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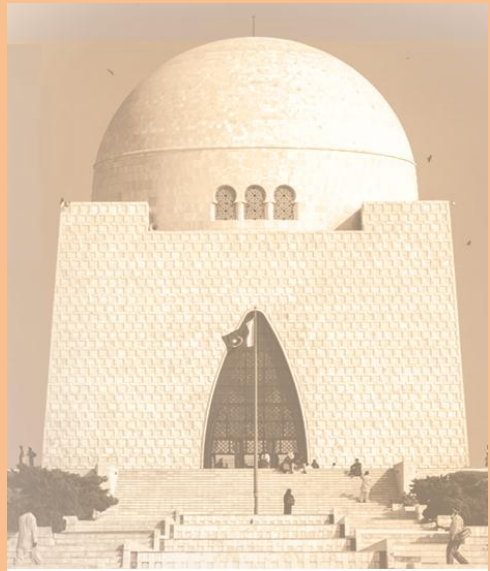
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**Dr. Munir Ahmad
Editor**

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MODELING COMPUTED BEAM WIDTH FLUCTUATIONS OF PARABOLIC ANTENNA OF COMMUNICATION SATELLITES

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ABSTRACT

A power radiating signal element acts as a transducer converting the electrical waveform from a generator to an electromagnetic wave for transmission. This structure is known as antenna. At the receiving end the antenna performs the inverse function that it alters the arriving electromagnetic waves in to an electrical waveform. It has been resulted that antenna is a reciprocal device. The satellite communication experts need to be able to launch radio quanta that by disparity, have well specified coherent properties.

According to several different physical mechanisms we have observed the propagation of radio waves such as (i) free space propagation or line of sight propagation, (ii) reflection, (iii) refraction or transmission, (iv) diffraction, (v) scattering and (vi) wave guiding.

In this communication parametric characteristics such as (i) radiation patterns, (ii) the power gain, (iii) the directivity, (iv) the beam width, (v) the aperture, (vi) the polarization, (v) their impedance with their model equations. Finally the implementation of antenna arrays gain by concentrating their emission of quanta towards particular directions. The modeling of beam widths with aperture ratio of Parabolic Reflectors for microwave ranges of frequencies (500M Hz-30 G Hz) and fluctuations in the beam width for different frequencies will be illustrated. Modeling of the beam widths will illustrate

1. INTRODUCTION

A radio (or wireless) antenna is termed as the structure that has been associated with region of transition between a guided wave and a free space wave or vice versa. The first radio antenna was constructed by Heinrich Hertz, a professor at Technical Institute in Karlsruhe, Germany in 1886, he assembled apparatus as described a complete radio system operating at meter wavelengths with an end-loaded dipole as the transmitting antenna and a resonant square-loop antenna as receiver. He also experimented with a parabolic reflector antenna. The Figure 1 depicts a schematic of an antenna system. Antennas are the essential communication link for aircraft and ships. These are the devices that link us with all cellular phones and all types of wireless.

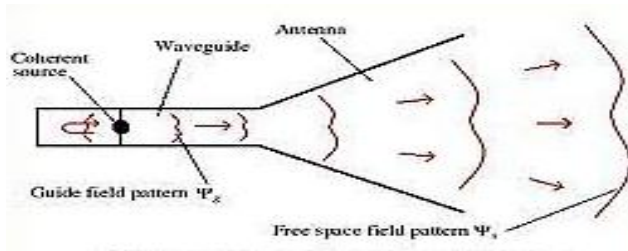


Fig. 1: Schematic of An Antenna System

In the above Figure, generator with a transmission line, tapered transition and E fields have been shown. The free space wave radiating in three dimensions A guided TEM (Transverse Electric and Magnetic Mode) connecting transition region. In the Figure 2.a communication link with transmitting antenna and receiving antenna that is remote from the transmitting antenna so that the spherical wave radiated by the transmitting antenna arrives as an essentially plane waves at the receiving end. We have observed the propagation of radio waves.

