Threshold Phenomena in a Throbbing Dusty Plasma

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A dust cloud trapped in a plasma often contains a dust-free region ("void") near the plasma center. This void has important effects [1, 2]: it induces a spatial inhomogeneity of the dust particle distribution and is at the origin of many intricate unstable phenomena. One of this behavior is the heartbeat instability consisting of successive contractions and expansions of the void [3]. This instability is characterized by a strong nonlinear dynamics [4] which can reveal the occurrence of incomplete sequences corresponding to failed contractions. Experimental results based on high-speed imaging are presented for the first time and underline this threshold effect in both the dust cloud motion and the evolution of the plasma light emission.

Figure 1 starts with a strong enhancement of the central plasma emission which is related to a real void contraction (image 122). This phase is followed by the void expansion where the central light is strongly reduced in comparison with the surrounding plasma. In 184, the central emission is expected to accelerate its increase and to reach a value inducing the next contraction. On the contrary, the enhancement stops and the plasma emission follows the typical behavior of a new expansion (192) similar to 127 but with less marked changes. The real contraction is then delayed and the strong emission enhancement starts in 225. It reaches its maximum in 234 where the real contraction occurs.

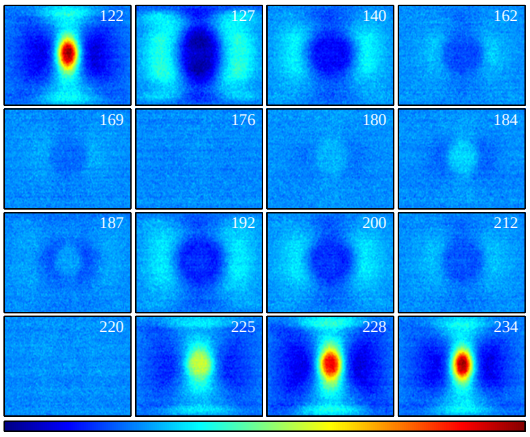

Figure 1: Evolution of the plasma luminosity (false colors) during a sequence containing 1 failed contraction in 184.

References

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