Turbulence and chaos in quantum plasma

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Recently, there has been a great deal of interest in investigating the properties of high density quantum plasmas. Due to the richness of phenomena encountered in quantum plasmas, theoretical physicists have experienced the multiple character of the quantum plasma manifestations and have suggested the use of different theoretical models and approaches that have revealed interesting connections between theory and the experimental evidence. Turbulence is an important phenomenon that is responsible for many aspects of plasma dynamics, particularly structure formation and transport of particles, momentum and energy. The concept of turbulence in quantum systems was conceived more than 70 years ago by Onsager and Feynman, but the study of turbulent ultra cold gases is very recent. The presence of intense turbulence in quantum plasma leads to the modification of its physical properties which induces anisotropy, thereby damping small-scale velocity structures. These systems exhibit universal statistical properties such as: chaotic behaviour, self-organized criticality, complexity, etc. In quantum plasma, at low temperatures, the turbulence also produces large correlations between the variables of the system.

In the present paper, we have studied quantum turbulence observed in perspective of quantum chaos theory. We study temporal and spatio-temporal chaos in turbulent quantum plasma and formation of micro structures and other transient macro structures through stochastic approaches. Maximum Lyapunov exponent (MLE) is computed and plotted in a two dimensional parameter (quantum diffraction parameter, Mach number) space to identify regions where weak and not so weak chaos appears. We also study the stability of transient structures and statistical properties.