CHAPTER 1

INTRODUCTION

Plasma (*Greek* πλάσμα, –ατσζ, τό , meaning something molded or fabricated) is the fourth state of matter and it is said that almost 99% of the matter in the universe is in the plasma state. The solar system is embedded within the vast domain of solar plasma. With the advances in space technology resulting from the joint endeavour of the astrophysicists, geophysicists, plasma physicists all over the world to have a fair knowledge of the stellar phenomena, we are aware of the complicated physical situations created by the earth's magnetic environment while moving through plasma. The solar corona, the interstellar space, auroras in the ionospheric region, the radiation belt, the magnetospheric region having Magnetopause as the boundary enriched with plasma activities, attract much attention of the researchers.

The precise definition of a plasma states the collective behaviour of the medium. When the electron mean free path is much longer than the characteristic dimensions of the collective phenomena, we have the collisionless plasma ($s.t. \omega\tau \ll 1$), ω is the oscillation frequency and τ is the relaxation time. In the collisionless approximation of a plasma, the Vlasov-Maxwell equations are best used after exclusion of terms related to the discreteness of particles. But the long range particle interactions still prevail, which can be further removed for the sake of mathematical simplicity, through the use of the macroscopic variables after integrating the Vlasov equation over all velocity space.

Plasma is a many body system with high number of degrees of freedom. Such systems require proper dynamical treatment to account for the position and velocity of all the particles. Macroscopic flow variables representing the density, the temperature, the average velociy, the pressure are used in such descriptions of the system in connection to its momentum and mass conservation laws. These macroscopic variables are defined in terms of velocity moments of the distribution function $f(\boldsymbol{x}, \boldsymbol{v}, t)$ which contains the statistical description of plasma as a many particle system. The differential equation for the distribution function is the starting equation, suitably the Maxwell-Boltzmann equation (i.e. the relevant kinetic equation for plasma). The neglect of the terms representing the binary collisions, reduces this equation to the Vlasov equation (or the collisionless Boltzmann equation). Numerous authors have given their efforts in describing the varieties of wave modes in plasma, either stable or unstable, in which short-range collisions are completely neglected. It has been cited that binary collisions are completely negligible in determining the plasma properties for periods as short as 1 sec. In case of wave particle interaction process, the requisite time period is much shorter than this collision time. The density and temperature requirements in a collisionless plasma had been important topics of research for the magnetic confinement of a deuterium or tritium plasma throughout the decades. It has been shown that plasma confinement in tokamaks is obtained by non collisional anomalous processes driven by instabilities. The computer simulations applied for the solution of problems in plasma physics are also based on particle behaviour of the medium within the fluid context (Krall and Trivelpiece, 1973; Chen, 1977; Matsumoto and Sato, 1984; Stix, 1992). In our works, we have made use of the hydrodynamical treatment in plasma for the mass conservation equations together with the quasi-neutrality condition which keeps away the microscopic process of electron plasma from the macroscopic behaviour of the plasma fluid particles.

In plasma, we have by definition, the simultaneous interactions between the charged particles associated with the electric and magnetic force fields, produce the collective behaviour to face the coherent and turbulent states, prevalent in the medium. By the coherent character of the medium, any small disturbance from any source gets transmitted throughout the medium to a long range. In the transmission procedure, the nonlinearity appears and naturally produces steepening and breaking effects, chaos etc. in the medium.

To pay for the inquisitiveness of scientists towards the transient behaviour of plasma due to its formation at high temperatures and with external disturbances, one has to concentrate in the study of waves and instabilities in plasma which is quite tentalizing and in turn may contribute towards the completion of the tokamak research in various projects relating to controlled thermonuclear reactions

(fusion). History itself heads towards the simple concept underlying in the tokamak plasma definition, despite the complexity of the constitutional nonlinearity in the plasma medium through the successful story, right from the first conceivement in the form of experiment (Tokamak T- 3 built in the 1960's) at Kurchatov Institute in Moscow. Many other tokamaks, namely the Alacator at MIT, PLT at Princeton, ELMO at Oak Ridge, JET (Joint European Torus) at Abingdon in England, DIII-D in USA, TT-60 in Japan and also the medium sized ADITYA tokamak in India are worth mentioning. Moreover, proposed experiments like ISTP, STEP, GEM, INTOR, NET, SSTR, ITER, if co-ordinated by advanced type of computer simulation study, will definitely upgrade the present status of tokamak. Thermonuclear ignition and problems of burning plasmas have become the fascinating and challanging tasks to the tokamak scientists.

