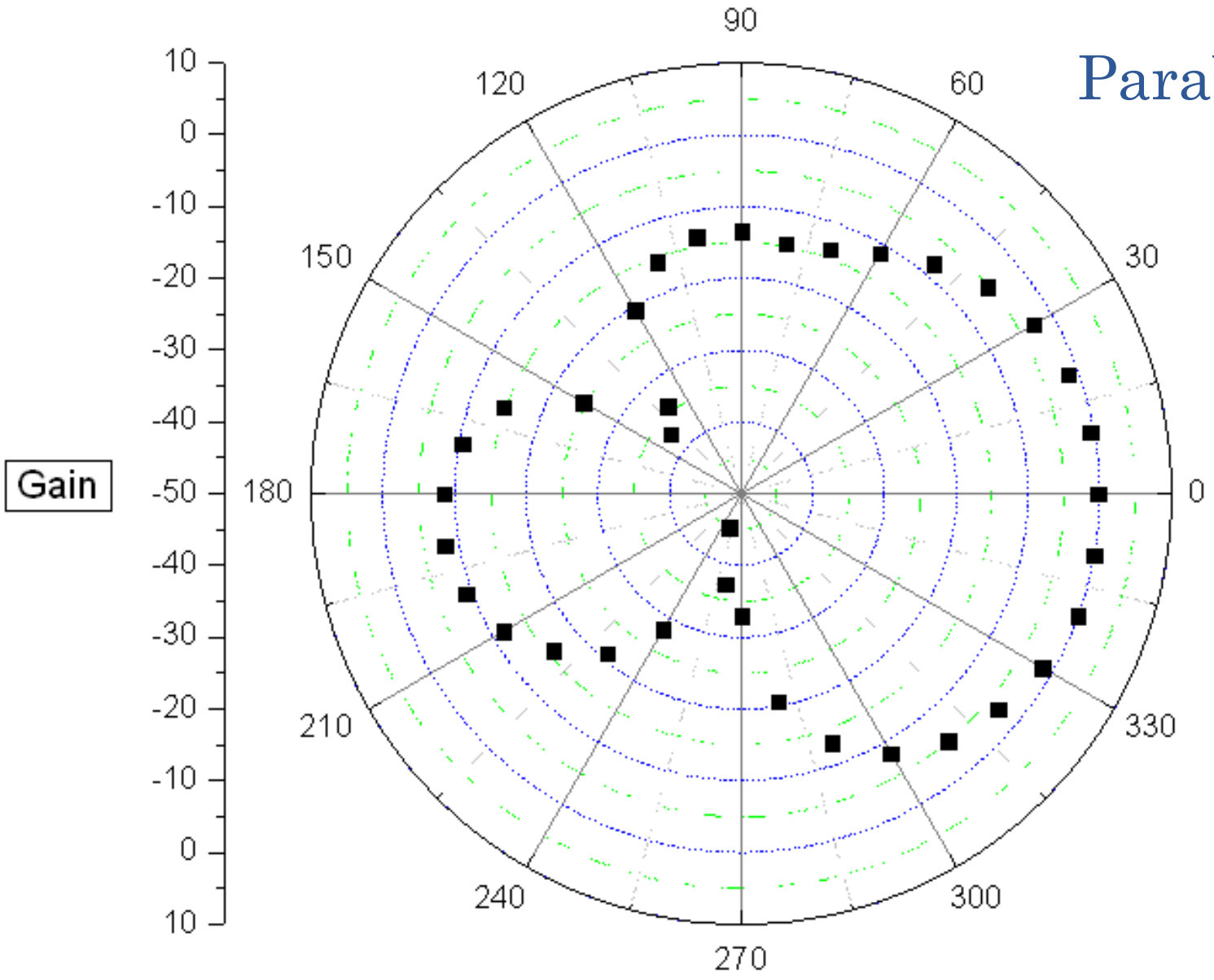
Methodology

- The circuit was set up as indicated in the procedure.
- The receiving and transmitting antennae were placed a distance d apart.
- The current in the multimeter was noted.
- The receiver antenna was rotated w.r.t. the transmitter antenna and the current was noted at different configurations.

