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Theme:

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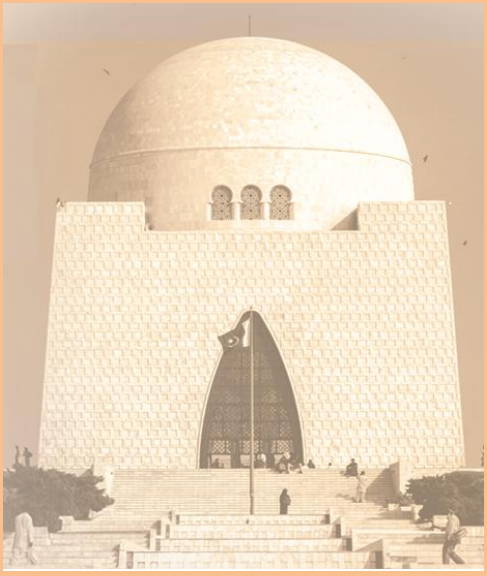

March 24-26, 2014

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Dr. Munir Ahmad
Editor

CONTENTS

1. 001: Modeling computed Beamwidth Fluctuations of Parabolic antenna of communication Satellites
   Arshad Hussain and M. Ayub Khan Yousuf Zai 1-8
2. 002: Wavelet Characterization of Skip Distance Fluctuations for Radio Wave Communication in Pakistan
   M. Ayub Khan Yousuf Zai, Akbar Ali Jilani and M. Rashid Kamal Ansari 9-16
3. 003: Examining Cosmic Rays Persuade on Cloud envelop under Pakistan Global Regions
   Faisal Nawaz and M. Ayub Khan Yousuf Zai 17-24
4. 006: Study the Gaussian Preview of Skip Distance for Radio Wave Propagation at Extraterrestrial Region of Pakistan
   Akbar Ali Jilani and M. Ayub Khan Yousuf Zai 25-32
5. 008: Monte Carlo Simulation of Environmental and Business Data with Matlab and R
   Muhammad Arif Hussain and Adnan Alam Khan 33-46
6. 009: Empirical Assessment of the Effects of Atmospheric Humidity on Cloud Cover at Pakistan Lower Atmosphere
   Faisal Ahmed Khan Afridi and M. Ayub Khan YousufZai 47-52
7. 010: Spectral Analytical Perspective of Solar Flare
   Saifuddin Ahmed Jilani and M. Ayub Khan Yousuf Zai 53-60
8. 017: Patterns of Age-Specific Fertility Rates of Pakistan Region-Wise
   Hira Fatima Waseem and Farah Yasmeen 61-68
9. 018: Modeling and Forecasting Electricity Consumption in Pakistan
   Farah Yasmeen and Muhammad Sharif 69-76
10. 019: Functional Time Series Models to Predict Age-Specific Breast Cancer Incidence Rates for Women in Karachi
    Sidra Zaheer and Farah Yasmeen 77-86
11. 020: The Use of Analysis of Variance in Data Monthly Summary Report: A Case Study of East Nile Model Hospital
    Siraj O. Omer 87-92
12. 022: Optimization Through Fractional Factorial Design: Evaluating the Factors that Influence the Crispiness and Softness of the Pizza Dough
    Zara Omar and Hafiz Mohammad Aamir 93-106
13. 027: Astronomical Improve Model of Prayer Timing with Error Analysis
    Maqsood Alam, Rabia Tabassum and Yusra Waseem 107-120
14. 031: On the Impact of Pair Work on the Speaking Skills of L2 Learners
    Nasreen Z. Pasha and Isabel William 121-128
15. 033: Using PCA, Poisson and Negative Binomial Model to Study the Climatic Factor and Dengue Fever Outbreak in Pakistan
    Syed Afrozuddin Ahmed and Junaid Saghir Siddiqi 129-146
16. 034: On Modification of Estimator of the Percentile Coefficient of Kurtosis in the Case of Distributions Self-Inverse at Unity
    Saleha Naghmi Habibullah and Syeda Shan-e-Fatima 147-154

