Labex INTERACTFS (https://labex-interactifs.pprime.fr/)

2022 Projet Proposition d'un module de cours à destination des doctorants

I. Informations générales :

Etablissement d'accueil ***Institution***	**X UP** ☐**ENSMA**
TITRE du cours en français ***French title***	**GRAVITATION ANALOGUE EN HYDRODYNAMIQUE INTERFACIALE**
TITRE du cours en anglais ***English title***	**ANALOGUE GRAVITY IN INTERFACIAL HYDRODYNAMICS**
Enseignant ***Teacher***	Germain Rousseaux **Tel :** 05 49 49 69 59 **Email :** germain.rousseaux@univ-poitiers.fr

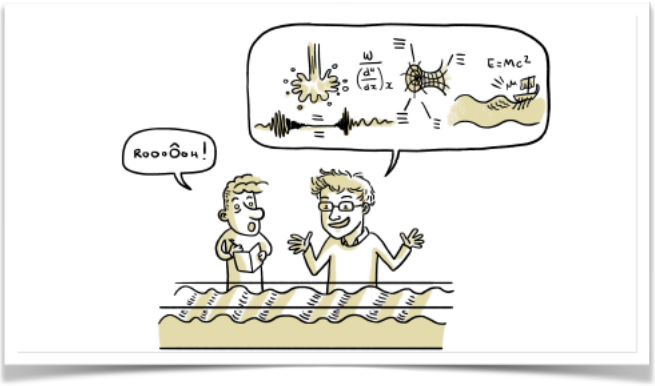
Jours	Horaire	Salle
Mercredi 25 Mai	10h-12h	175/177 H2 Futuroscope
Mercredi 1er Juin	10h-12h	175/177 H2 Futuroscope
Mercredi 8 Juin	10h-12h	175/177 H2 Futuroscope
Mercredi 15 Juin	10h-12h	175/177 H2 Futuroscope
Mercredi 22 Juin	10h-12h	175/177 H2 Futuroscope
Mercredi 29 Juin	10h-12h	175/177 H2 Futuroscope

II. Brève description du cours proposé

INTERACTIFS LABEX II. THEME: FLUIDS AND ELECTRICAL PHENOMENA AT INTERFACES YEAR 2022

Analogue Gravity in Interfacial Hydrodynamics

Germain Rousseaux CNRS Institut Pprime Poitiers

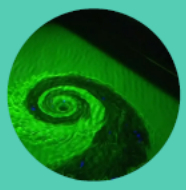


Trandisciplinary specialty training

This course is an introduction to Black Hole Physics and the expansion of the Universe through a physical analogy with interfacial flows (duration: 6 lessons of 2h = 12h).

In 1974, Stephen Hawking, eager to show that black holes were not thermodynamic objects, predicted to his own surprise that black holes, classically dark objects, radiate quantically. He confirmed the concept of black hole temperature, which is proportional to the surface gravity (the tidal acceleration) at the horizon of the black hole, the place where the speed of light corresponds to the escape speed occluding the inside the black hole from the rest of the universe. Hawking's radiation, which links the fields of quantum, gravitational and statistical physics, is an open window and an ultimate test for a theory of quantum gravity, which remains to be formulated. Unfortunately, the temperature is so small compared to the

A fish in a river behaves like light in curved space-time



A tub's siphoning vortex is a spinning black hole model à la Kerr

A circular jump in a sink simulates a white fountain (temporal inversion of a black hole)

1 HYDRODYNAMICS

Free surface flow, hydraulics jump, thin films

2 GENERAL RELATIVITY

Painlevé-Gullstrand metric

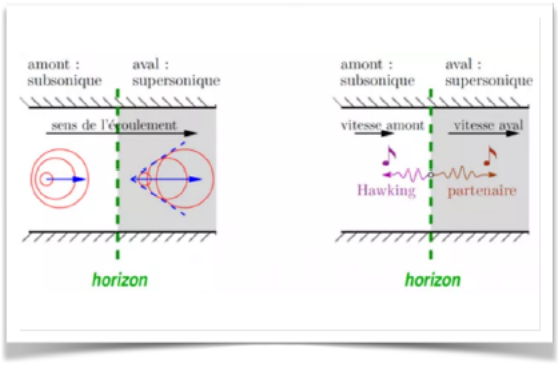
FLRW metric

3 INTERFACES

Water waves

Capillary waves

Soap bubbles



microwave cosmic background glow (the original Big Bang light) that it's like watching a firefly in a car headlight or hearing a whisper. in a rock concert: there is therefore no chance of observing Hawking's radiation in an astrophysical context despite the recent direct observation of the accretion disk of a black hole by the Event Horizon telescope. The field of Analogous Gravitation has turned this assertion upside down. We will introduce in this graduate school course some of the most advanced concepts and techniques in condensed matter physics (physical hydrodynamics, Bose-Einstein condensate, etc.) to observe an analogue of Hawking radiation in black holes laboratory, dive into a hydraulic wormhole for an interstellar journey or even model the expansion of the universe with soap bubbles. We will not study real gravitational objects, but analogues. Classical hydrodynamic and interfacial superfluid flows mimic space-time metrics with horizons. They are based on an analogy discovered by William Unruh in 1981 for acoustic waves and in 2002 for waves on the surface of water: the black hole is like a river flowing towards a waterfall, with a potential singularity like that at the center of a real black hole. We will therefore present the bases necessary to understand the current research challenges. Ulf Danielsson concluded the popularized presentation of the 2020 Nobel Prize in Physics with the prospect that the next step after observing an astrophysical black hole will be to find out what is happening at a horizon, the interface between two worlds par excellence ...

https://www.france.tv/france-4/c-est-toujours-pas-sorcier/c-est-toujours-pas-sorcier-saison-4/3144105-les-trous-noirs-ogres-de-l-univers.html

"As you probe ever closer to the horizons of the black holes, Nature might have new surprises in store..."

ON THE TEACHER

CNRS researchers in Physical Hydrodynamics at the Pprime Institute in Poitiers in the interdisciplinary Curiosity team created in January 2021

Research on Analogue Gravity for about fifteen years

Generalist, he has a penchant for Physical Analogies

Interface physics: wave-current interaction, tidal bore, thin films, soap films, interfacial instabilities, internal waves

English spoken: the lectures may be in English

germain.rousseaux@cnrs.fr +33(0)5 49 49 69 59