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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

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