Science Dialogue at Kobe High School

November 14th, 2023

Hello! はじめまして!

My name is Clément Moreau. I am from France and I am a researcher in applied mathematics at the Research Institute for Mathematical Sciences at Kyoto University. It is my great pleasure to come to your school next week and talk about my job and my research. I am looking forward to meet and discuss together.

Here is a preview of the contents of my presentation next week, so you can make sure you understand the important words in English. I marked some keywords which are perhaps technical with an asterisk and listed them at the end of this document.
Please think about what you would like to know or what you think when reading the following, and prepare questions if you wish. After each part of my presentation, I will take some time to answer your questions.

See you next week!

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My self-introduction : being a researcher is about exploring!

First of all, I would like to introduce myself and talk about why and how I became a researcher. In my opinion, a researcher is a curious person who likes to always learn about new things.
Before coming to Japan, I lived in several different places: the French cities of **Nantes**, **Paris** and **Nice**, and even one year in **York**, in the United Kingdom. Every time I moved to a different place, I discovered and learned many interesting things, and I really liked it, so I wanted to experience it again! This is one of the reasons why I decided to come live in Japan and to become a scientist.



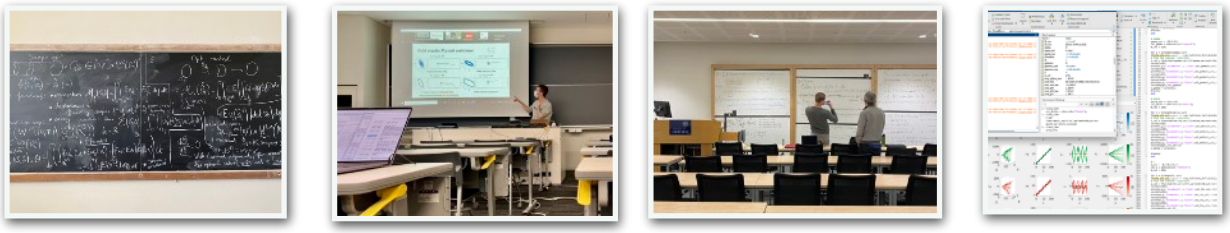

Some views of France and England

Thus, I would like to share some things I found interesting in the places where I have lived during my life. Hopefully, it will also make you curious and make you want to explore the world!

What do scientists do all day long?

Then, I will tell you about my studies and what it means to become a researcher. My specialty is **mathematics and physics**, but research in any topic has the same goal: **extending the borders of knowledge**. I would like to explain how one can study to achieve this exciting mission, in particular when preparing a ***doctorate****.

After this, I will talk about my job. Maybe it seems mysterious what researchers do in a laboratory. When I meet new people and tell them I am a mathematician, they often ask me what I do all day long. I think they wonder what it means to do research, especially in mathematics.
For me, it is a multi-faceted job where every day is different: doing calculations, working on ***numerical simulations****, reading about the last scientific news, discussing with colleagues, writing articles, going to conferences, teaching, and a lot more!



My daily life as a mathematician

Especially, I want to tell about what I like the most about being a researcher: **being free**, **always learning about new things**, and **traveling around the world** to meet other researchers.

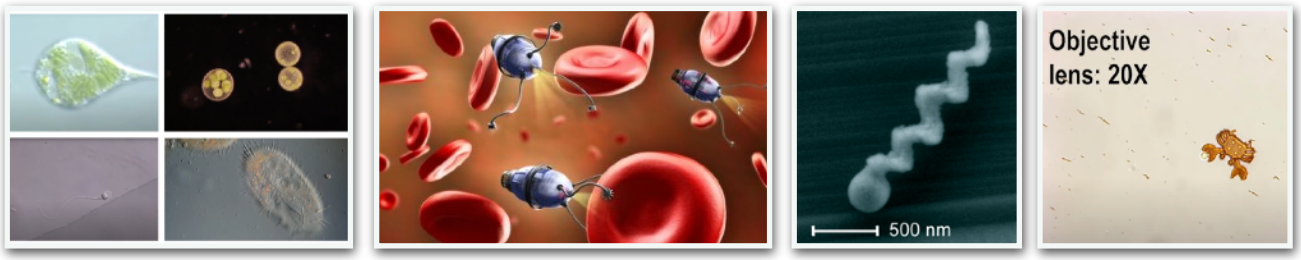
At this point, it should be time to finally talk about science.

The wonderful world of microscopic swimming

I will talk about my favorite topic: ***fluid dynamics****. Simply said, it deals with studying the motion of fluids. This is a vast and complicated topic with many research questions in many research fields, including physics, biology, mathematics and engineering: for example, you can think about the air around a plane, the water in a pipe, or the blood in our veins. For all of these, it is important to understand how they move, and we can do it by studying fluid dynamics equations (there are many of them, but maybe you heard of a famous one : the Navier-Stokes ***differential equation****).

I am particularly interested about fluid dynamics at the **microscopic scale** and specifically about ***locomotion****. Locomotion in water is called swimming, so for microscopic objects, we call it micro-swimming. It is also very important for a lot of ***micro-organisms****: ***bacteria**** and other tiny animals swim around to look for food and nutrients, ***spermatozoa**** swim to reach the egg, etc. Moreover, in medicine, to cure some diseases

or perform **non-invasive surgery**, it would be very helpful to be able to build **microscopic robots** which would swim inside the human body.



Micro-organisms and micro-robots

Have you ever wondered how it would be to swim inside water if you **measured only a few thousandths of a millimetre**? Would it be the same as swimming in a swimming pool? As a matter of fact: no, it wouldn't. When you are this size, ***inertia**** is negligible and the water (or any other fluid) around you appears to be extremely ***viscous****, as if you were swimming very slowly in a swimming pool full of honey! For that reason, swimming at microscopic scale is difficult and looks different from our usual world.

A flavour of scientific research

My research is about understanding better **how micro-organisms swim**, and elaborating **strategies** to **drive around swimming micro-robots**. There are many questions we can ask about this topic, and many ways to answer! This is why I want to explain about different method to solve these questions and problems.

As a mathematician, I am mainly focused on **theoretical questions**: I study the **equations that govern a robot's motion**, and try to predict if it is possible to **control** it to make it reach a target position, or follow a **prescribed trajectory**. To achieve this goal, I look at **fundamental mathematical problems** as well as ***numerical simulations**** on the computer.

Finally, I would like you to experience conducting research for a few minutes! So, we will try to answer together a simple research question: what is the best way to swim for a microscopic flagellum? We will build a ***model**** with equations and do numerical simulations to try to obtain some results.

Some technical keywords: doctorate, fluid dynamics, differential equation, micro-organism, bacterium, spermatozoon, flagellum, locomotion, inertia, viscosity, elasticity, mathematical model, numerical simulation.