New challenges for analogue gravity? A bridge between Condensed Matter and General Relativity

Organisers: Mathieu Isoard (Freiburg), Maxime Jacquet (LKB, Paris), Theo Torres (Nottingham)

The success of the analogue gravity session, organized during the 2018 JMC in Grenoble, showed the growing interest for analogue gravity: it is clear that a large scientific community has gathered around the main themes of this field of research. Initially, analogue gravity was developed to reach a specific goal: the observation of Hawking radiation. After a long period of improvement of the theoretical and experimental techniques, the spontaneous creation of particles was finally observed in a Bose-Einstein condensate in 2019.

Vortex in a water flow seen from the side. Nottingham Black Hole Laboratory.

Aside from that objective, the approach of wave phenomena of analogue gravity makes a connection between all aspects of condensed matter – from hydrodynamic to optics, from theory to experiments –with General Relativity and Quantum Field Theory in Curved Spacetime. That is, analogue gravity is not a mere application of General Relativity, but an independent field of research which represents a new source of inspiration to deepen our understanding of fundamental processes at the interface of the many systems aforementioned. By using tools originally developed in gravitational physics, analogue gravity not only allows for a new interpretation of condensed matter experiments: it also offers a platform to design new experiments to explore regimes which still lack a theoretical description. For this reason, and in line with the 2018 session, we wish to define future challenges for our field of research.

During this workshop, we would like to gather the various members of the condensed matter community (hydrodynamics, non-linear optics, fluids of light, supraconductors, cold atoms, etc.). They will present specific topics in their field of research for which the tools, concepts and methods developed in gravitational physics may shed new light on their own field. Concomitantly, condensed matter physics is a well-established field which might bring new insights and new perspectives in General Relativity and Cosmology – for which the theory is not fully unequivocal in some limits.

In addition, we wish to encourage researchers from the gravity community to join our dialogue and to present their work in order to increase the variety of notions discussed during our session.