Synchronization in a conservative optical lattice

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In a conservative optical lattice, it is possible to trap cold atoms thanks to the external potential created by the reactive effects of the atom-light interaction. We study the behaviour of an atom trapped in a conservative square lattice in 2D, where the potential leads to non-linear movement equations that make chaos likely to appear. The parameters of the lattice, like the laser detuning [1] or the phase between the orthogonal standing waves that form it, allow to modify the dynamics of the atom and, in particular, to control the presence of chaos.

I will present some results of a deterministic approach on the behaviour of the atom inside the potential wells, which include simulations of the real potential and some calculations of an approximated situation. In particular, I will show how certain configurations of the square lattice lead to a synchronization [2] phenomenon between the movements of the atom in the two directions of space. This synchronization inhibits chaos and makes possible the existence of periodic and quasi-periodic solutions.

Finally, I will also present some of the preliminary results of a quantum approach on an atom trapped in a conservative square lattice.

References

[1] D. Hennequin, P. Verkerk, Phil. Trans. R. Soc. A **368**, 2163 (2010).

[2] D. Hennequin, P. Verkerk, Eur. Phys. J. D **57**, 95 (2010).