Quantum hysteron: macroscopic quantum tunneling resolved by FORC method

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Macroscopic quantum effect (MQE), taken as a non sense point of discussion concerning the early quantum mechanics, has become a subject of great interest after introduction of the macroscopic quantum tunneling concept by Caldeira and Legget in the beginning of the 1980's [1]. Since then, the quantum tunneling of a large magnetic moment has been a common phenomenon in the studies of MQE. In this context, single molecular crystalline magnets, like Mn_{12} acetate, are model systems that permit the observation of quantum tunneling of the magnetization, thermal-assisted quantum tunneling and resonant tunneling of magnetic moment [2, 3]. Among other interesting characteristics, experiments indicate a very high magnetic anisotropy, with a superparamagnetic behavior above 3K, approximately [3]. In this work, we will show a novel experimental procedure, based on the adaptation of well known first-order reversal curves (FORC) method for the quantum steps in the hysteresis loop, to study the quantum tunneling of macroscopic magnetization in Mn_{12} molecular magnets. This procedure could be easily be extended to others two-levels quantum systems as well. [1] A. O. Caldeira and A. J. Legget, Phys. Rev. Lett. 46 (1981) 211. [2] M. A. Novak and R. Sessoli, in Quantum Tunneling of magnetization QTM94, edited by L. Gunther and B. Barbara, NATO ASI Series E (Kluwer, Dordrecht, 1995), Vol. 301, p. 171. [3] J. R. Friedman, M. P. Sarachik, J. Tejada and R. Ziolo, Phys Rev. Lett. 76, 20 (1996).