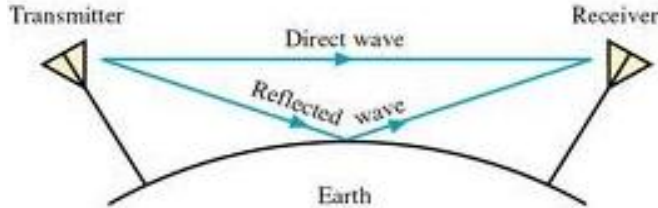


Fig. 2: Mechanisms of Transmission and Reception of Radio Wave Propagation

2. TERMS AND CONDITIONS FOR ANTENNAS

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) **Directive gain:** This is termed as the ratio of the power density radiated in the particular direction by the antenna to the power density that would be radiated by an isotropic antenna. Both power densities are measured at the same distance and both antennas radiate total power. It is also considered as power ratio. The directive gain of all practical antennas is greater than unity.
- c) **Directivity and Power gain:** Maximum directive gain is directivity i.e. the gain in the direction of the major lobes of radiation pattern.
- d) **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. In the present study UHF also considered for microwave reception and transmission.

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 [1-3].

3. REFLECTOR-TYPE ANTENNAS OR PARABOLIC REFLECTORS

A parabola having symmetry about the z – axis is sketched in Figure 3. A characteristic of parabola is that called its focus length of a path $FP+PA$ to a point on the line AF is constant regardless of where point A is taken on the parabola. This equal length is true any line AF that is parallel to the y -axis. 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 3.

$$\begin{aligned} FP + PA &= p + p \cos \theta' \\ &= p(1 + \cos \theta') \\ &= 2f, \\ p(1 + \cos \theta') &= 2f \end{aligned}$$

Since the parabola is described in polar form by,

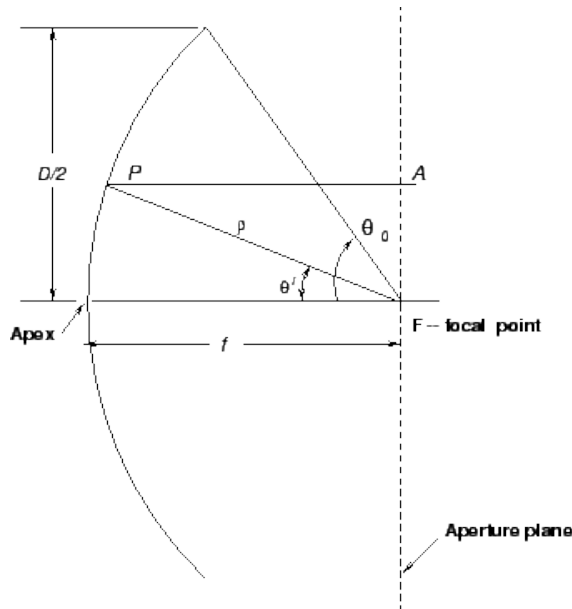


Fig. 3: Geometry of Parabolic Reflector

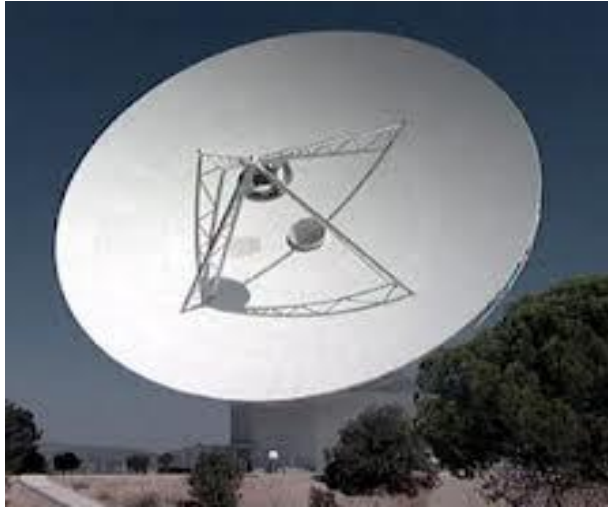


Fig. 4: A view of Deep Space Parabolic Dish Antenna

4. COMPUTATION OF BEAM WIDTH FOR PARABOLIC REFLECTOR DEEP SPACE SATELLITE ANTENNA

A deep space parabolic dish antenna is depicted in Figure 4. The directional patterns of the antenna using parabolic antenna reflector as shown in Figure 5 has very sharp main lobe, surrounded by a number of minor lobe 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

