IUCAA NCRA

RADIO ASTRONOMY WINTER SCHOOL 2020

CORNER REFLECTOR

NCRA • TIFR

Submitted by

Group 10

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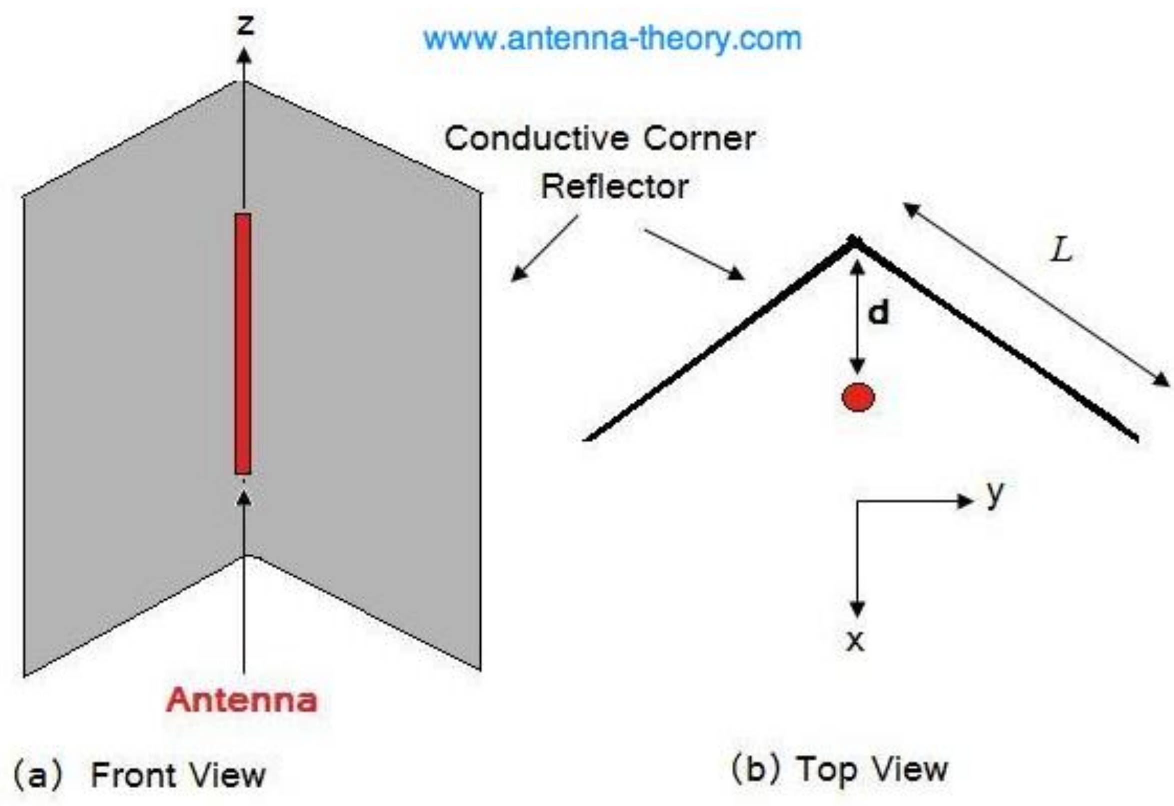
ABSTRACT

This experiment was conducted as a part of Radio Astronomy Winter School (RAWS) 2020 to study and verify the characteristics of corner reflector antenna. A corner reflector antenna is a type of directional antenna used at very high frequencies. Invented in 1938 by John D. Kraus, it consists of a dipole-driven element placed at an angle, roughly 90°, in front of two flat, rectangular reflecting screens to better collimate the energy in the forward direction, to prohibit radiation in the back & side directions. Corner reflectors have a moderate 10-15 dB gain, a high 20-30 dB front-to-back ratio, and a wide bandwidth range.

