Cold damping in Microscope : a quantum thermodynamical analysis of noise.

Jean-Michel Courty*[1]

[1]Laboratoire Kastler Brossel (LKB (Jussieu)) – Université Pierre et Marie Curie (UPMC) - Paris VI, CNRS : UMR8552, École normale supérieure [ENS] - Paris – Case 74 - Tour 12, 4 place Jussieu, F-75252 Paris CEDEX 05, France

Abstract

The control of noise is essential in the success of the Microscope mission. In order to achieve the resolution needed to detect a potential equivalence principle violation signal at the level of 10-15 m s-2, the proof mass has to be shielded from non gravitational forces while the thermodynamical noise has to reduced by using the active technique of cold damping. This active noise control allows one to reduce the effective noise temperature below the ambient thermal level.
In the early development phase of the Microscope experiment, we have set up a quantum thermodynamical analysis of noises in a cold-damped capacitive accelerometer which has confirmed the results of the classical analysis developed in the Microscope team. The cold damping technique has then attracted the interest of the quantum optics community. It has been shown that, with an active feedback loop, it was in principle possible to cool the oscillator down to its ground state, equivalent to zero temperature. This technique is nowadays one of the main resources in the rapidly growing domain of quantum opto-mechanics.

As the launch of Microscope is now approaching, we propose to refresh the early analysis to match the current instrument design. We could then confront the real noise in the experiment with the quantum thermodynamical analysis of noise and evaluate the effectiveness of the cold damping technique. Furthermore, the noise of Microscope experiment could be used as a source of information. By mining this data source, important information may be retrieved about the performance of the instrument.

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*Speaker