The immense energy released due to fusion reaction, has become a fruitful and highly potential source despite of having numerous constraints in the plasma processing. As a consequence,various important research fields have emerged and it takes a turn in the vast domain. Speculations about ITER (International Tokamak Experimental Reactors) have started. Elucidation of the plasma confinement process to make the tokamak reaearch a success in the field of controlled thermonuclear fusion, has become the illuminated goal that appears as achievable through scientific procedures. The Lavitron, the production of superdense Laser plasma, creation of poloidal magnetic field in tokamaks, are some of the milestones achieved in plasma research. Plasma can have very high thermal energy density due to its electromagnetic flow behaviour and hence, the ohmic heating is a principal option for the researchers besides being engaged in the attainment of stability (within the context of larmour radius) in the confining process. In addition to heating and confinement of plasma, the radiation loss of energy is an important aspect of plasma research. This loss is again increased by the presence of impurities and then 'dusty plasma' occupies a unique position. Acceleration upto the Plackian energy level has been obtained. Studies of solitary waves will throw some more lights in this respect. The inverse free electron laser, the inverse Cereknov accelerator, laser driven grating Linac are some of the related accelerators.Some major experiments are being carried out at UCLA (USA). The mechanism of instability is a basic problem in different fusion schemes. Generation of high velocity by small accelerations over long times in MHD generators has been made possible to convert thermal energy into electrical energy.

It is a matter of fact, that plasma is dispersive as a medium (the refractive index of plasma is not a constant but depends on the frequency of light) and various types of waves can be generated in this medium . The consideration of wave steepening out of various nonlinear processes in the medium adds to the effect of dispersion. A typical balance between the wave nonlinearity and dispersion leads to the formation of solitary waves, a kind of waves that propagate with constant speeds for a long time preserving their shapes. Solitary waves is the class, that is best studied from the point of view of the interstaller gas phenomena as well as the controlled thermonuclear fusion or tokamak research. Solitary and shock structures, induced by poloidal flow in tokamak, have been discussed by Taniuti *et al.*(1992). Solitary waves are studied by EL-Labany *et al.* (1996) in weakly relativistic warm plasma. Soliton dynamics are studied extensively during the recent years in relation to the form invarience of soliton action as a quasiparticle in the background plasma (Chiueh and Juang, 1997). In case of current carrying plasmas, formation of a strange soliton in two wave - collapses has been shown by Schamel and Hassan (1997). Explosion of solitons has been studied by Das *et al.*(1997). Different types of solitons such as pulse soliton, lattice soliton, envelope or hole , kink , breather , fluxon, together with bright and dark solitons have been discussed by Remoissenet (1993) in the book " Waves called solitons". The primary method is an observational one, which is endowed with the cause and effect relationship of the observed phenomena. From such evidences, various theories have been developed that can explain the observed phenomena on a more general basis. For example, the observation of solitary waves by Scott Russel in August, 1834 (reported in 1844 a) was followed theoretically by Russel (1844 b), Korteweg-de Vries (1895) and numerically by Zabusky and Kruskal (1965).

In the theoretical aspect, general methods of describing plasma motions constitute a greater part of the wave theory. Simple wave theory provides the hydrodynamical theme of having all flow varibles as functions of one of them, say potencial (electric) $\Phi = f(x - Vt)$ where x indicates the measure of transfer along the direction of motion and V the phase velocity. This property leads us to the simplification of the differential equations related to plasma motion to another set of algebraic equations by the Fourier (Laplace) transform method. After this stage, a compatibility condition

(constraint) leading to dispersion relation is obtained through the elimination of the flow variables. This relation appears as a function of the wave frequency ω and the wave number k. A dispersion relation describes every response of the medium to the disturbance having slight occupation, to generate a linear dispersion relation. Plasma is a medium that responds violently to external disturbances and the plasma particles are known to interact amongst themselves. Consequently, the disturbances have the possibility of becoming larger, so that the linearization processes underlying in the Fourier Analysis method may fail. Such is the situation which needs the nonlinear treatment in the wave motions in plasma. Thus, the study of basic plasma waves is divided into a linear theory and a nonlinear theory.

The evolution theory in plasma waves is such that one starts with the linear theory and predicts about the possible wave formation. As time passes, the growth in the wave amplitude detects that nonlinearity has started and the medium has deviated far from the equil.ibrium configuration in a time dependent manner.

