

For students of Master 1,2 in physics,
Presentation of the **group mathematical-physics** in
the **Institut Fourier** of mathematics in Grenoble

presentation by **Frederic Faure**.

October 16, 2020

1 The laboratory **Institut Fourier**

is on the Grenoble campus:

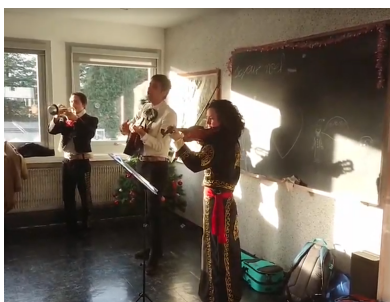


There are 120 researchers working in different topics of mathematics: Algèbre et géométrie, Combinatoire et didactique, Géométrie et topologie, **Physique mathématique**, Probabilités, Théorie des nombres. There is a big library.

- Daily work is reading, doing computations or discussing with the black board like this



or sometimes like this (☺):



2 What is mathematical physics?

- It may concern **all the subjects of physics**. As in theoretical physics we **study and develop mathematical models and methods used in physics**.
- Some difference with “theoretical physics” is that we are not directly in relation with new experimental results in physics. Our work relies on **mathematics**, results are published in mathematical journals and presented as **new theorems with their proofs**. Numerical experiments may be used to find new ideas or for illustration of the results.

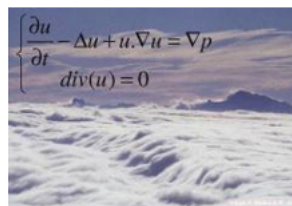
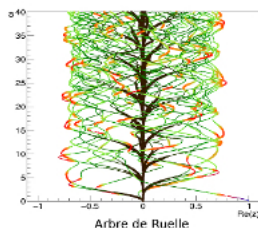
3 Topics in the grenoble groups of mathematical-physics and probability

20 people. More details with names and links are on the [web page](#), you can contact. See also the [probability group](#).

- **Relations between quantum mechanics and classical mechanics**: decoherence, semi-classical approximation, adiabatic methods, quantum chaos... try to understand the behavior of these quantum systems using specific models.
- **Fluid mechanics**: try to check if the model (Euler, Navier-Stokes) is well posed, find and study specific solutions: vortices etc...
- **General relativity**: try to prove that the model of black holes are stable with respect to perturbations (hence relevant as a physical model). Propagation of waves in curved space-time. Develop models of quantum field theory on curved space-time and study specific effects (Unruh..)
- Models of **electromagnetism** coupled to matter.
- **Dynamical systems and chaos theory**: consider simple models on deterministic dynamics with sensitivity to initial conditions and try to predict long time behavior. Find emergent probabilistic laws. Try to prove the Gibbs-Boltzmann distribution and Fourier law for heat propagation, from a deterministic model.
- **Statistical physics**, population dynamics in ecology, percolation, phase transitions.

Mathematical techniques that are used are e.g.: Partial differential equations, theory of distributions, theory of operators, spectral theory, differential geometry, Riemannian geometry, symplectic geometry, probability, etc..

- Remark: in 2021-2022, there will be a **Master 2 program** on mathematical physics. [Contact](#).



4 Some link to discuss

Let us meet on jitsi: https://meet.jit.si/Fourier_institut