CHAPTER-7
CONCLUSIONS AND FUTURE SCOPE

The principal goal of this compiled thesis is to understand the stability behaviors of various collective waves in diversified self-gravitating inhomogeneous astro-space plasmas alongside an exploration into their linear and nonlinear saturation eigenstructures. The collective excitation dynamics is herewith studied in a wide-range spectrum of astro-space parametric windows with the help of analytical, numerical and graphical methods. In the analytics, we apply standard formalism of the Fourier perturbation techniques, reductive perturbation techniques (multiscale analyses) and Sagdeev pseudo-potential (non-perturbative) methods.

In the linear regime, it is seen that the grain-mass acts as a stabilizing source to the cloud against self-gravitational collapse. Multiparametric factors affecting the instability saturation patterns are also identified and characterized in the nonlinear regime. Our investigated results are in good agreement with the earlier reports by others in similar directions. On application, the obtained results may be helpful in understanding the bounded structure formation mechanisms spontaneously triggered via the wave-kinetic processes sourced in redistribution of fluid mass, energy and angular momentum in dense interstellar media in different realistic astronomical conditions. The main conclusive remarks from the various Chapters compiling the thesis are given as:

1. In Chapter-1, a synoptic highlight on the diversified existential properties of astrophysical complex plasmas is conclusively provided with a special mention to the collective instability dynamics ultimately destined to the initiation of bounded structure formation.

2. We find, as in Chapter-2, an interesting dynamical fact that the interstellar constitutive dust grain-mass acts as a stabilizing source to the gravito-electrostatic instability excited in partially ionized dispersive astroclouds in the presence of turbo-magnetic effects.

3. In Chapter-3, it is seen that the weakly nonlinear electrostatic eigenmodes propagate as compressive monotonic aperiodic shock-like structures and the gravitational eigenmodes germinate as compressive non-monotonic oscillatory shock-like patterns. It is specifically noticed that the constitutive grain-charge (grain-mass) acts as electrostatic stabilizer (gravitational destabilizer) to the nonlinear turbo-magnetized cloud fluctuation dynamics.
Conclusions and future scope

4. It is found in Chapter-4 that the strongly nonlinear fluctuations in collisional astroclouds evolve as electrostatic compressive shocks and self-gravitational rarefactive solitons; where, the ion-drag force acting as a stabilizer to the electrostatic wave counterparts only.

5. In Chapter-5, it is seen that the electrostatic fluctuations in multifluidic nonuniform gravoviscous astroclouds evolve as rarefactive damped oscillatory shock-like structures; while, the self-gravitational ones, as compressive damped oscillatory shock-like patterns. The negatively-to-positively charged dust-mass ratio acts as destabilizer (stabilizer) in the electrostatic (gravitational) case; whereas, the negative-to-positively charged dust-charge ratio acts as stabilizer (destabilizer) in the electrostatic (gravitational) instability case.

6. It is found in Chapter-6 that the strongly nonlinear wave fluctuations in multifluidic nonuniform gravoviscous astroclouds support electrostatic compressive dispersive shock-like structures and self-gravitational non-monotonic compressive shock-like structures. It may, furthermore, be speculated that the referral frame velocity behaves as a destabilizer (stabilizer) in the electrostatic (gravitational) instability case in the complex astroclouds.

Finally, we briefly include some possible future refinements of the specific model approaches for further precise findings likely to be more informative and relevant in the varied astro-space-cosmic environs. In this PhD thesis, a number of analytic simplifications are made. We admit that a number of unavoidable factors should be considered at the outset, such as grain rotations, different inhomogeneous gradient forces, diffusions, grain-size distributions, grain-mass distributions, etc. Such refinements are indeed needed to see the real modified spectrum of collective waves and instabilities of great astronomical relevancy. Such instability excitations originate new wave-kinetic fluid transport processes responsible for the initiation of astrophysical structure formation through the spontaneous mechanism of redistribution of mass, energy and angular momentum in varied astro-space-cosmic media.