In the study of solitary plasma waves, it is desirable to make a glimpse into the role of mathematics, which is of the utmost importance in our studies. Nonlinear wave phenomena are of two basic types - weakly nonlinear and highly (or totally) nonlinear. In the first case, perturbation methods provide a powerful tool for the analysis of the differential equations governing the dynamics of the system. Generally the reductive perturbation scheme,

$$u=\sum_{n=0}^{\infty}\varepsilon^{n}u_{n}(\xi,\tau)$$

for the flow variable u is useful in deriving a large number of representative equations, where $\xi=\varepsilon^{\alpha}(x-Vt)$, $\tau=\varepsilon^{\alpha+1}t$, ε ($<<1$) is the small parameter that indicates the magnitude of the rate of change. Here u depends on ξ and τ only for the validity of the time dependent description of the flow. Some of the fascinating equations derivable under this scheme to describe waves are cited below:

(i) Boussinesq equation

$$\left(\frac{\partial^2}{\partial\tau^2}-V^2\frac{\partial^2}{\partial\xi^2}-\mu\frac{\partial^4}{\partial\xi^2\partial\tau^2}\right)u=\frac{1}{2}\frac{\partial^2u^2}{\partial\xi^2}$$

where $u=(\xi,\tau)$ is a

one-dimensional wave field satisfying far field properties, V is the phase velocity in the limit of long wave length, μ represents the dispersion with dispersion relation $\omega(k) = Vk - \frac{1}{2} V\mu k^3$ obtained by linearizing about $u = u_0$ a constant, ($k \ll 1$). This equation can describe solitary waves propagating to the left and to the right ($V > 0$ or $V < 0$). One dimensional continuums are described through this equation for discrete microscopic structures also.

(ii) Nonlinear Schrödinger equation (by KBM method equivalently)

$$i\frac{\partial A}{\partial \tau} + p\frac{\partial^2 A}{\partial \xi^2} = q\,|A|^2 A$$

where $p = \frac{1}{2}\frac{dV_g}{dk}$, $\quad q = -\frac{\partial D}{\partial |A|^2} \Big/ \frac{\partial D}{\partial \omega}$,

V_g being the group velocity and D represents the nonlinear dispersion function. The nonlinear modulation of a quasi-monochromatic wave can be described by this equation, where q stands for the nonlinearity. Karpman & Kruskal (1969) first introduced this equation. The corresponding linear dispersion relation is

$$\omega = \frac{1}{2} k^2 - |A_0|^2 A_0 q \qquad (\text{about } A = A_0)$$

This equation shows strong dispersion.

(iii.) Vector derivative nonlinear Schrödinger equation (VDNLS)

$$\frac{\partial \boldsymbol{u}}{\partial \tau} + \alpha\frac{\partial}{\partial \xi}[\boldsymbol{u}\,(u^2 - u_0^2)] + i\lambda\frac{\partial^2}{\partial \xi^2}(\hat{\mathbf{e}} \times \boldsymbol{u}) = 0$$

describes the coupling between two waves with significant dispersion effects.

(iv.) Korteweg-de Vries- Burgers' (KdVB) equation

$$\frac{\partial u}{\partial \tau} + u\frac{\partial u}{\partial \xi} - \nu\frac{\partial^2 u}{\partial \xi^2} + \mu\frac{\partial^3 u}{\partial \xi^3} = 0,$$ ν is the term denoting dissipation.

The linear dispersion relation $\omega = u_0 k - \mu k^3 - i\,\nu\,k^2$ shows combined effect of dissipation and dispersion.

(v.) Korteweg-de Vries (KdV) equation

$$\frac{\partial u}{\partial \tau} + pu\frac{\partial u}{\partial \xi} + q\frac{\partial^3 u}{\partial \xi^3} = 0 \quad , q > 0$$

that governs long waves with weak dispersion and weak nonlinearity. The corresponding linear dispersion relation $\omega = u_0 k - qk^3$ shows the 3rd order space derivative of u with dispersive effect.

(vi) Modified Korteweg-de Vries (MKdV) equation

$$\frac{\partial u}{\partial \tau} + pu^2\frac{\partial u}{\partial \xi} + q\frac{\partial^3 u}{\partial \xi^3} = 0$$

For consideration of the cases where the nonlinearity is of higher order and the nonlinear coefficient is equal to zero in the KdV equation, the MkdV equation is taken into account.

