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Design and realization of a ^{41}K Bose-Einstein condensate experiment to study the many-body atomic kicked rotor model

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The quantum kicked rotor (QKR) is a paradigmatic model of quantum chaos displaying dynamical localization (DL), which can be mapped onto an Anderson model in momentum pace. The QKR has been widely used to investigate Anderson-like physics experimentally by using laser cooled atoms exposed to a pulsed standing wave. In the presence of interactions, while the mean-field approximation displays a destruction of DL, new theoretical studies have shown the presence of a many-body DL in the Tonks-Girardeau regime. It shows the richness of the QKR problem with interactions, and motivates the experimental study of this system. In this talk, I will present the development of an experimental setup based on telecom fiber amplifier technology for the production of ^{41}K Bose-Einstein condensates (BEC). Useful frequencies are generated by our original laser-cooling system[1] in the telecom domain (C-band) before the power amplification and the frequency doubling steps. It thus preserves a high level of reliability for this kind of application. We also developed a frequency stabilization technique [2][3] and demonstrated its applicability in the cold atom domain, based on telecom technology, by using ro-vibrational transitions of the acetylene molecule. Finally, for the evaporative cooling in an optical dipole trap, we have built an original telecom laser system based on power control that does not require any active element in free space. In parallel with the development of the telecom laser sources, we have conceived and built the rest of the experimental system (ultra-high vacuum system, magnetic traps, electronic systems, etc). Thanks to these developments, we observed a condensate of $2 \cdot 10^5$ atoms, which will allow us to perform later experiments on the QKR model in the presence of interactions.

[1] C. Cherfan et al., Optics. Express,28 : 494-502 (2020);
[2] C. Cherfan et al., Appl. Phys. Lett, 119, 204001 (2021);
[3] C. Cherfan et al., Frontiers in Optics + Laser Science 2021, paper FM1A.3.

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