Disordered quantum systems simulation with Potassium Bose-Einstein Condensate

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The kicked rotor is a paradigmatic model for classical and quantum chaos. This model displays a classical diffusive motion, where quantum interference may lead to dynamical localization [1]. This phenomenon has been shown to equivalent to Anderson localization [2] [3], a ubiquitous quantum phenomenon which governs the properties of a large class of insulator materials in condensed matter physics. Since its introduction in 1979, the kicked rotor model aroused wide interest theoretically and experimentally. Recently, theoretical studies have reported new results on periodically kicked Bose gas in the presence of interatomic interactions [4] [5]. A new experimental apparatus creating quantum degenerate gases has been recently built in our group to investigate this new physics.

Experimentally, a Bose Einstein Condensate (BEC) submitted to a periodically pulsed standing wave of light reproduces the kicked rotor model. In a BEC, interaction strength between atoms can be controlled by using Fano-Feshbach resonance. The ^{41}K BEC experiment we have built is able to generate nearly pure ^{41}K BECs of 400k atoms with high repetition rate (~16s). We have recently observed a resonance of 39mG wide at 409,17G in the $^2S_{1/2}$ (F=1, m_F=1) state. This resonance allows us to reach several interatomic interaction regimes: repulsive, attractive and non-interacting. The last ingredient needed for the study of our system is the periodically-pulsed optical potential, which I built and characterized during my thesis. The originality of the system lies in the generation of powerful infrared pulses, converted to the near infrared domain using second harmonic generation. We are able to produce pulses at a repetition frequency between 100 kHz to 500 kHz with peak optical power up to 350W. This new laser system will allow us to explore physics of the periodically kicked Bose Einstein Condensate in the presence of tunable interatomic interactions.

References

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