For weakly nonlinear dispersive waves, the KdV equation is the lower order nontrivial consequence of a perturbation approximation. Higher order corrections in the equation, are also admissible. However, by renormalizing the velocities of KdV solitons, one can obtain the asymptotic N- soliton solutions. Envelope soliton solutions can be obtained from DNLS, NLS equations. The KdV equation can also be derived from the viewpoint of the derivative expansion (KBM) method. It is necessary to move the co-ordinate system with the phase velocity (but not the group velocity) of the wave in order to obtain the KdV equation.

In almost all asymptotic perturbation methods, the concept of multiple scales is involved either explicitly or implicitly. The KdV and the NLS equations are of attractive importance because they can be solved to give rise to solitary wave solutions. Both the equations are well known for the speciality of their solutions representing solitons (that are remarkably stable even after interactions between different amplitude- solitary waves). Hirota's (1971) methods for KdV and NLS equations give remarkable opportunity to study N-soliton solution of these equations . Inverse scattering transform also gives exact solutions to these equations (Gardner *et al*,1967). The consideration of coeffients of various orders of smallness, gives rise to the different order solutions.

For a highly nonlinear response of a system, such perturbation method fails to account for the actual description of the system. In plasma physics, we have a specific method to describe solitary waves through the energy integral

$$\left(\frac{d\phi}{d\xi}\right)^2 + 2K(\phi) = 0\,,$$

with the Sagdeev potential $K(\phi)$. In this purely non perturbative method, the pseudo-potential $K(\phi)$ is such that $K(\phi) < 0$ for solitons and $K(\phi) > 0$ for holes. If K be the field potential, then the condition for the potential well is

$$\left.\frac{d^2K(\phi)}{d\phi^2}\right|_{\phi=0} < 0\,,$$

where $\frac{d^2\phi}{d\xi^2} = -\frac{dK(\phi)}{d\xi}$ and $K(\phi)$ is the pseudo-potential. Here ϕ is to be treated as a particle so that $K(\phi)$ becomes a potential. The shape of the soliton solution can be found from

$$\pm\xi = \int_{\phi}^{\phi_0} \frac{1}{\sqrt{-2K(\phi)}}\,d\phi\,,$$

ϕ_0 is the value of ϕ where $K(\phi)$ crosses the axis from below (ϕ_0 is the amplitude). Completing this integration numerically, one can obtain the soliton profiles, which result in typical bell-shaped structures. In deriving this Sagdeev potential $K(\phi)$, one has to integrate the set of nonlinear equations by going to the wave frame and thus the total nonlinearity is incorporated.

In the small amplitude limit of the solitary waves, the energy integral gives the solution

$$\phi = 3\delta M\, sech^2\left[\frac{(\delta M)^{1/2}}{\sqrt{2}}(x - Mt)\right]$$

where, for $\phi_{max} \ll 1$, it can be assumed that $M = 1 + \delta M$. The argument of this solution is

$$\frac{\varepsilon^{1/2}}{\sqrt{2}}\left\{x - (1+\varepsilon)\,t\right\}\ ,\ \text{i.e.}\ \frac{1}{\sqrt{2}}\left\{\varepsilon^{1/2}(x - t) - \varepsilon^{3/2}t\right\}$$

with $\delta M = \varepsilon$ ($\ll 1$) which admits the stretched variables $\xi = \varepsilon^{1/2}(x - t)$, $\tau = \varepsilon^{3/2}\, t$ used in the reductive perturbation scheme for KdV type solitons.

The first experimental observation was made by Ikezi (1973) for ion acoustic compressive soliton (that could be described with the KdV equation) at the time of creation of the double plasma (DP) device along with the new method of nonlinear ion acoustic wave excitation. Temerin *et al.* (1982) have stated that their observation of "spiky" (pulsed) electric fields at altitudes of $1R_e$ above the auroral zone may suggest the existence of these fields as ion acoustic solitons. As a follow up treatment, this problem relating to auroral particle acceleration, was studied theoretically by Lotko and Kennel (1983) to show that these spiky (pulsed) electric fields can evolve from initially small amplitude ion acoustic solitons. The works of Watanabe (1984) were also observed by Ludwig *et al.* (1984) by taking K^+ positive ions and SF_6^- negative ions with the electron component. Nakamura (1987a, b) in his experimental investigations has shown that in the presence of negative ions, the coefficient of the nonlinear term in the KdV equation may change sign, depending on the concentration of negative versus positive ions. Further, the existence of rarefactive soliton solutions for this negative coefficient was also confirmed. In case of warm plasma, the possibility of wave breaking (if T_e, T_i become comparable) of the ion acoustic type can be overcome by taking $T_e >> T_i$. Experiments on KdV soliton by Cooney *et al.* (1991) were performed in a positive ion - negative ion plasma. In a different experimental setup (1991) for positive ion negative ion plasma, these authors have used the relation

