Observation of spatio-temporal instabilities in a Magneto-Optical Trap

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Nowadays, Magneto-Optical Traps (MOTs) are mainly used as a source of cold atoms, for example, to study quantum phase transition, cold molecules or to build metrology setups. However, recent studies have shown that studying the MOT can be very useful because it is similar to plasma system [1,2]. MOT has the advantage of being a quite simple setup with high level control compared to plasma one, so it can be used as a model system.

We are interested in the dynamics of a cloud of cold atoms in a regime of stochastic instabilites. This regime was previously studied in a retro-reflected configuration [2]. In such a system, the mean variables are the number of trapped atoms and the position of the cloud center of mass. The stochastic instabilities are characterized by a noise amplification randomly in time. More precisely, the variable evolution presents a low noisy signal with bursts of large fluctuations. Inside a burst, frequencies around 100 Hz are observed.

In the present work, we want to go further than the previous study which only considered the temporal dynamics. We add a fast video camera to the detection system. This camera has a high sampling rate ($>$ 1000 pictures/s) and is thus suitable for our observation. I will develop the method used to extract information from the huge amount of data produced by the camera. We will show that only some spots inside the cloud are unstable and not the whole cloud. The number of spots and their distribution vary in time due to the stochastic origin of these instabilites. I will be able to model the atomic collective motion responsible of the unstable behavior.

References

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