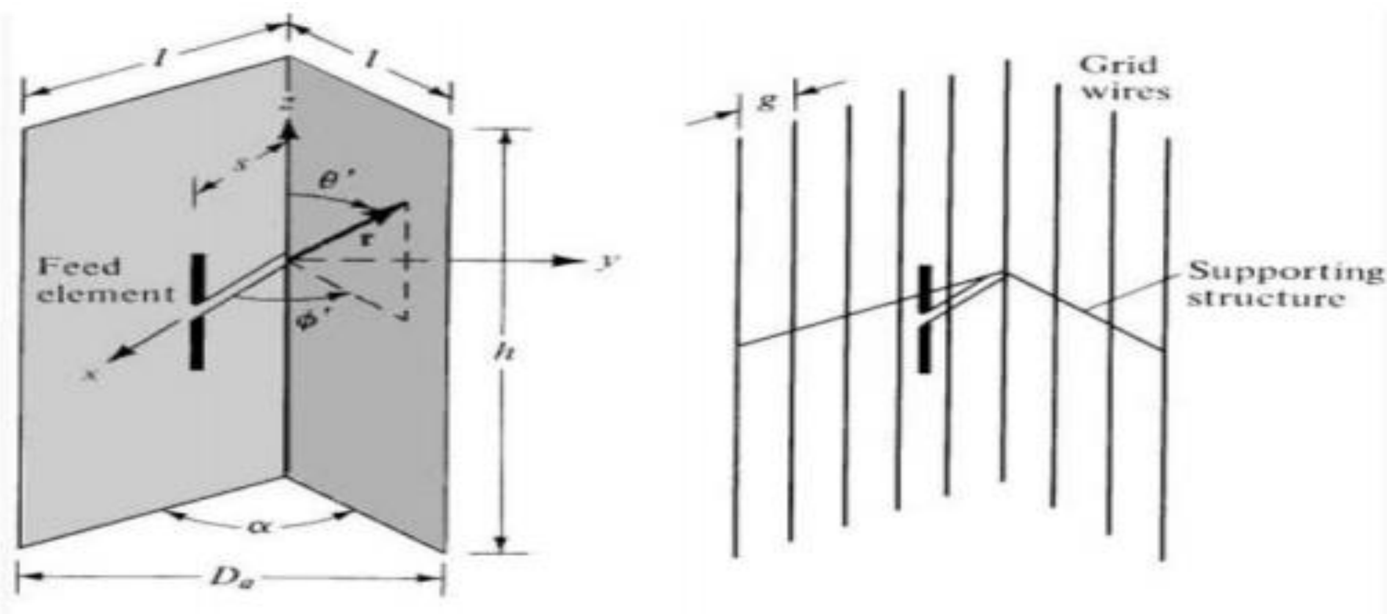
PRINCIPLES INVOLVED

To increase the directivity of an antenna, a fairly intuitive solution is to use a reflector. For example, if we start with a wire antenna (lets say a half-wave dipole antenna), we could place a conductive sheet behind it to direct radiation in the forward direction. To further increase the directivity, a corner reflector may be used, as shown



If the reflector is used as a passive target for radar or communication applications, it will return the signal exactly in the same direction as it received it when its included angle is 90. To maintain the given system efficiency, the spacing between the vertex & the feed element must increase as the included angle of the reflector decreases, & vice-versa.
The radiation pattern of this antenna can be understood by using image theory, and then calculating the result via array theory.

For reflectors with infinite sides(l), the gain increases as the included angle between the planes decreases. Greater Bandwidth is obtained when the feed elements are cylindrical or biconical dipoles instead of thin wires and when wavelength is large compared to tolerable physical dimensions, the surfaces of the corner reflector are frequently made of grid wires rather than solid sheet metal (g<λ/10).