$$\varphi = \frac{70\lambda}{D} \quad (1)$$

$$\varphi_o = 2\varphi \quad (2)$$

where λ = wavelength, in meters

φ = beamwidth between half-power points, in degrees

φ_o = beamwidth between nulls. In degrees

D = mouth diameter of the parabolic antenna in meters
= 2 meters in this case

5. RESULTS AND DISCUSSIONS

We have computed the beam width in the UHF and Microwave ranges and do stochastic modeling to obtain mode 1 equation. This equation can be used to model fluctuating dynamics of deep space paraboloid reflector. Figure 5 illustrates radiation patterns of Parabolic Reflectors or for Microwave ranges of frequencies (500M Hz-30 G Hz) [4-5].

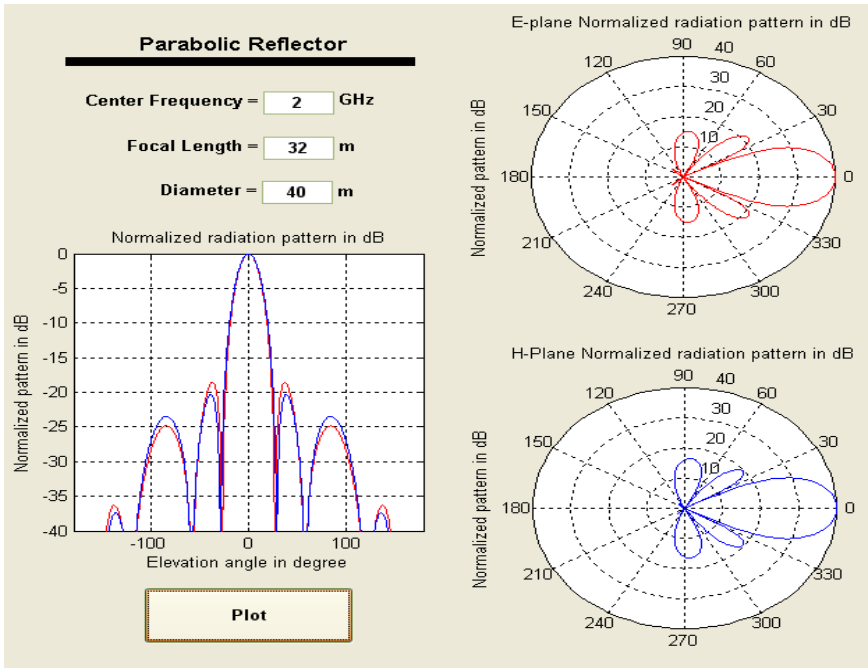


Fig. 5: Radiation Patterns of Parabolic Reflector or Microwave Dish

In this Figure beam widths are manifested for different elevation angles. We have computed this beamwidth from the following model equation:

$$Y_t = 19.27 - 1.12152 * t \tag{3}$$

Figure 6 Depicts the variation of beam width with Frequency in Parabolic Reflector in Figure 7. Illustrations the residual plots including (i) Gaussian interpretation, (ii) residual versus fitted values, (iii) display of histogram for residuals and frequency, (iv) versus order that is residuals and observed order. For accuracy measures we can compute (a) MAPE = 81.9085, (b) MAD = 04.4352, (c) MSD = 42.2225 that validate the model accuracy as given in the Figure 6.

Figure 8 examines that the partial autocorrelation function for Beam width with lags 5 seems to be sinusoidal wave function that also with diagnostics validates the model as mentioned above.