17. 036: Data Mining Techniques for Researchers
Nadia Qasim, M. Qasim Rind and M. Saleem Sheikh 155-166
18. 038: Analysis for the Degree of Purchase Intention in Product Test
Hina Gul and Muhammad Amin 167-172
19. 039: Investigating the Relationship between Self-Talk and Self-Determination on Psychological Well-Being of Pre-Linguistic Deaf Students
Sadia Batool, Rubab Afzal and Muhammad Qasim Rind 173-178
20. 041: Risk Estimation of Hepatitis (B and C) among Provinces of Pakistan using only Descriptive Stats from PMRC Houses Hold Survey Report
Syed Adnan Ali and Maria Rahim 179-184
21. 043: The Determinants of FDI's in Pakistan
Syed Monis Jawed 185-190
22. 046: A Comparison between FTS Models and APC Models
Saba Mughal and Farah Yasmeen 191-200
23. 047: Assessment of Genetic Variation Across a Heterogeneous Population Using Anthropometric Data
Nuzhat A. Akram, Bilal Abdullah Sheikh, Mansoor Ahmed, Aisha Abbas, Warda Ramesa Malik and Salman Azmi 201-208
24. 052: A Statistical Analysis of Need and Possibility of Administration of Bacteriophage Therapy
Ahmad Rahman 209-218
25. 058: The Impact of After Sale Services on Consumer Buying Behavior in Broadband Industry of Karachi
M. Ibrahim Shamsi, M. Haris Abdullah and Farhal Naseem Ansari 219-228
26. 059: Assessment of Statistical Approaches to Model Low Count Data: An Empirical Application to Youth Delinquency
Taimoor Malik and Syed Arif Ali 229-236
27. 060: The Impact of Institutional Development on Short-term Return Predictability in an Emerging Market of Pakistan
Abida Hafeez and Mohammad Nishat 237-248
28. 061: Short-term Return Predictability using a Parametric Stock Market Efficiency Test: Evidence from the Karachi Stock Exchange
Abida Hafeez 249-264
29. 065: Relationship Between the Student's Preference and the Demand of the Subfield in Market
M. Ashar Burney, Syed Adil Imam, Wajahat Maqbool, Ammar bin Aamir Ali Kamal, Ali Raza, Ali Feroz and Waqas Ahmed 265-272
30. 072: A Statistically Analysis on the Effects on Student's Studies Using Social Networking Sites
Ali Shah, Maria Naveed, Ahmed Salim, Vishal Sharma, Vikash Kumar Batra and Fareeha Sultan 273-278
31. 073: Statistical Analysis on the Role of GPA, Qualifications and Skill Sets in the Recruitment and Selection of an Applicant (Graduate)
Humza Bin Javaid, Unais Qayyum, Ebad Nabi Hashmi, Arsal Asif, Akeed A. Farees and Fareeha Sultan 279-284