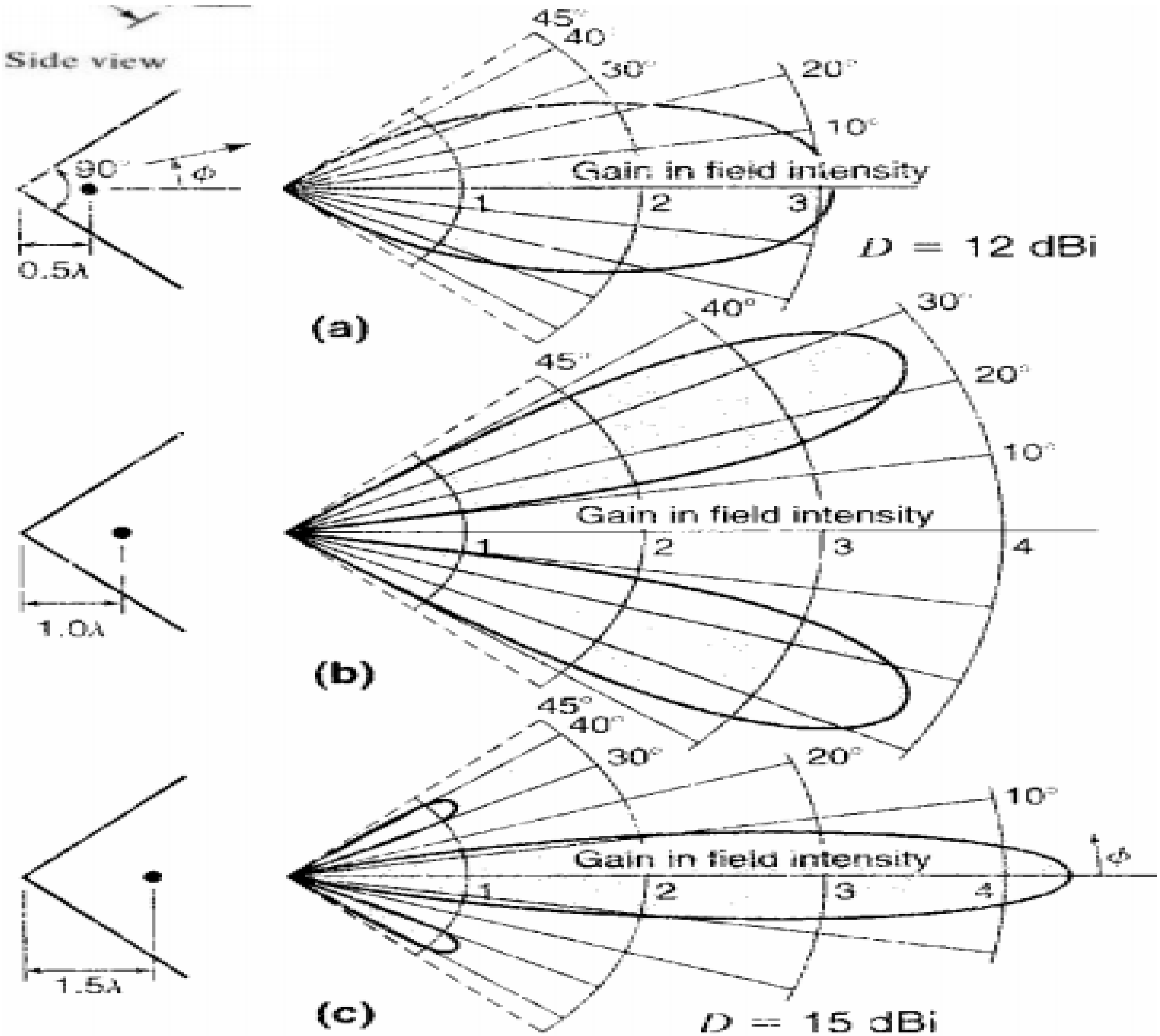
(c) Perspective view (d) Wire–grid arrangement

Typical values of dimensions of corner reflected antenna:

$$\lambda < D_a < 2\lambda$$
$$l \approx 2s(\alpha = 90°)$$
$$l > 2s(\alpha < 90°)$$
$$\lambda/3 < D_a < 2\lambda/3$$
$$h > (1.2 - 1.5)\ x\ length\ of\ feed\ element$$

How radiation resistance varies with spacing?

- If the spacing become too small, the radiation resistance decreases.
- For very large spacing, the system produces undesirable multiple lobes, & loses its directional characteristics.
- increasing the size of the sides does not greatly affect the beamwidth & directivity, but it increases the bandwidth and radiation resistance

