Scattering of surface waves on an analogue black hole

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Recent years have witnessed an explosion of interest in Analogue Gravity in a great variety of physical systems. One of the goals of this field is to experimentally confirm Stephen Hawking's prediction that black holes emit thermal radiation.

With this objective in mind, we have embarked on the study of a hydrodynamical black hole horizon, created by a current rendered inhomogeneous thanks to the presence of an obstacle on the bottom of a hydraulic channel. In contrast to previous studies, the flow is here transcritical. In other words, we can distinguish two separate regions, in the first of which (the *subcritical* region) the flow speed is inferior to the speed of long-wavelength waves, while in the second (the *supercritical* region) it is superior to this speed. Moreover, the flow is accelerating, i.e. it is directed from the subcritical to the supercritical region. The flow is thus analogous to the curved spacetime in the vicinity of the horizon of an astrophysical black hole.

We show that an incident co-current wave, coming from the subcritical (exterior) region, is partially converted into a reflected wave propagating against the current, and partly into a negative-energy wave propagating with the current in the supercritical (interior) region. This gives a total of three outgoing waves, rather than two in the absence of transcriticality. The measured scattering coefficients are in good agreement with the predictions of the non-dispersive theory, where the kinematical description in terms of an effective spacetime metric is exact. An important feature of this process is that the scattering takes place in two stages a bit away from the horizon, and does not exhibit the thermality of the Hawking effect. Finally, we show the emergence of characteristic peaks in the two-point correlation function of free surface deformations, again indicating the presence of a horizon.