$$\left(\frac{\delta n}{n}\right)\left(\frac{\text{half(width)}}{\lambda_{\text{Debye}}}\right)^2 \approx \text{constant}$$

as the first clue in the identification of the signal as a KdV soliton. For the background gases of *Ar*, *He*, N_2, they have confirmed the existence of compressive solitons only. Velocity of a KdV soliton is shown to depend on wave amplitude through the relation

$$v \approx C_s\left(1 + \frac{1}{3}\frac{\delta n}{n}\right)n,$$

where C_s is the linear velocity.

In the Sagdeev potential limit beyond which solitary waves can not propagate, total nonlinearity is taken into account to generate the maximum possible amplitude of a solitary wave. After attaining this value, the motion becomes multivalued i.e. nonlinearity is no more balanced by dispersion.

Solitary Alfvén waves can be described with the help of MKdV equation. We see that the quadratic nonlinearity in case of ion-acoustic solitons described by the KdV equation is not competent for the description of the Alfvén nonlinearity. In the case of Alfvén solitons, we have the cubic nonlinearity. The nonlinear surface wave mode and the shear Alfvén mode owe their coupling to the collective effects. The connection between various phenomena like micropulsation activities in near earth regions and the *r-f* heating prospects in toroidal tokamaks, is accepted by the scientific community. Thus, the stability of Alfvén waves has become an attractive subject both in the domains of space plasma and tokamak plasma.

The work in this thesis has been designed into two main parts which are devoted to the study of solitary ion acoustic and Alfvén waves along with a bit of stability analysis preceeded by the introductory chapter.

Plasma research has become a fascinating area of study and leads to productive stepping in the field of global economic development. Industrial plasma [(i.) thermal and (ii.) glow discharge or non-equillibriam] are allowed to pass through multi- operational processes in their interaction with the materials to be processed, so as to make physical, chemical and metallurgical transformations successful, e.g. the processing of hydrocarbon plasma at low temperatures towards realisation of high quality diamond. Most of the traditional industries, in addition to the high technology industries, are aware of the high quality production range which creates a massive impact in the minds of the world's economists. It is a matter of pride for plasma research, that a thumb- nail - size microprocessor starts functioning as the 'brain' of a computer by carrying signals even four times more efficiently (with less interference) than before. Superconductors, high technology fine ceramic powders, bio-ceramic coatings in the form of spray in surgery, the unique plasma flame and many others, have proved that they can work with more efficiency and also without picking up objectionable impurities while working.

Not to speak of anything in details, but one can easily visualise over the complex field of ' plasma application ' as an assembly of deposition, removal or embedding of plasmas (dielectrics) in different forms through simultaneous effects of chemical, physical and thermal (metallurgical) transformations: e.g., ion nitriding (in hardening), anti-corrosion or other coatings, ceramic, recording media, computer chips with high efficiency, plasma polymerization,all are plasma treatments done with deposition method, while sputtering, etching, refining are linked with removal. Surface modification, welding, ion implantation for matching of high temperature alloys, electronics (semiconductors) are outfit matches in plasma embedding .

The tremendous development and growth oriented knowledge in the field of economics, science and technology, must have a proper balance with respect to plasma physics applications so as to increase the fruitful performances by the researchers in the greater interest of the welfare of human beings.

In **chapter 2** , we take up the case of a warm plasma model and consider disturbances of the ion acoustic type when the negative ions are present. Formation and propagation of solitary waves are also considered next in **chapter 3**, where the finite (small) ion temperature has been neglected. For this, we assume that the thermal velocity of each component of plasma ion is small enough in comparison to the phase velocity of the waves under consideration. Resonant effects such as Landau damping and particle trapping by the waves, are assumed to play a negligible role in the evolution phenomena. The nonlinear coefficient in the KdV equation changes sign, depending on the concentration of negative versus positive ions, thus admitting the formation of both compressive and rarefactive solitary waves. The existence of two different modes of propagation for ions with a finite temperature and the dramatic role of the negative ions in exciting ion acoustic waves in the plasma, have long been studied. It has also been established that the formation of ion acoustic soliton in the presence of negative ions does not depend on the temperature of the ions. Mishra and Chhabra (1996) have taken three different plasma systems (i) an Ar^+ plasma with F^- negative ions, (ii) a H^+ plasma with O_2^- negative ions and (iii) a H^+ plasma with H^- negative ions to study the ion acoustic, compressive and rarefactive solitons in a warm, multicomponent plasma with negative ions. We have considered a small perturbation measure ε when the electrons have a constant initial drift velocity along the one dimensional flow direction.

