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Quantum nondemolition measurement of light intensity fluctuations in an optomechanical experiment

Antonio Pontin[1,2] Michele Bonaldi,[3,4] Antonio Borrielli,[3,4] Lorenzo Marconi,[5] Francesco Marino,[2,5] Gregory Pandraud,[6] Giovanni A. Prodi,[4,7] Pasqualina M. Sarro,[6] Enrico Serra,[4,6] and Francesco Marin,[1,2,5,8]

1 Dipartimento di Fisica e Astronomia, Università di Firenze, Via Sansone 1, 50019 Sesto Fiorentino (FI), Italy

2 Istituto Nazionale di Fisica Nucleare (INFN), Sezione di Firenze, Via Sansone 1, 50019 Sesto Fiorentino (FI), Italy

3 Institute of Materials for Electronics and Magnetism, Nanoscience-Trento-FBK Division, 38123 Povo (TN), Italy

4 INFN TIFPA, 38123 Povo (TN), Italy

5 CNR-INO, L.go Enrico Fermi 6, 50125 Firenze, Italy

6 Delft University of Technology, Else Kooi Laboratory, 2628 Delft, The Netherlands

7 Dipartimento di Fisica, Università di Trento, 38123 Povo (TN), Italy

8 LENS, Via Carrara 1, 50019 Sesto Fiorentino (FI), Italy

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 scheme [1]. 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 device [2], 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 achieving a sub-shot noise level.

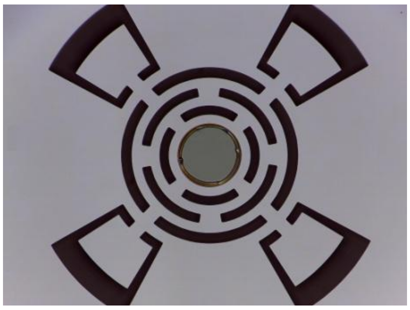

Fig. 1 SEM image of the micro-mechanical device with the central, 0.4 mm diameter, mirror.

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