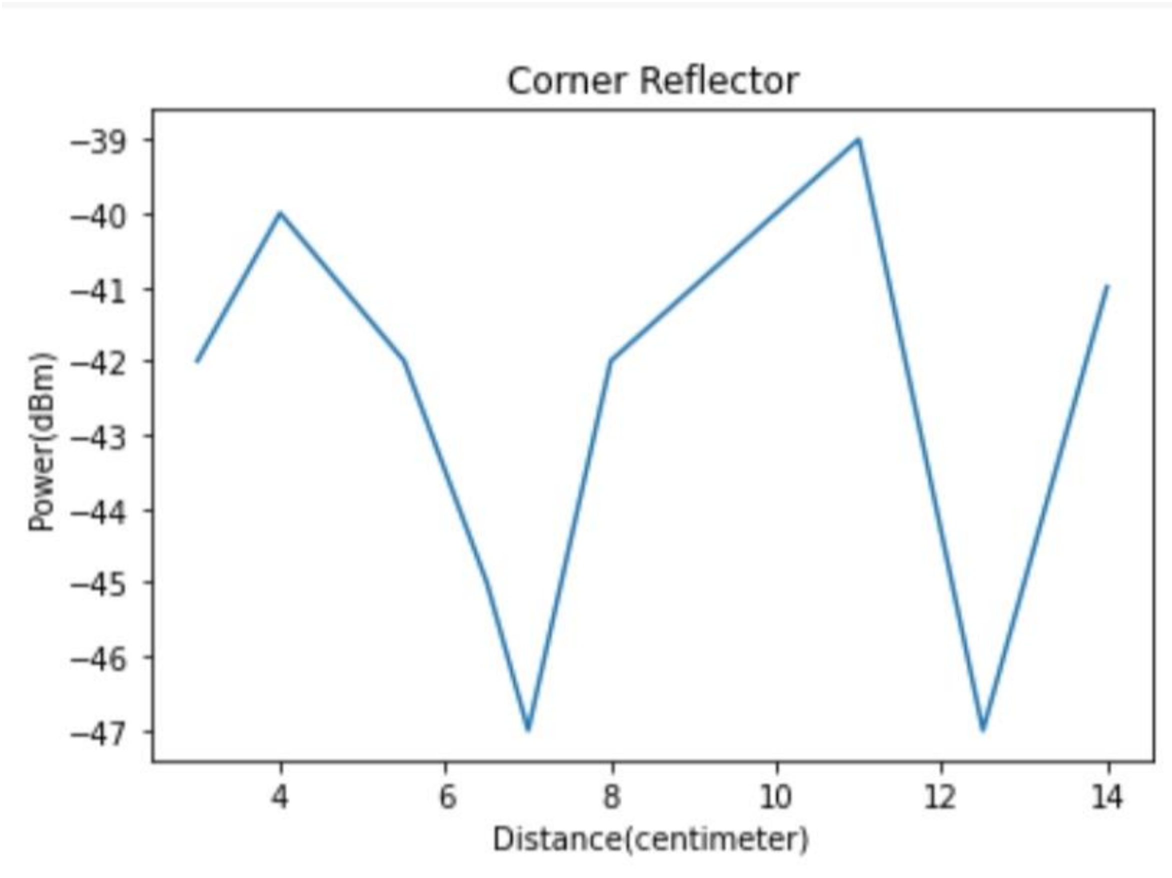


PROCEDURE

- Cut the three 12*12 cm square pieces of cardboard and attached with some glue or solution.
- Cover the inner part of the antenna with aluminium foil (If the antenna is made up of metal plate no need to cover with aluminium).
- Take the reading at open field to avoid the reflections from the wall.
- Take observation without the corner reflector antenna.
- Now keep the corner reflector antenna and transmitter at the centre.
- Take the reading at the receiver end at different angle

RESULTS AND DISCUSSION

The receiver was kept at a fixed distance of 50 cm from the transmitter. The readings of power (in dBm) obtained at the receiver end were noted by varying distances of the transmitter from the reflecting plates of the corner reflector.



We know that for constructive interference

$$\delta = \pm(2n + 1)\frac{\lambda}{4}, where\ n = 0,1,2,3..$$

While for destructive interference

$$\delta = \pm n\frac{\lambda}{2}, where\ n = 0,1,2,3..$$

Where δ is the distance of the transmitter from the back reflector.

In our experiment, a mobile hotspot of frequency 2.4 GHz was used which corresponds to a wavelength of 12.5 cm. As per the theory maxima should come around $\lambda/4 = 3.2$cm but we got a maxima at 4 cm.

Similarly, theoretically a minima should be a $\lambda/2 = 6.25$ cm but in our plot we got minima at 7 cm.

This deviation from the predicted maxima and minima clearly indicates the additional interference caused by the radio waves reflected from the side plate of the corner antenna besides the reflection from the back plate.

Thus, for a corner antenna there is a collective interference of the direct signal from the feed as well as the reflection from two other plates