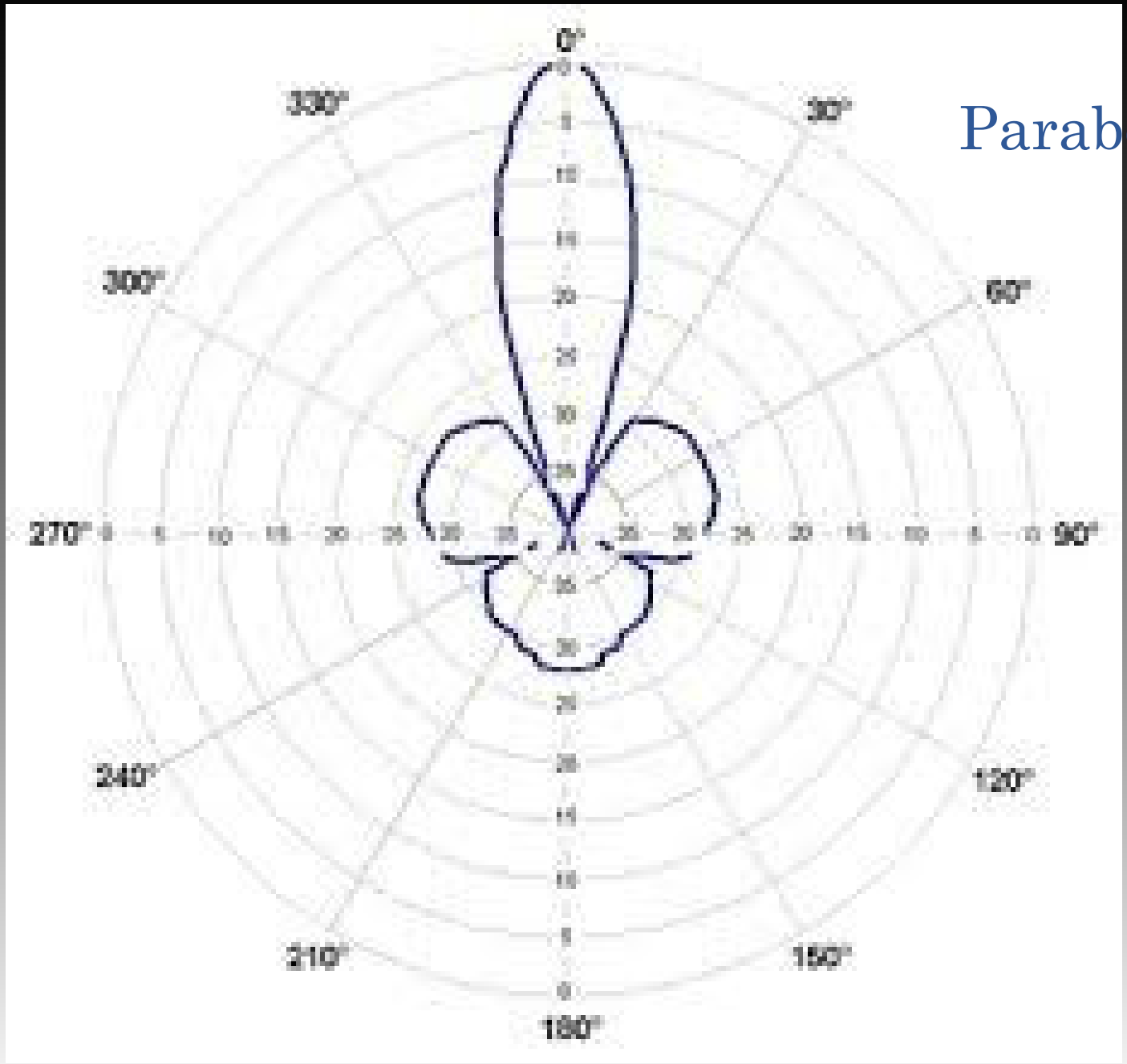
Experimental Conditions

- Distance between transmitter and receiver antenna d = 1.08m
- Receiver antenna : Folded dipole, length = 17.3 cm
- Angular separation between observations = 10 degrees
- Current from RF generator = 76 microAmperes
- Frequency = 668 MHz

