Study the Fluctuating Dynamics of Radiation patterns generated by communication satellite antennas Parabolic Reflector as a Conformed Case

M. Ayub Khan Younsuf Zai*
Department of Applied Physics and Institute of Planetary Astrophysics, University Of Karachi.

Arshad Hussain*†
Department of Applied Physics, University Of Karachi.

Faisal Ahmed Khan Afridi*†
Department of Applied Physics and Institute of Planetary Astrophysics, University Of Karachi.

ABSTRACT

The signal power is radiated into a substantial angular region of atmosphere by the transmitting antenna and only a small fraction is intercepted by the receiving antenna. The proper knowledge of antennas is essential for the communication scientists to evaluate the performance of a communication system. The satellite communication experts need to be able to launch radio quanta over a very limited range of frequencies and hence quantum energies. In some cases they wish to launch the quanta particularly in a certain direction, towards a known location where they are to be received. They do all these things by means of a structure called an antenna.

Antennas are devices used either for the emission or for the reception of radio quanta. An emitting antenna is a device supplied by an electric power generated at a certain frequency and radiation of waves in space. According to several different physical mechanisms observed for the propagation of radio waves that are given below: free space propagation or line of sight propagation, reflection, transmission, diffraction, scattering and wave guiding.

In this communication the types of satellite antennas for emitting and receiving power have been discussed that depend on their intended use as well as on the frequency and they include (i) Horn antennas (ii) paraboloid reflector etc. Some parametric characteristics such as (i) radiation pattern, (ii) the power gain, (iii) the directivity, (iv) the beam width, (v) the aperture, (vi) the polarization, (v) their impedance with their model equations are also mentioned. The modeling of beam widths with aperture ratio effects and fluctuations have been illustrated.

INSPEC Classification : A9555L, A9630, B5270

Keywords : Satellite antennas, satellite communication, coherent properties, quantum energies, parametric characteristics, aperture ratio effects

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* M. Ayub Khan Younsuf Zai
† Arshad Hussain
† Faisal Ahmed Khan Afridi

IBCT is published by the Institute of Business and Technology (IBT), Ibrahem Hydi Road, Korangi Creek, Karachi-75190, Pakistan.
3. Terms and conditions of antenna

According to the effectiveness of the antenna resistance, degree of concentrating the radiation and their polarization, there are important terms used in connection with antennas and their radiation patterns:

(a) Antenna Gain: It has been observed that all antennas concentrate their radiation in some direction to a greater or lesser extent. The power density in that direction must be greater if the antennas are omni directional.

(b) Maximum directive gain in directivity. The power radiated by an isotropic antenna to develop a certain field strength at a certain distance is divided by a practical power to yield a ratio. Power is fed to the directive antenna to develop the same field strength at the same distance. The only difference is seen for directivity the radiated power is considered for directive antenna whereas for power gain the [power is fed to the antenna is taken]. Therefore, the two terms are identical except that power gain takes into account the antenna losses. This may be given as

\[
\text{Power gain} = D \times (\text{efficiency of Antenna} = 1 \text{ for lossless antenna})
\]

Where

\[
D = \text{directivity (maximum directive gain)}
\]

The two are almost equal for VHF and UHF antennas. Power gain has some importance.

(c) Radiation Resistance: It is the ratio of power radiated by the antenna to the square of the current at the feed point.

(d) Bandwidth, beam width and polarization:

Bandwidth has the same concept and it refers to the frequency range over which operation is satisfactory and generally taken between the half power points. The criterion of "satisfactory performance" Bandwidth of an antenna is the angular separation between the two half power points on the power density radiation pattern and quoted in degrees.

The angular separation between the two 3-dB down points on the field strength radiation pattern of an antenna. Polarization refers to the direction in space of the electric vector of the electromagnetic wave radiated from an antenna and is parallel to the antenna itself.

Antennas are referred as vertically or horizontally polarized. All VLF.

LF and MF antennas are made vertically polarized because of the proximity of the ground.

Selection of feed point: Voltage and current feed. Feed-point impedance.

Directly fed antennas

Directional High frequency antennas: Dipole Array, Parasitic elements include driven element, reflector acts as concave mirror, and a parasitic element shorter than the driven one from which the energy tends to increase radiation in its own direction and behaves like convergent convex lens called a director.

In this communication we present the fluctuating dynamics of parabolic antenna.

As we know that the parabola is a plane curve defined as the locus of a point that moves so that its distance from another point called focus plus its distance from a straight line called directrix. All these geometric characteristics yield an excellent microwave or light reflector. The reflector provides a high gain because, like the mirror of a reflecting telescope, it collects from a large area and concentrates it at the focal point (3-4).