In **chapter 4**, the generation of nonlinear Alfvén waves with arbitrary phase velocity by an intense pulse is considered in order to determine the dependence of the amplitude of driven waves on the group velocity of the pulse (or the phase velocity of excited wave fields). Analytical, as well as numerical studies of the problem are carried out within the quasi-static approximation. The possible charge separation as a result of the finite Larmour radius effect is responsible for the coupling of the electrostatic mode which afterwards develops the formation of Kinetic Alfvén Soliton (KAS). Strong electromagnetic spikes having the appearance of solitary structures, have been observed to dominate the auroral low frequency turbulence in the altitude range 1700-600 km and these are described as KASs with both density dip and density hump. Experimental observations are carried out at 1 eV temperature in an environment where α ($=\beta/2Q$) and varies between $10^{-3}\mu_i \sim 10^{-1}\mu_i$ with μ_i equal to 1 for hydrogen ions (Wu *et al.*, 1996). In our treatment, low frequency or MHD range specified by ($\omega << \Omega_{ci}$) is considered since such waves are closely related to MHD shock waves. For long wave lengths, such studies are made by taking $k\delta_i << 1$, where $\delta_i = (m_i/e^2\mu n_o)^{1/2}$.

Depending upon results, and as in experimental setup for most conveniently undertaken experimental tests of MHD wave theory in cylindrical magnetoplasmas, we have considered the steady magnetic field B parallel to the axis of z. Generally, the electron inertial term is important if L (characteristic length) $\sim \delta_e$ where $\delta_e = (m_e/\mu n_o e^2)^{1/2}$. When the strength of the kinetic effect depends on the finite ion temperature through the pressure variation, it becomes important to study the above relation between L and the plasma frequency. We have introduced the finite but small ion temperature through the pressure term in the fluid equation of the warm ion component in the presence of the drifting electrons along the direction of the external magnetic field in **chapter 5.** Equal stress has been given to the roles played by the ion temperature and the initial drift velocity of the electrons in the formation of kinetic Alfvén waves (KAW), through the parametres α (ratio of the ion temperature T_i to the electron temperature T_e) and v'_e (the initial drift velocity of the electrons) respectively.

Lastly, in **chapter 6**, we have considered the quasi- steady linear stability analysis of kinetic Alfvén waves. We have used in this stability analysis, analytical methods for the case of KAWs in a cold plasma and numerical analysis for that in a warm plasma. For finite k with small ω ($\omega << \Omega_{ci}$), the Alfvén wave (shear mode with phase velocity $v_A cos\theta$) instability has been studied to see the dominance of Q over β . The latter part of this analysis consists of the study of the mode evolving through a parameter that describes the warm plasma motion leading to a shearing type of instability. The shearing instability analysis is carried out by Rucklidge & Mathews (1996) in nonlinear conversion and magneto conversion. The exponential growth in the normal mode is studied through the existence of complex ω for real k by Ghildyal and Kalra (1997).

Recent research developments in multi- ion plasmas relating to astronomical phenomena, show different characteristic properties compared to those in ordinary hydrogen plasmas. Such astrophysical multi- ion plasmas are available as dusty plasmas mostly in cometary regimes or in planetary rings. Due to charge separation effects, on account of variable charges on the dust grains, nonlinear evolution of plasma waves can be studied by means of perturbation on stable waves at the linear level. Moreover, instabilities due to momentum loss or gain, in addition to relative streaming effects between the electrons and the ions, are expected. Thus, an overall change in the nonlinear dynamics of plasma can be noticed if the field of research from the present status be extended to the field of dusty plasma. Another important aspect of plasma research lies in the field of laser produced plasmas. Plasma waves created by laser pulses, can be studied to get important results in the light of nonlinear steepening of leading edge of wave packets through the self- focussing of the pulses. It is observed that the generation of quasistatic magnetic fields (QSM's) is bound to be one of the most interesting and significant influence on the overall nonlinear plasma dynamics in laser produced plasmas.

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