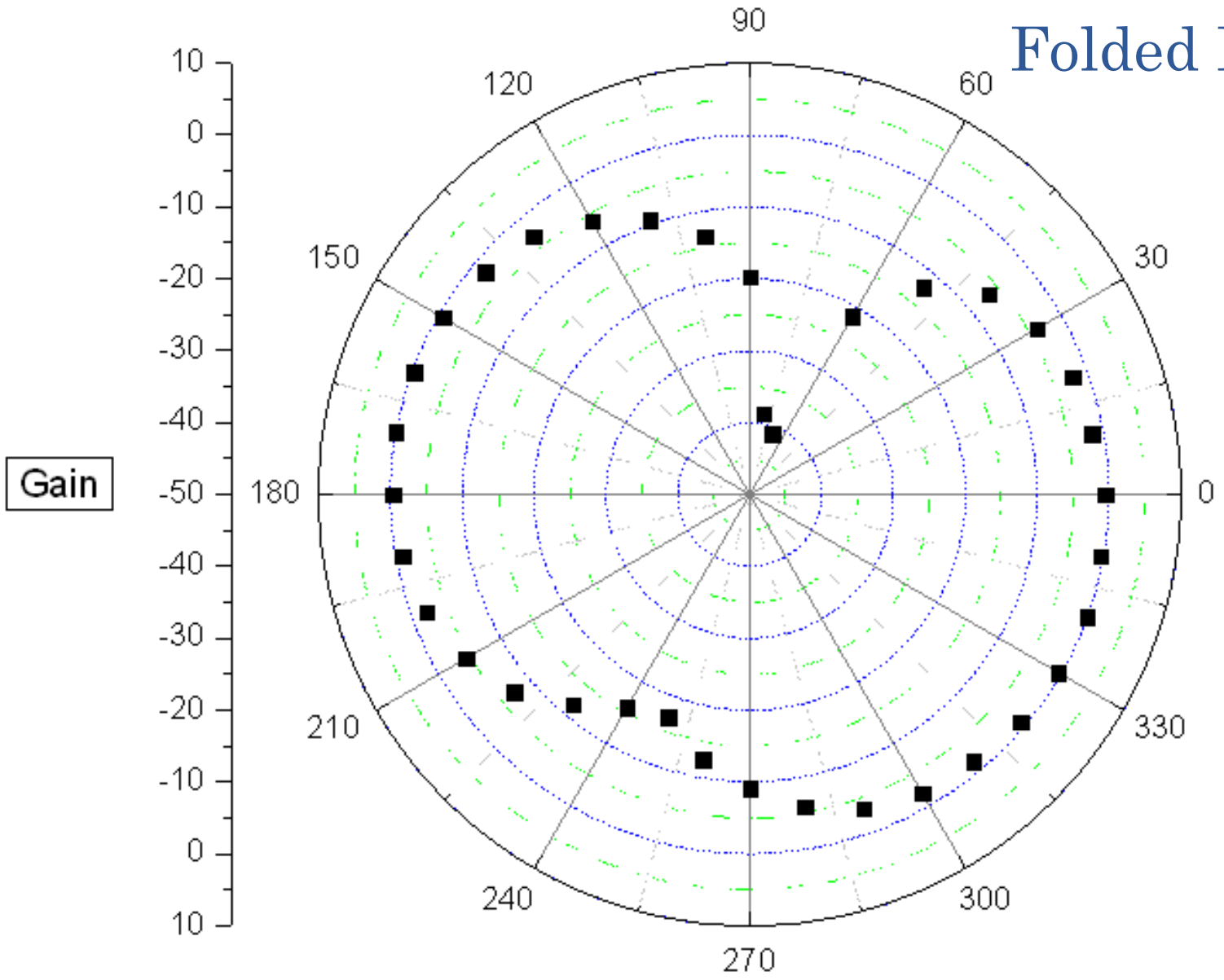
Parabola


Gain
10
0
-10
-20
-30
-40
-50
-40
-30
-20
-10
0
10
90
120
60
150
30
180
0
210
330
240
300
270