4. Parabolic Reflectors

A number of factors, that determine parabolic reflector antenna radiation patterns but the most important ones are the radiation pattern of the feed antenna and the shape of the reflector. Parabolic reflectors have the exceptional characteristic that all path lengths from the focal point to the reflector and on to the aperture plane are the same. As shown in Figure 4.

\[
FP+PA = o + pcos0' = p(1 + cos0') = 2f
\]

Since the parabola is described in polar form by,

![Figure 4. Geometry of Paraboloid Reflector.](image-url)
General structures with directive gain of and effective areas of different antennas are given below that are useful in determining the important features of antennas. In table 1, it has been given:

**Table 1. Antenna Structures with directive gain and effective areas**

<table>
<thead>
<tr>
<th>Antenna</th>
<th>Dimension</th>
<th>Directive Gain</th>
<th>Effective area (A) compared to Physical Area (A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Half Wave Dipole</td>
<td>$\delta/2$</td>
<td>$D = 1.6$</td>
<td>$A_e = 0.03/\varepsilon^2$</td>
</tr>
<tr>
<td>Horn Antenna</td>
<td>a x b</td>
<td>$D = 10 , ab/\varepsilon^2$</td>
<td>$D = 0.8A_p$</td>
</tr>
<tr>
<td>Parabolic Reflector</td>
<td>$D = 70, r^2/\varepsilon^2$</td>
<td>$A_e = 0.6 , A_p$</td>
<td></td>
</tr>
<tr>
<td>Rectangular array</td>
<td>axb/a</td>
<td>$D = 70ab/\varepsilon^2$</td>
<td>$A_e = A_p$</td>
</tr>
</tbody>
</table>

5. Paraboloid Reflector and Computation of Beam width for deep space reflector

The directional pattern of an antenna using paraboloid reflector as shown in figure 5 has very sharp main lobe, surrounded by a number of minor lobes that are much smaller. The 3-D shape of the main lobe is like a fat cigar in the direction AB. If primary or feed antenna is non-directional then the paraboloid will produce a beam of radiation whose width is given by, where $D =$ mouth diameter and

\[
\psi = \frac{72 \lambda}{D} \quad (1)
\]

\[
\phi_e = 2\psi \quad (2)
\]

where $\lambda =$ wavelength, in meters
\(\psi = \text{beamwidth between half-power points, in degrees}\)
\(\phi_e = \text{beamwidth between nulls, in degrees}\)
\(D = \text{mouth diameter of the paraboloid antenna in meters}\)

6. Results and Discussions

We have computed the beam width in the UHF and Microwave ranges and do stochastic modeling to attain model 1 equation. This equation can be used to model fluctuating dynamics of deep space paraboloid reflector. Figure 6 illustrates radiation patterns of Parabolic Reflectors or for Microwave ranges of frequencies(500 MHz-30 GHz). In this figure beam widths are manifested for different elevation angles. We have computed this beamwidth from the following model equation:

\[
Y_r = 19.27 - 1.12152 * t \quad (3)
\]

**Figure 5. Display of a Deep space Paraboloid Reflector**

**Figure 8. Radiation Patterns of Parabolic Reflector or microwave dish**
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Figure 7. Variation of Beam width with Frequency in Parabolic Reflector in Deep Space

Figure 8. Model residual illustrations

Figure 9. Trend analysis for beam width variations

7. Conclusions

The concept of an antenna is limiting factor in all communication systems. In this presentation developed complex antennas for satellites have been discussed. They provide multiple beams and orthogonal polarization from a single antenna. Reflector antennas with clustered feeds are also presented with their radiated patterns. We have also computed beam widths for parabolic reflector at UHF and Microwave frequencies. In this communication the Dynamics of Radiation patterns has been introduced along with the Radio Wave propagation mechanism. Radiation mechanism of antenna and Mode of Propagation have been discussed. Terms and conditions for Satellite Antennas with UHF and Microwave...
ranges its radiation patterns with parabolic reflector as a special case and its radiation patterns have been explained. Computation and modeling of beam width for deep space Paraboloid Reflector is also the topic of great interest in this communication for considering reliability as an important issue in satellites.

Acknowledgement:

I would like to thank the organizers of 4th International Conference on IT Challenges in next five years for Pakistan at the Institute of Business and Technology (BIZTEK), Karachi, Pakistan, December 7th, 2013 to provide me opportunity to present this piece of information before the eminent scientists as an invited speaker.

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