

Traces of the Unruh effect in surface waves

Guilherme B. Barros¹, André G. S. Landulfo², George E. A. Matsas³, João Paulo C. R. Rodrigues⁴

^{1,3,4}Instituto de Física Teórica, Universidade Estadual Paulista

²Centro de Ciências Naturais e Humanas, Universidade Federal do ABC

¹gb.barros@unesp.br, ²andre.landulfo@ufabc.edu.br, ³george.matsas@unesp.br,

⁴jp.rodrigues@unesp.com

One of the most interesting effects in quantum field theory is the Unruh effect¹. Discovered in the 1970s, it states that while an inertial observer in the Minkowski vacuum freezes to death at the absolute zero, a uniformly accelerated observer will see a thermal bath of particles with a temperature $T_U = a\hbar/(2\pi k_B c)$. It was a revolutionary discovery in its own right, and it corroborated the fact that the concept of particle itself is observer-dependent². Despite its conceptual importance, the effect has never been directly measured³, since the acceleration required to generate a thermal bath at $T = 1K$ is of the order of $10^{20}m/s^2$. On the other hand, analogue gravity in condensed matter has received much attention since the 1980s, after Unruh reached the conclusion that acoustic black holes emit phonon radiation, just as black holes emit particles (the Hawking effect)⁴.

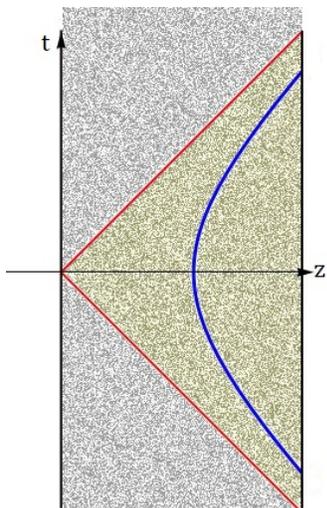


Figure 1: Experiment suggested by Ulf et al. The red line represents the sound cone, and the blue hyperbola represents the accelerated observer, moving through a white noise.

Recently, Ulf et al.⁵ found that introducing a Gaussian white noise in the water (which is used as a classical analogue for the inertial quantum vacuum), accelerated observers (Figure 1) see not only white noise but also a kind of thermal spectrum, with a characteristic temperature equivalent to the Unruh one. This conclusion is particularly interesting, since it does not rely on any quantum effects.

In this talk we will revisit this problem giving emphasis to the fact that real experiments in condensed matter will always have to take into account the boundaries of the system. Our work focuses mainly on trying to understand how the insertion of boundary conditions in the problem affects Ulf et al.'s results.

¹W. G. Unruh, Phys. Rev. D 14, 870

²S. A. Fulling, Phys. Rev. D 7, 2850

³G. Cozzella, A.G.S. Landulfo, G.E.A. Matsas, D.A.T. Vanzella, Phys. Rev. Lett., 118, 161 102 (2017)

⁴W. G. Unruh, Phys. Rev. Lett. 46, 1351

⁵U. Leonhardt, I. Griniasty, S. Wildeman, E. Fort, and M. Fink, Phys. Rev. A 98, 022118