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## Forging graphene pseudospheres to mimic curved space-times

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In a previous work it was shown that the realization of the graphene topology on a Beltrami pseudosphere can lead to the analogue realization of the Hawking-Unruh effect [1]. This effect predicts that quantum fields in curved space-time with an horizon exhibit a thermal character due to the quantum vacuum and to the relativistic process of measurement.

Here we construct a computational model of a solid-state black-hole analogue consisting of a graphene membrane characterised by a three-connected tessellation engineered to shape it in the form of the Beltrami's pseudosphere, which is a surface with constant negative Gaussian curvature. Heptagonal and pentagonal defects emerge on the surface due to the negative curvature [2]. We devise a new algorithm to scale-up the pseudosphere dimensions reaching a radius R ~ 100 nm of the event horizon. Furthermore, we elaborate a tight-binding (TB) approach to calculate the local density of states (LDOS) for these extended curved structures. Comparison between the numerically evaluated LDOS [3] and the theoretically predicted one [1] shows, within uncertainties, its thermal nature, establishing the presence of a black hole type horizon in the system.

## References

 A. Iorio, G. Lambiase, Quantum field theory in curved graphene spacetimes, Lobachevsky geometry, Weyl symmetry, Hawking effect, and all that, Phys. Rev. D, 90, 2014
S. Taioli et al., Lobachevsky crystallography made real through carbon pseudospheres, J. Phys.: Condens. Matter, 28, 2012
T. Morresi, D. Binosi, S. Simonucci, R. Piergallini, S. Roche, N. M. Pugno, S. Taioli, Exploring spacetime singularity and Hawking radiation through deformed

S. Taioli, *Exploring spacetime singularity and Hawking radiation through deform graphene membranes*, submitted (2019)

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