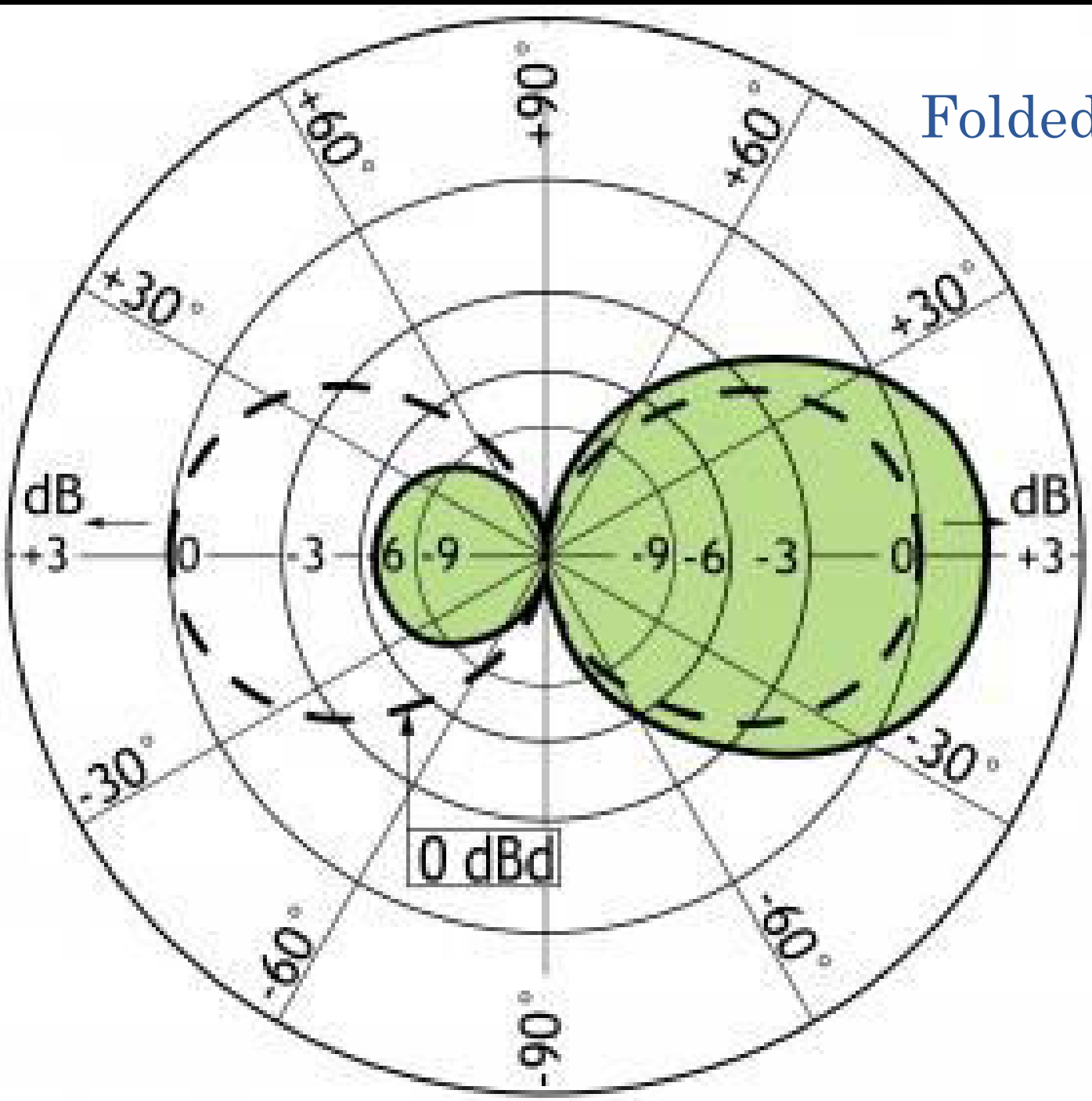
Parabola



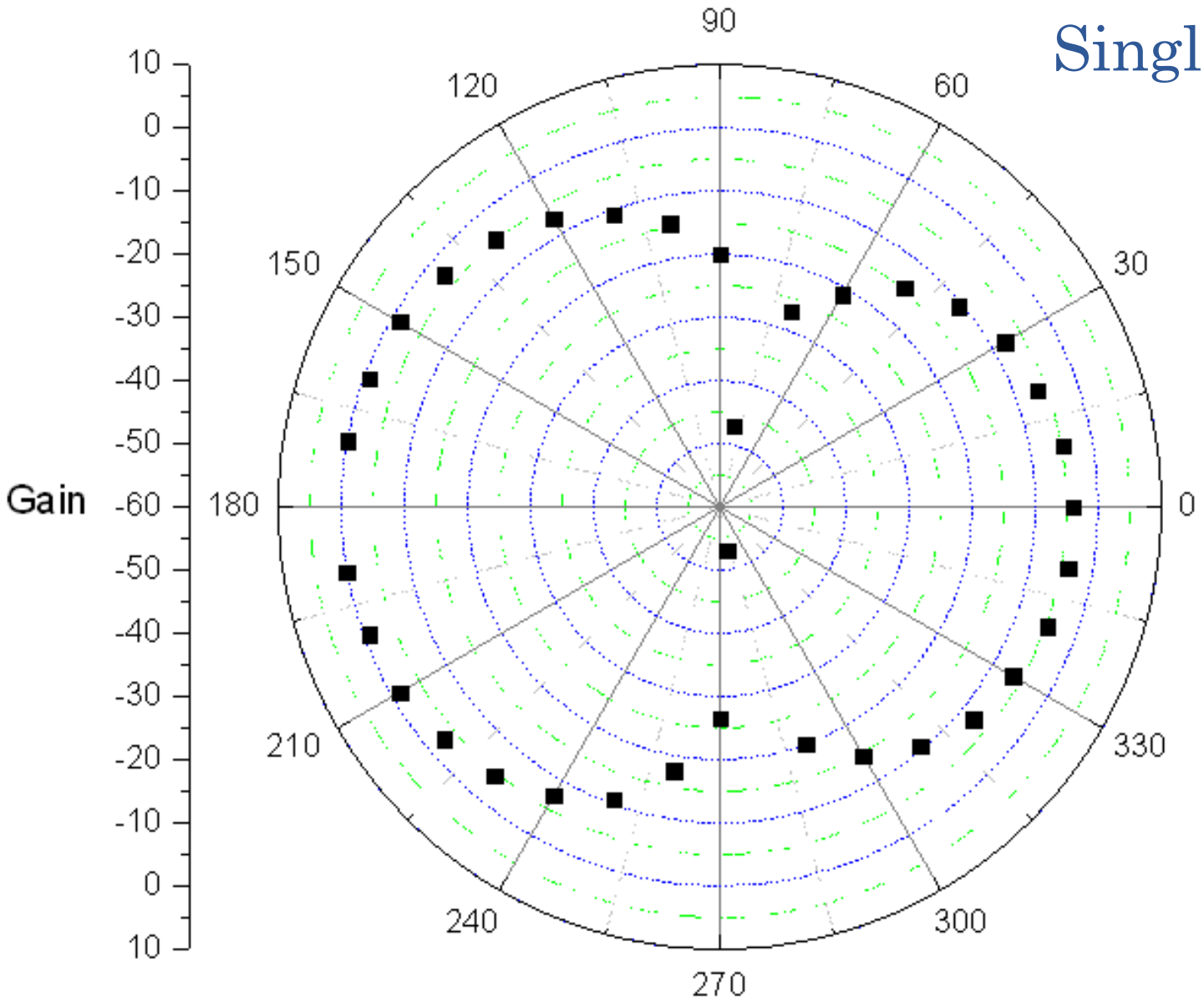
Folded Dipole



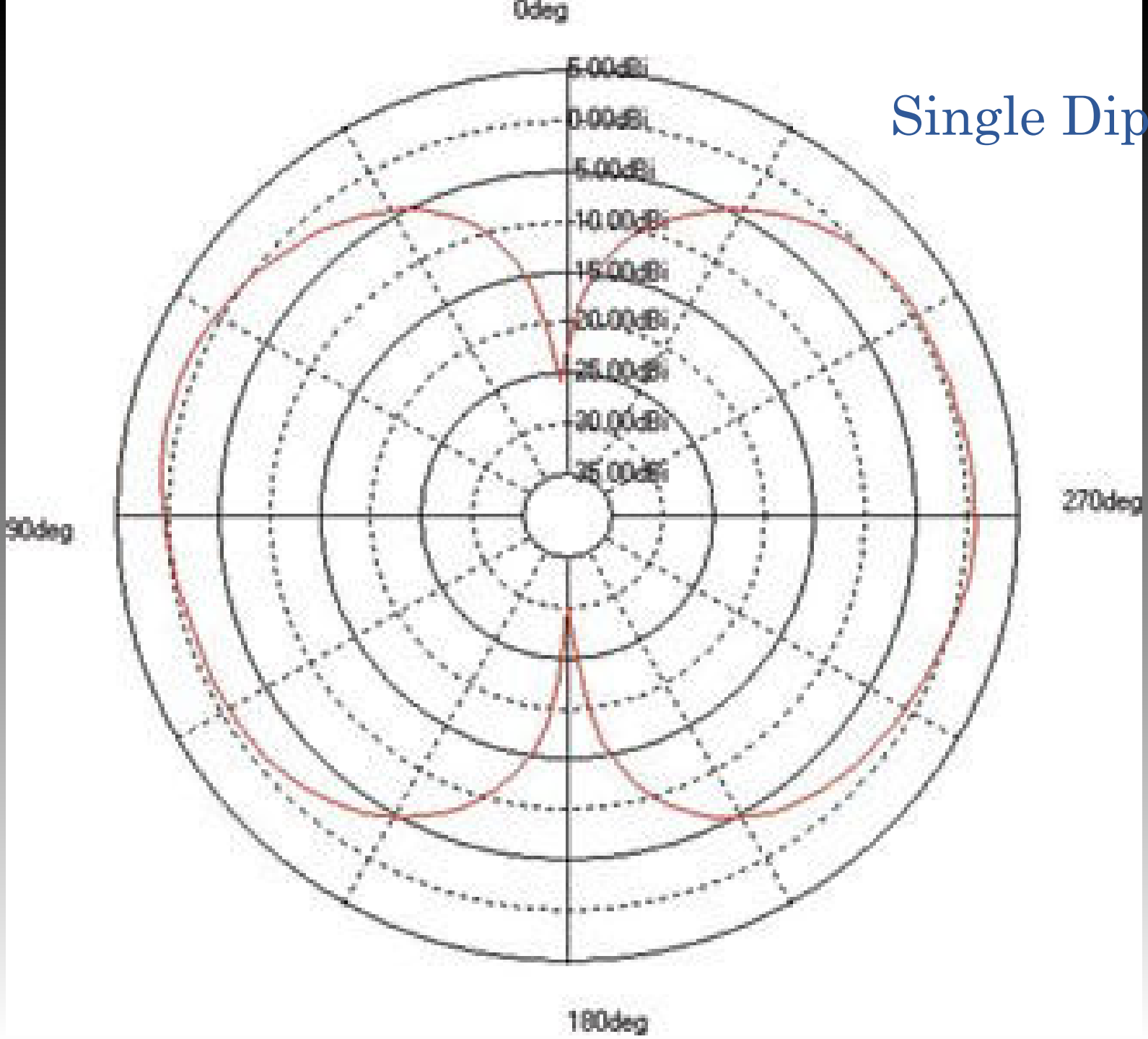
Folded Dipole



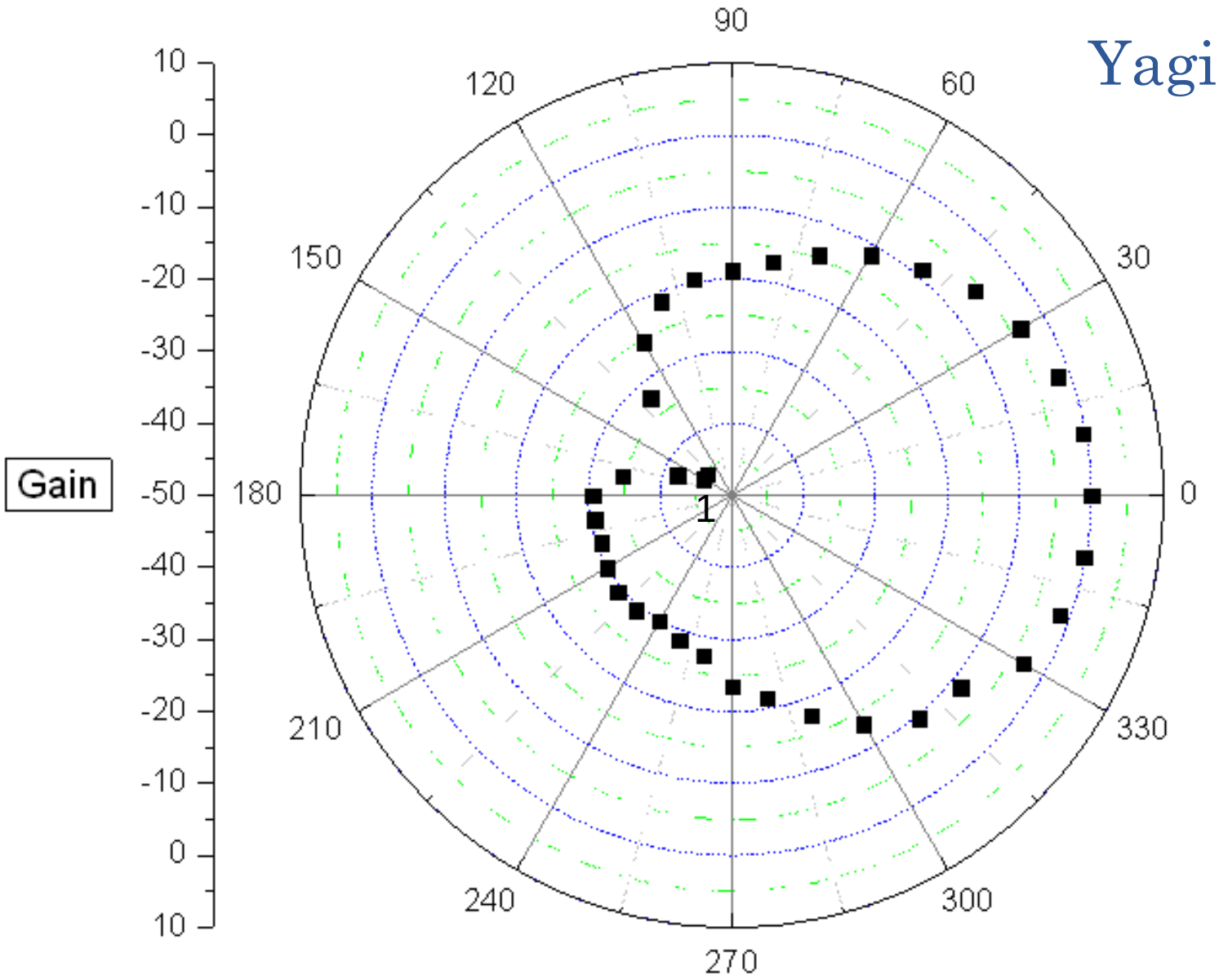
Single Dipole



Single Dipole



Yagi Uda


Gain
90
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60
150
30
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210
