

Optomechanical quantum nondemolition measurement of light intensity fluctuations

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According to quantum mechanics, there exists a class of observables for which is possible to confine the perturbation produced by a continuous measurement to the conjugate variable. Therefore, it is possible to devise experimental schemes that allow estimating the observed variable with arbitrary accuracy, or preparing it in a well-known state. Such schemes are referred to as quantum non-demolition measurements (QND). Among these observables there is the amplitude of the light field. Indeed, it is possible to exploit a movable mirror to implement a QND scheme¹. Intensity fluctuations of an optical field impinging on it are not affected by the interaction. However, the movable mirror is excited by the associated radiation pressure. This, in turn, affects the phase of the field.

We have performed an optomechanical experiment, based on a Fabry-Pérot cavity in which the end mirror is a high Q micro-mechanical device², where we have simultaneously measured intensity fluctuations of the field reflected by the cavity and the mirror motion imprinted in the phase fluctuations. By exploiting the correlations between these variables, we demonstrate a reduced uncertainty on intensity fluctuations actually reaching a sub-shot noise level.



SEM image of the micro-mechanical device with the central, 0.4 mm diameter, mirror.

1. K. Jacobs, P. Tombesi, M. J. Collett, D. F. Walls, Phys. Rev. A 49, 1961-1966, 1994.
2. A. Borrielli, A. Pontin, F. S. Cataliotti, L. Marconi, F. Marin, F. Marino, G. Pandraud, G. A. Prodi, E. Serra, M. Bonaldi, Phys. Rev. Applied 3, 054009, 2015.