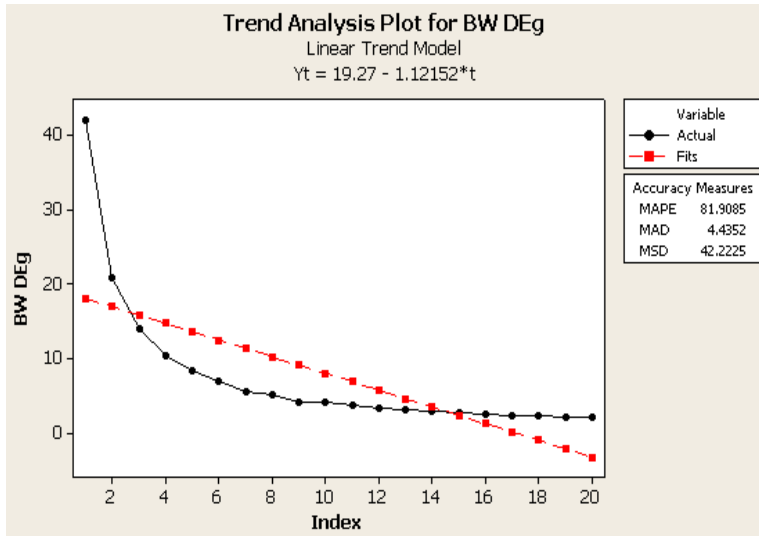


Fig. 6: Trend Analysis for Beam Width Variations

This manifests variations of beam width with Frequency in Parabolic Reflector in Deep Space. This shows trend analysis for beam width variations along with the parametric values [6-7].

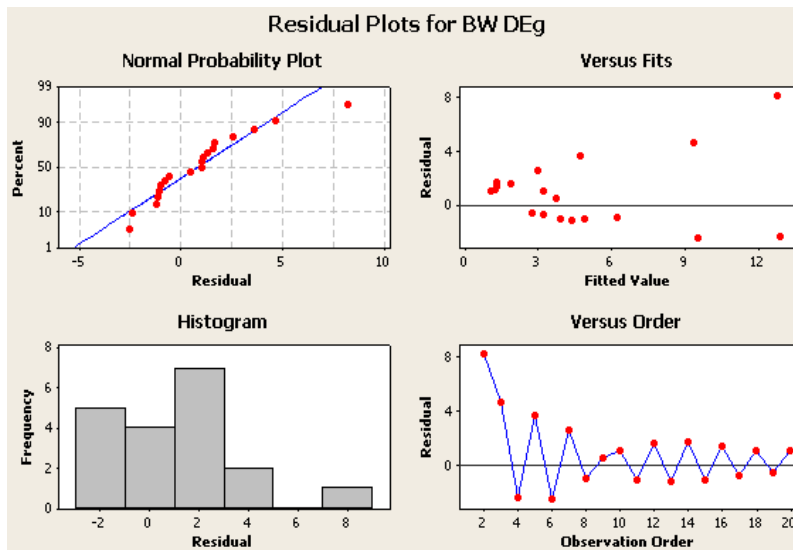


Fig. 7: Model residual illustrations of this the residual plots include

- i) Gaussian interpretation,**
- ii) residual versus fitted values,**
- iii) display of histogram for residuals and frequency,**
- iv) versus order that is residuals and observed order.**

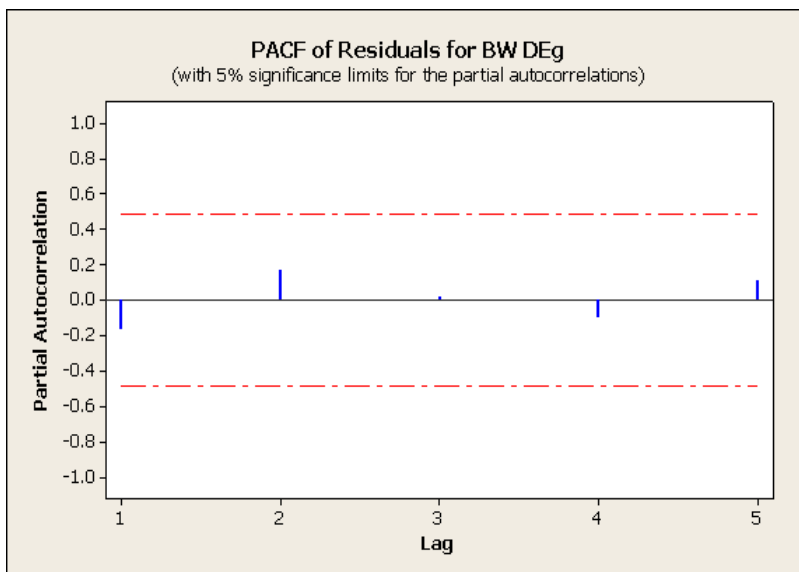


Fig. 8: Partial Autocorrelation function for Beam width

5. 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.

6. ACKNOWLEDGEMENT

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