Quantum simulation of strong field phenomena and curved spaces in deformed optical lattices

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Low energy excitations in specially designed optical lattice systems can behave like relativistic particles. Inhomogeneous perturbations of these lattices can give rise to effective coupling to artificial electromagnetic fields and curvature. We give a review of interesting strong field phenomena, like *spontaneous pair creation* or *graviational lensing*, still not accessible in direct experiments, which can be simulated with cold atoms in finite size optical lattices.

References

[1] N. Szpak and R. Schützhold, Phys. Rev. A 84, 050101
[2] N. Szpak and R. Schützhold, New J. Phys. 14, 035001
[3] L. Klar, N. Szpak, and R. Schützhold, arXiv:1901.09880
[4] N. Szpak, arXiv:1410.1567

Figures

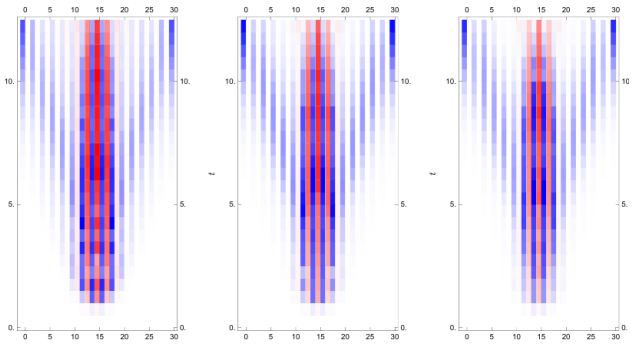

Figure 2: Simulation of *spontaneous pair creation* in lattice from Fig. 3 with attractive, none and repulsive interaction.

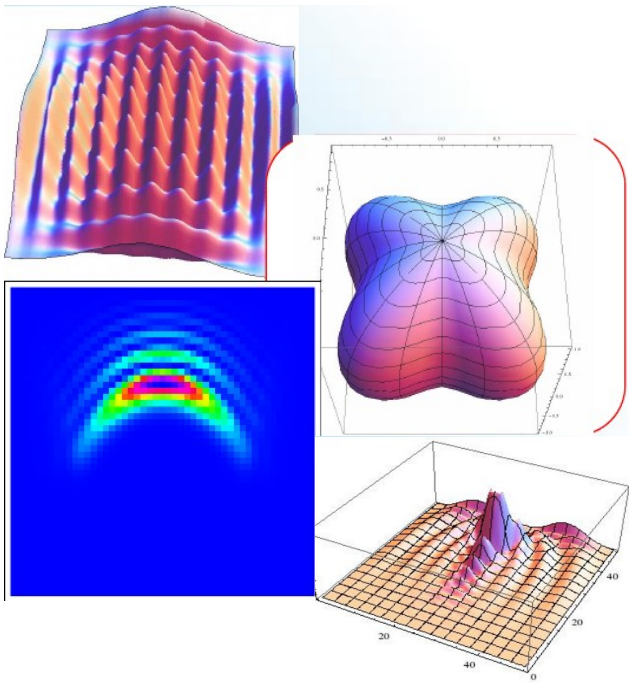

Figure 1: Finite size effects in a deformed optical 2D lattice (left top), interpreted in terms of a continuous analogue curved space (right top) lead to a *gravitational lensing* of propagating plane wave excitations (bottom left, right).

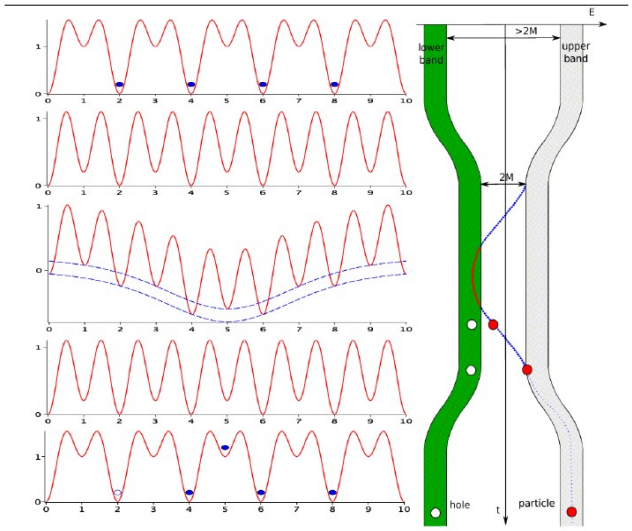

Figure 3: Modulated 1D optical lattice can simulate *spontaneous pair creation* via the dynamical Schwinger effect.