32. 074: A Statistical Analysis on the Reasons of Changing the Telecommunication Network Brands
M. Abeer-ur-Rehman, Shayan Ahmad, M. Imran Rafique, M. Maaz Shams Syed Usman Nizami, Wasif Ali Khan and Fareeha Sultan 285-292
33. 075: Impact of Smartphone's on University Students: A Statistical Analysis
Vikash Lal Dodani, Avinash Kumar, Paras Kumar, Ahsan Islam Muhammad Noman, Sarfraz Ahmed and Fareeha Sultan 293-300
34. 076: Power Crisis: A Result of Mismanagement Rather Than Unavailability of Resources
Waleed Arshad, Muhammad Naveed Sharif, Sheharyar Mohsin Abeeha Sattar and Fareeha Sultan 301-306
35. 081: Pakistan in IT after 10 Years: A Statistical Analysis
M. Faraz, M. Raza Devjani, Manisha Kumari, Wajeeha Ihsan Saba Mohammad Ali and Ayesha Mahmood 307-314
36. 082: Retrospective and Prospective Sampling Approaches and Multivariate Analyses for the Assessment of Genetic Variation Across A Heterogeneous Population
Nuzhat A. Akram and Shakeel R. Farooqi 315-332
37. 084: Consumer Buying Behaviour: A Factor of Compulsive Buying Prejudiced by Windowsill Placement
Irfan Hameed 333-340
38. 086: Impact of Modern Web Media on Mass Media and Print Media
Hina Gul, Muhammad Asrar-ul-Haque and Samar Ikram 341-346
39. 087: Correlation between Energy to Noise Ratio and Bit Error Rate in Chaos Based Communication System
Nida Ashraf, Faisal Afzal Siddiqui, Sheikh M. Zeeshan Iqbal and Shabana Rizvi 347-358
40. 088: Development Strategies in OIC Countries
Khateeb Ullah Khan 359-364
41. 094: Population Projection using Modified Markov Chain
Muhammad Zakria and Faqir Muhammad 365-380
42. 099: Framework to Comprehend the Impact of Institutions Quality and Industrial Competitiveness on Economic Growth of Pakistan: An Empirical Investigation
Yasir Ali Soomro 381-390
43. 104: Spatial Analysis of Hepatitis-C Epidemiology in Faisalabad District
Samaira Batool and Muhammad Yaseen 391-396
44. 106: Modeling Survival Rates of Cardiovascular Patients in Faisalabad
Sidra Saleem and Muhammad Yaseen 397-402
45. 110: Factors Affecting Yield and Taste of Popcorn: A Planned Approach
Laiq Muhammad Khan and Ejaz Ahmed 403-420
46. 112: Study of Problems Faced by the Private Secondary Schools Subject Teachers in the Integration of ICT during Teaching and Learning Process
Rubina Usman Ali and Tayyaba Zarif 421-432

47. 113: Regional cloud cover changes and its impact on wintertime temperature variability using Singular Value Decomposition Analysis
Syed M. Fahad Riaz and Danish Mumtaz 433-440
48. 114: Computer and Transports
Irshad Ullah 441-444
49. 115: Computer and Students Management
Irshad Ullah 445-450
50. 116: Computer and Entertainment
Irshad Ullah 451-456
51. 119: University Branding, Its Effect on Industry for Fresh Graduated Student's Job Placement
M. Ibrahim Shamsi, Syed Shuja Hasan and M. Salman Samad 457-464
52. 121: Brand Equity Trends among Top Automobile Brands
Kamran Siddiqui and Maliha Khaqan 465-474
53. 129: Role of Statistical Analysis in Self-Assessment for Program's Improvements: A Study of an Engineering School of Pakistan
Farrukh Idrees 475-490
54. 136: On Firm Performance the Effect of Span of Supply Chain Integration
Muhammad Ibrahim Shamsi, Syed Taha Ali and Uzair Ahmed 491-500
55. 146: Statistical Analysis of Violence against Women in Southern Punjab
Rashada Qazi 501-506

Proc. 12th International Conference on Statistical Sciences
Karachi, Pakistan – March 24-26, 2014, Vol. 26, pp. 1-8

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.

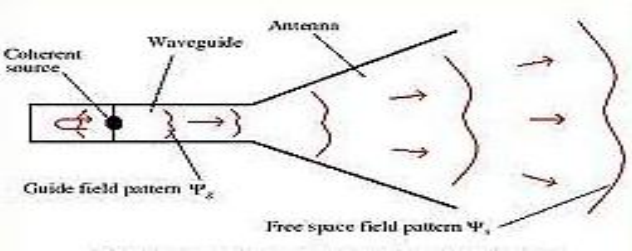

Fig. 1: Schematic of An Antenna System

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.

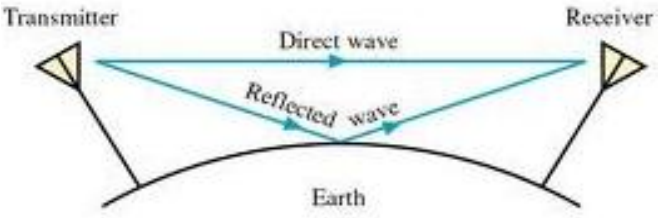

Fig. 2: Mechanisms of Transmission and Reception of Radio Wave Propagation

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 teds 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.

