Chapter 9

Summary of the Work Done and Scope for Further Investigations

9.1 Summary

The Sun, a typical star becomes amazing by its nearness. Though it is an ordinary star we face a huge number of troubles that require a basic consideration. The difficulties faced are those which are related with the influence of the Sun on the Earth, the environment near the Earth and space weather difficulties that have an impact on life and technology. The magnetic dynamo and the solar cycle, the solar atmosphere as well as transient vigorous events for example flares, CMEs, shocks and speeding up of particles are amazing troubles. We can understand from satellite information those procedures that are connected to the decadal solar cycle and short durational time scale as their influences should instigate cyclical or impulsive feedbacks in the climate. The modern advancements in magneto-hydrodynamic dynamo concept have failed to understand the physics of the solar magnetic cycle in a better way. The comparative time scales of various flux transport procedures in the dynamo chain of incidents and their interaction based on which procedure govern are the determining factors of this memory.

Solar atmosphere is a powerful source of radio emission with the special feature that shorter wavelengths enter deeper into the atmosphere and nearer to the surface of the Sun. Even solar transients, for examples flares and CMEs produce powerful radio emission. Radio observations are significant as they have helped us to understand almost all the difficulties faced for many years. Spectroscopy and imaging observations are the two ways along which the study of solar radio emission has progressed .Imaging observations are done at diverse frequencies with interferometric array for number of years. Whereas specially unresolved wide band spectroscopy are studied by utilizing fixed frequency polarimeters, in swept-frequency and also in wide band digital spectrographs, spectroscopy of high resolutions are employed. Numerous radio telescope designs like interferometers, spectrometers and imaging-spectrometers have come into existence to monitor solar radio activity. CMEs, filament eruptions and highly vigorous flares are the diverse activity phenomena on the Sun that has increased charged particle flux in the space, x-ray, gamma-rays and thus influenced the space weather near the Earth.

The origin of all these activities is the solar magnetic field. The cause of all these activities is the solar magnetic field which is a matter of great concern today. Although the knowledge and understanding of different attributes of solar magnetic field has advanced a lot, still the topics of 11 year sunspot cycle, coronal heating, the sunspot’s
composition and dynamics, stability or instability of magnetic structure is yet not clear. To achieve a detailed understanding of these topics the magnetic field monitoring and recordings are needed with a huge spatial and temporal coverage. Due to the important and intrinsic function of magnetic fields in solar activity phenomena, solar physicists have developed novel and innovative devices.

The requirement of constructing a log periodic dipole antenna (LPDA) has arisen not only due to the enormous technological progresses and developments in solar activities but also to watch this occurrence in radio region. Antennas are employed to transmit or get electromagnetic waves and because of the principle of reciprocity the characteristics in both cases are identical.

LPDAs have attracted huge attention in recent times among all types of antenna due to its wideband frequencies, frequency response characteristics, simplicity of design and directivity. The wind-proof time-shared LPDA was built in the Department of Physics of Kalyani University, Kalyani situated in the state of West Bengal, for recording the radio signals ejected during the disturbed Sun and its plasma behavior was investigated during such conditions. Not only the constructed log periodic antenna can resist high speed winds but it also lessens the troubles of non-linear phase responses over ultra wide bands and frequency dispersions. It focuses on the design of the new LPDA and its performance. It is identified that LPDA is a scientific instrument for power spectrum radio data observing used broadband antennas at its front end and to fruitfully detect solar radiation as they give the delicate component of the radio detector. The dimensions of LPDA vary with frequency as it typically shows different radiation characteristics at different frequencies and can be constructed for any frequency. This type of antenna is regarded as elementary receiving element used in the present system which has an almost continuous coverage of a wide range of frequencies and one of the wideband antennas that suits various applications. It is also likely to design in order to achieve a gain much better (5-10 dB) and it is sensitive to a radio signal of the Sun.

9.2 Suggestions for Future Work

Although recently there are modern efforts to understand the Sun-Earth system, yet there is a great requirement of more sophisticated and detailed models and also advanced speculations of the great solar activity as its effect on humans nowadays is very severe. A vital role is performed by solar magnetic fields in the various activity phenomena of the Sun. These are noticed from the Sun’s radiative interior to the heliopause. They are evolved because of photospheric dynamics and emergence of flux and this leads to various activity phenomena such as flares, filament eruptions, coronal mass ejections (CMES). The space weather close to the Earth is directly affected by these phenomena which are accompanied by high energy emission and charged particles. To speculate such sorts of events an insight and knowledge of solar magnetic structures is needed. Though it is very challenging to measure solar magnetic fields, yet it is vital to determine it. It is very challenging because the measurements are required
to be done distantly by sensing the polarization (because of Zeeman Effect) of solar spectral lines. Moreover the distortion in imaging because of atmospheric “seeing” directs us to inferior spatial resolution and affects polarization dimensions. A research of the influence of vector magnetic field parameter on the solar acoustic p-mode will be conducted.

