

JSPS Science Dialogue

Alexis Marchand



福井県立高志高等学校

2025年3月6日

About myself

Name Alexis MARCHAND
アレクシ マルシャン

Country France

Job Researcher in mathematics
at Kyoto University

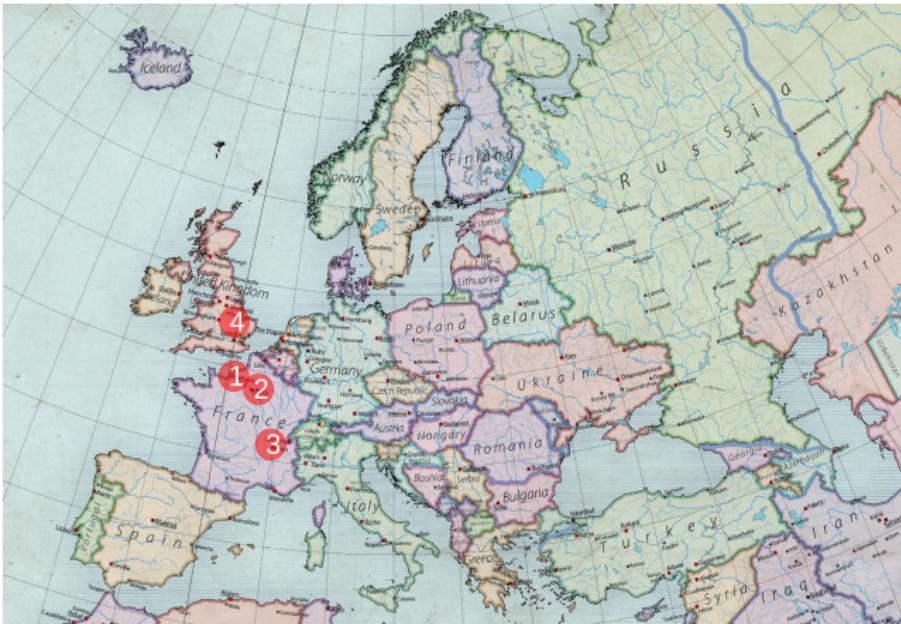
Hobbies Hiking, cycling,
cooking, reading,
learning Japanese calligraphy



My country

母国の話

My trajectory



- ① Born near **Paris** and grew up in **Normandy**
- ② At 18: started *preparatory school* in **Paris**
- ③ At 20: started university in **Lyon**
- ④ At 24: started PhD in **Cambridge, United Kingdom**

My trajectory



- ⑤ At 27: came to **Japan**

My country

France is famous for...

My country

France is famous for...

Paris



My country

France is famous for...

Baguette & croissants



My country

France is famous for...

Cheese



My home region: Normandy



I grew up near **Rouen**



Local cheese: **Neufchâtel**



Most famous place:
Mont-Saint-Michel



How I became a researcher

研究者になった話

Education in France and Japan

- **Common point:** there are **national entrance exams** (入試) for the most famous universities.
- **Difference:** in France, you need to spend two years in **preparatory school** before taking the exam.
- My preparatory school was a **boarding school** (寮).
- I entered **École Normale Supérieure de Lyon**, a university for future teachers and researchers.



My preparatory school in
Paris



ENS de Lyon

What made me want to become a researcher

- **Before university (入学の前):**
I enjoyed mathematics and always wanted to learn more.
Maybe there is also a subject that you really like?
- **At university (大学の時):**
I enjoyed learning and seized opportunities of memorable research trips.
- **During my PhD (大学院の時):**
I met many great people, especially my supervisor, who made me want to continue.



Research in Brazil



The University of Cambridge

My advice for Japanese high school students

- ① **Find what you like!**
好きな物を見つけて！
- ② **Failures are normal.**
失敗しても大丈夫です。
- ③ **Seize the opportunity!**
チャンスを掴んで！

What I find interesting about my research

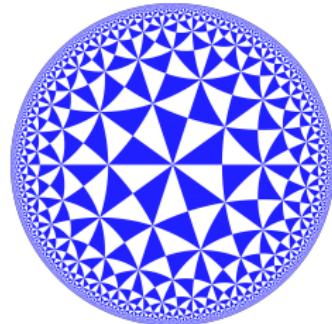
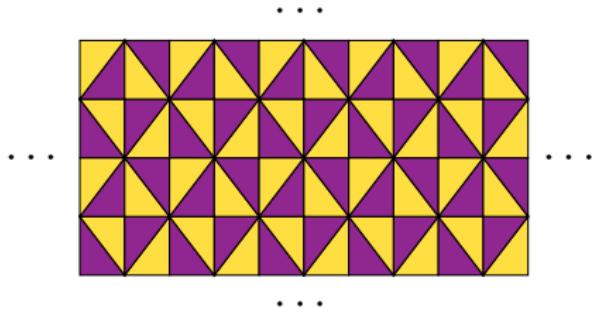
研究で面白いと思うこと

My area of research · 私の専門

I study ...