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

Since the parabola is described in polar form by,

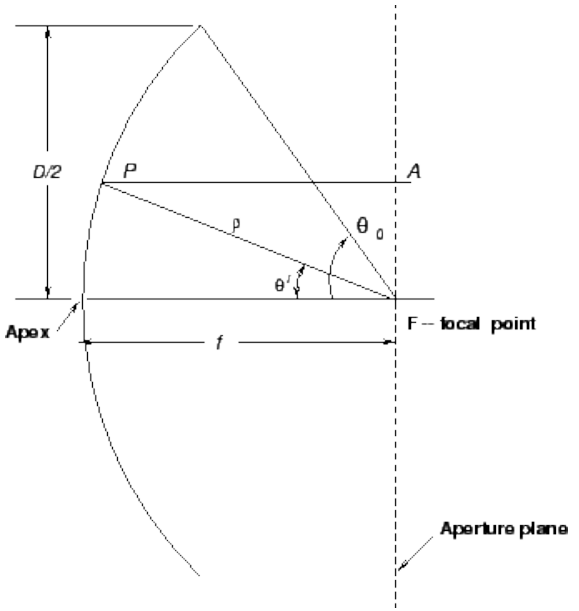

Fig. 3: Geometry of Parabolic Reflector

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

$$\varphi = \frac{70\lambda}{D} \tag{1}$$

$$\varphi_o = 2\varphi \tag{2}$$

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 l 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].

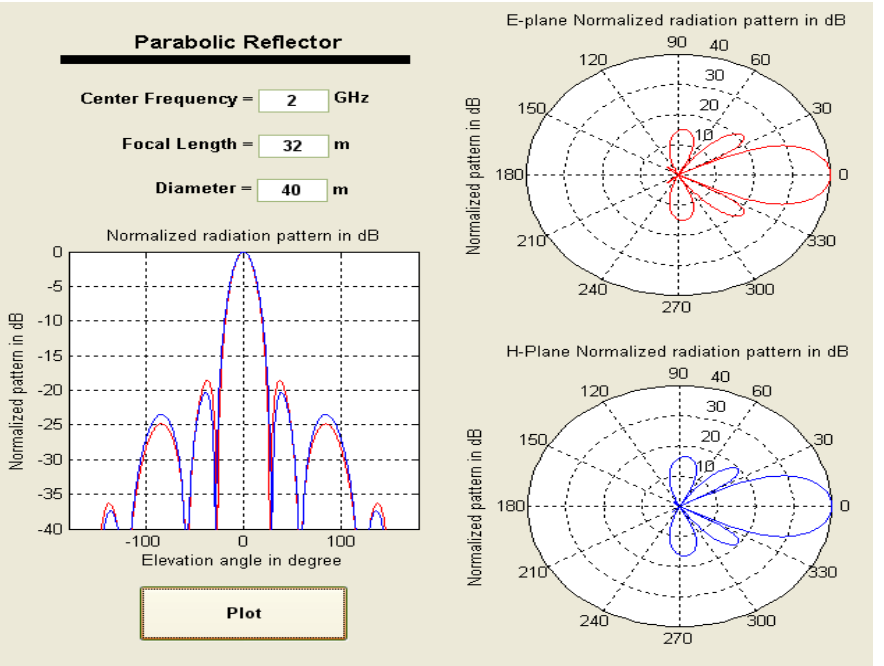

Fig. 5: Radiation Patterns of Parabolic Reflector or Microwave Dish

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

$$Y_t = 19.27 - 1.12152 *t \quad (3)$$

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.