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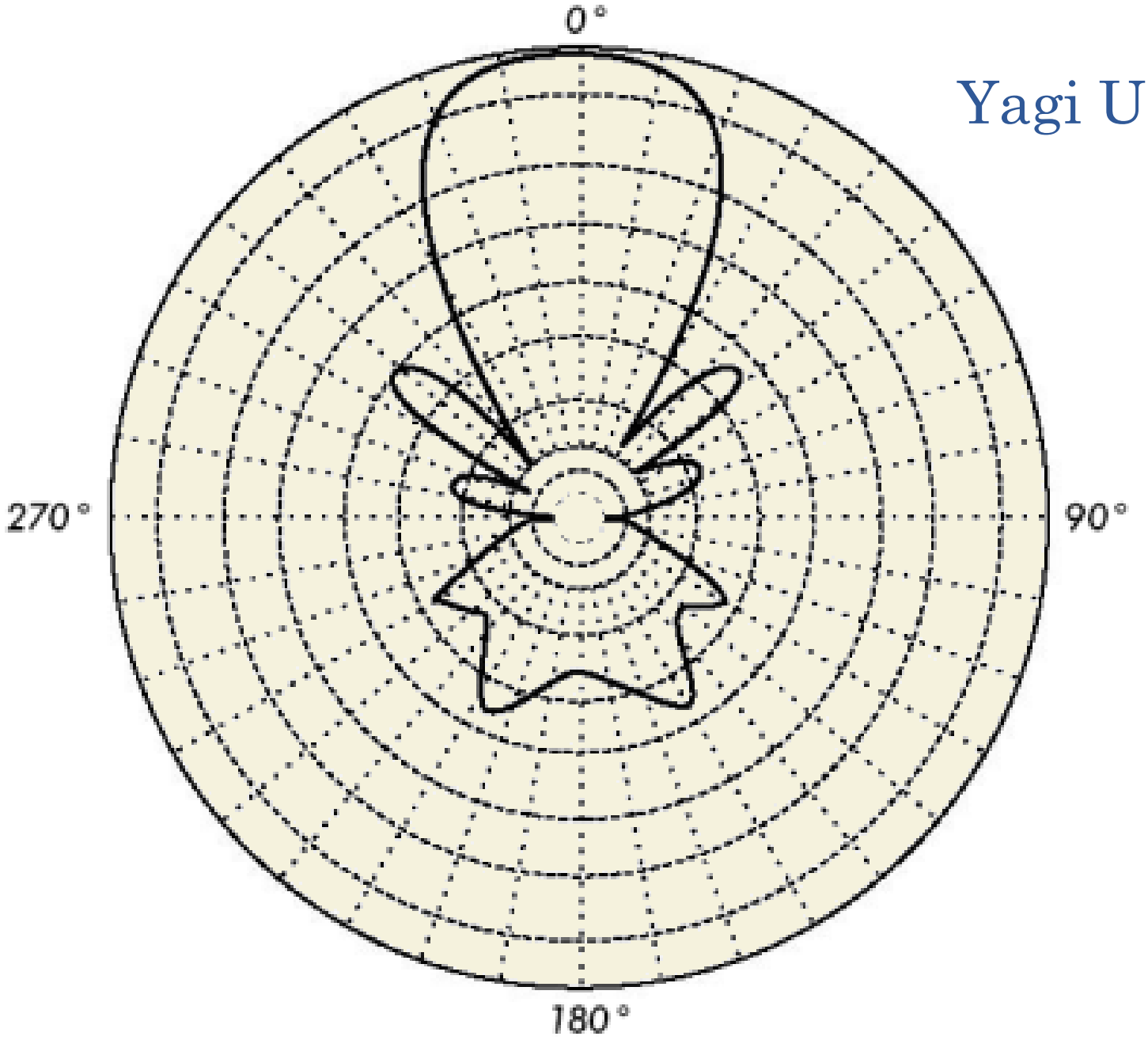
Yagi Uda



Results

Half Power Beam Width (HPBW)

Antenna	Main lobe (degrees)	Back lobe (degrees)	Expected Value (degrees)
Single Dipole	Could not be determined	82.43	80
Folded Dipole	90.35	72.83	56
Parabolic	67.70	NA	1-10
Yagi Uda	56.32	NA	50

Discussions and Sources of Error

- Reflections from walls and other obstacles could have contributed to a greater value of the HPBW.
- The values of current were fluctuating in the multimeter and the lowest observed value was noted to maintain consistency.
- Current could have been increased due to external noise sources like cellphones and human activity.
- The angle measured may have been different as the antenna was unstable on its stand.
- It was difficult to determine if the initial angle was zero.

Further Work

- The experiment could be done in a shielded room to get more reliable results.
- Several other types of antennae could be used as the transmitters and their radiation pattern determined.
- Different types of antennae could similarly be used to check if the radiation pattern depended on the receiver antenna.
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References

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- Low Frequency Radio Astronomy, Third Edition, J. N. Chengalur, Yashwant Gupta, K. S. Dwarkanath
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