Today solar radio observations are anticipated with the new and innovative forthcoming observational amenities. Solar imaging radio spectroscopy will afford us an exceptional chance to find height evolution and fine height structure of dynamical procedures in bursts energy discharges. Such type of information is very significant for showing the fundamental mechanism functioning in solar (and stellar) flares, the knowledge of which is too much essential for improving speculations of extraordinary events of space weather. This research is mainly concerned with the design of operating LPDA antenna. So as to achieve this, the engineer requires to have knowledge of all the different choices available so that one can approximate the possible functioning characteristics in special cases. Firstly, the engineer should have the ability to estimate the possible gain of an LPDA antenna for a specified length and operating bandwidth. Secondly, the number of dipole elements should be estimated whose outcome is the gain value n. Further the values of tau and sigma should be computed which would ultimately result in that gain. Fourthly, the effects if any, of a specified antenna parameter on the functioning of the antenna should be determined.

An LPDA with excellent performance from the view point of gain, bandwidth, beam width etc can be devised by optimization of its geometry. An excellent gain, wider polarization, input impedance bandwidth may be attained provided the optimization is done by controlling scale factor, spacing factor, subtended angle, zero offset and so on. In case of applications with various bandwidth and directivity requirements, the design concept can be scaled very easefully by adjusting the angle $\alpha$ and by increasing more elements which helps for the improvement of the VSWR. Thus it is possible to achieve additional efficient designs with smaller number of elements and with larger values of subtended angle. A careful study needs to be conducted on the input impedance of LPDA. Moreover the techniques of enhancing input impedance bandwidth requires to be discovered. The functioning of the LPDA may be optimized by employing suitable optimization mechanisms. Along with the analysis of the admittance matrix methodology for LPDA, the mutual impedance among the LPDA elements may also be studied as well as examined. Today there is a great requirement for reconfigurable antennas because of their small size, subsidized cost, light weight and small dimension.

One of the ways initiated for optimizing LPDA antenna in terms of expenditure was utilizing the minimum number of dipole elements (N) as the criteria. Though the minimization is specified by N, the technique utilized in achieving N takes into consideration each and every really helpful performance to determine the parameter of LPDA antenna. Finally the consequence of the minimization technique is optimized in functioning of the LPDA antenna. This statement is justified on the fact that N at
convergence is frequently corresponding with optimum space factor values. As the antenna is periodic in nature, it can be examined although it is not totally accurate and therefore more work is required to be done so that a better model can be achieved. All this phenomena are of interest to examine from the view point of design perspective, for instance by varying the phase difference and allowing the outermost components to be parasitic. The impact of the edge elements are a different field in which future work needs to be done.

To compute the functioning of the antenna, radiation patterns, input impedance plots, magnitude and phase plots of the element currents were utilized. As there is no well known technique for analyzing log periodic arrays, study and analysis of the radiation patterns was the prominent tool for determining the functioning of the array. So it is suggested that before dealing with log-periodic structures a near magnetic field study of consistently periodic components may throw some light into log-periodic functioning. It is highly possible that log-periodic counter parts will provide a good wideband performance, provided the detailed study of consistent periodic structures yields results. The radiation pattern is broad beam over the antenna’s operating frequency. The antenna’s front to back ratio makes it an ideal antenna to be utilized for a large phased array as no ground plane is essential, thus reducing the expenditure of the array. It was also evident that by combining a low noise amplifier into a feed point at the front portion of the LPDA, the antenna’s noise figure is reduced. The simulated outcomes of an LPDA exhibit a wide bandwidth antenna with steady radiation patterns.

For frequency reconfigurable antenna, identical gain and radiation patterns are got for all devised frequencies and also the unfavorable impacts of co-site interference are lessened. On varying the frequency without altering the whole dimension and structure of the antenna, reconfiguration of the antenna can be attained. The resonant frequency can be reconfigured by varying the structure with the capability of frequency reconfigurable antenna although the radiation pattern and polarization are unaltered. Therefore frequency reconfigurable LPDA array in the forthcoming days for broadband purposes can be devised. The examination of the polarization reconfigurable log periodic array through the alteration in the array’s structure is feasible. In future this research would comprise the amalgamation of LNAs into antenna arrays. In future the task on noise coupling work would include examining the concept in real array. The troubles of this experimentation would be very problematic to determine the noise functioning of a large phased array. The advantage of this research is that it permits the calculation of the noise coupling before the array is constructed and so it can be utilized to optimize the noise functioning of a phased antenna array.