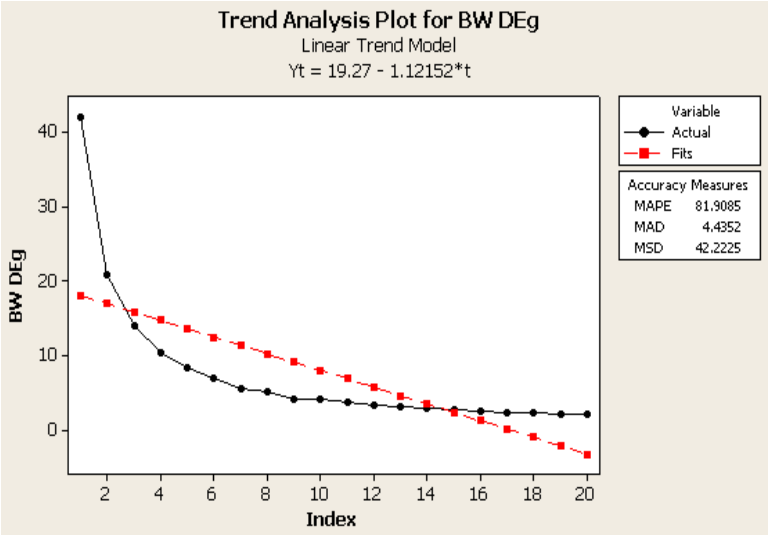

Fig. 6: Trend Analysis for Beam Width Variations

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].

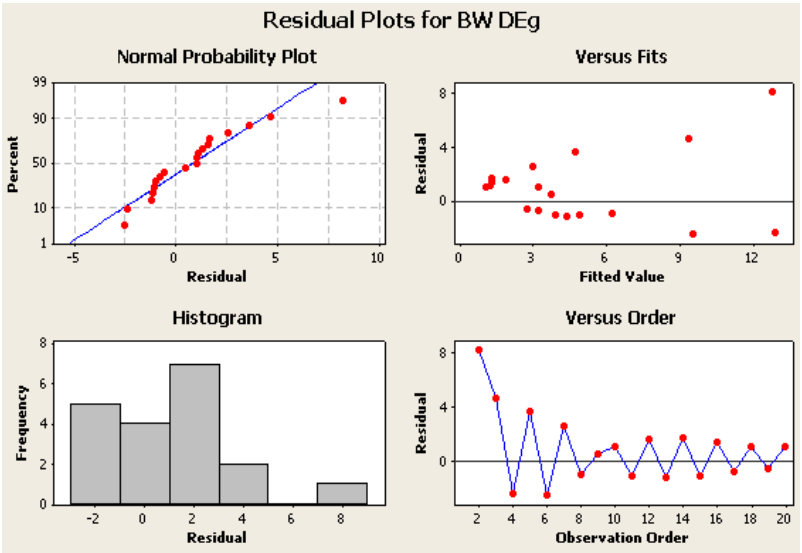

Fig. 7: Model residual illustrations of this the residual plots include
i) Gaussian interpretation,
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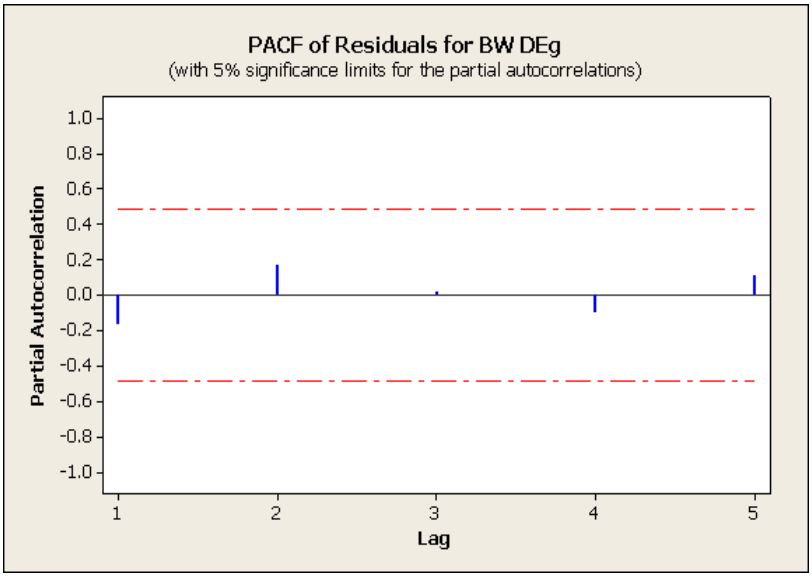

Fig. 8: Partial Autocorrelation function for Beam width

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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