Can we study turbulence in fluid complex plasmas?

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Turbulence is ubiquitous in nature and yet, it is far from being completely understood [1]. Complex plasmas are micrometre particles in a plasma environment of electrons, ions and neutral atoms. As they accumulate high negative charge due to higher mobility of electrons than ions, they interact with each other to produce collective behaviours, similar to many macroscopic systems. Thus, they provide a model system to study many fundamental problems like turbulence at a microscopic level. As these particles are relatively large and move comparatively slowly, we track them with high-speed imaging techniques of the ground-based PK-3 Plus laboratory [2] where our experiments are performed. We use dust acoustic waves, self-excited by the two-stream instability of ions moving past microparticles, to study turbulence. Due to considerable constant damping caused by the neutral drag force that slows down the microparticles as they collide with neutral atoms, it is necessary to study whether turbulence cascade can be observed before it is damped out. Here, we demonstrate that it is feasible to study turbulence in fluid complex plasmas even in the presence of constant background damping. In Fig. 1, an experimental snapshot is presented corresponding to the energy spectrum (red) in Fig. 2 with a power law of -1.3 (blue). In Fig. 2, we can also see that the cascade rate (green) is higher than the damping rate (pink) for a substantial range of wavenumbers, thus proving that it is possible to study turbulence as the background damping does not immediately damp out a developing energy cascade.

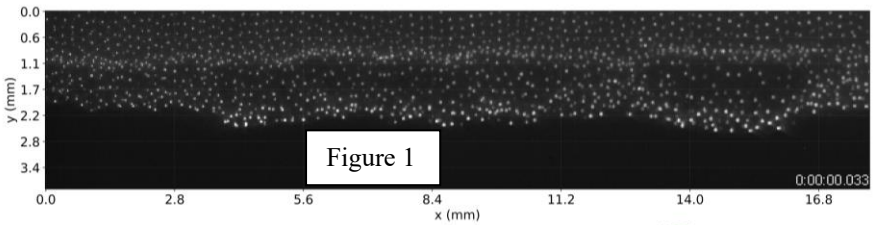
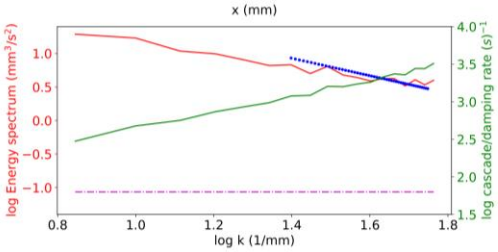


Figure 1

Figure 2



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[1] Frisch, U. 'Turbulence: The Legacy of A. N. Kolmogorov', Cambridge University Press, 1995.

[2] H. M. Thomas et. al., 'Complex plasma laboratory PK-3 Plus on the International Space Station', New J. Phys.10, 033036 (2008).