Geometric Group Theory 幾何学的群論

- Group Theory (群論) → theory of symmetry (対称)
- Geometric (幾何学的) → interesting geometric objects



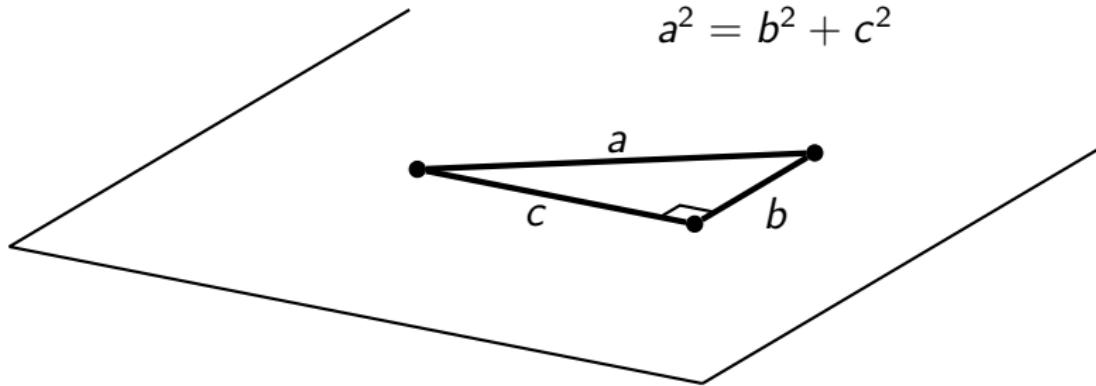
Euclidean geometry

ユークリッド幾何学

This is the geometry that you have studied at school.

It is the geometry of the **plane** (平面):

$$a^2 = b^2 + c^2$$

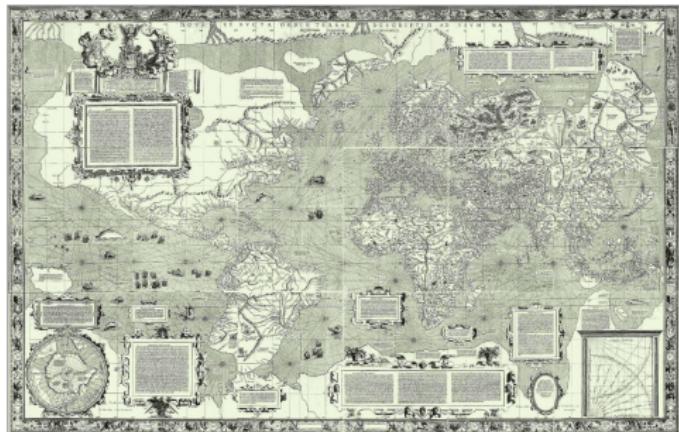
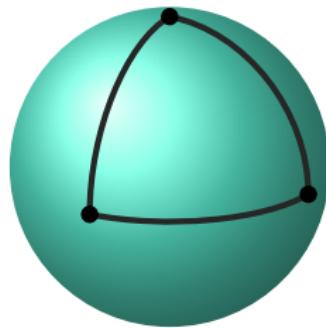


The plane has **zero curvature** (曲率がゼロ).

What do you know about Euclidean geometry?

Spherical geometry · 球面幾何学

This is the geometry of the **sphere** (球面):

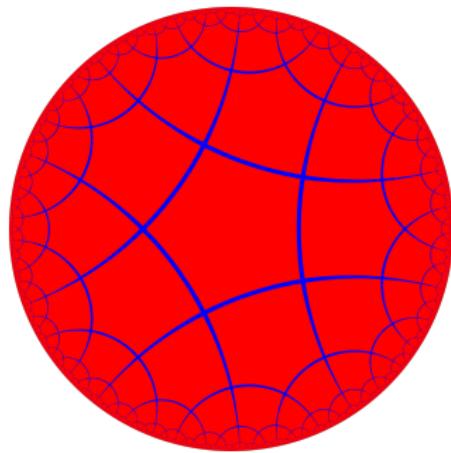
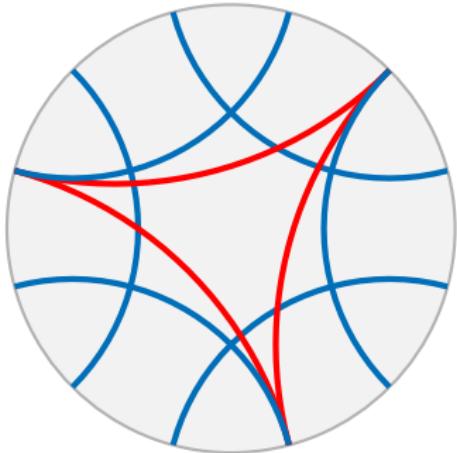


The sphere has **positive curvature** (曲率がプラス).

How is spherical geometry different from Euclidean geometry?

Hyperbolic geometry · 双曲幾何学

This is an abstract geometry.



This has **negative curvature** (曲率がマイナス).

It is a fascinating geometry.

The axioms of Euclid

ユークリッドの公理

Greek mathematician **Euclid** wrote a list of **axioms** (公理) for Euclidean geometry:

- ① Between points (点) A and B , there is a segment (線分).
- ② A segment (線分) can be extended to a line (直線).
- ③ There is a circle (円) of any centre (中心) and radius (半径).
- ④ All right angles (直角) are equal (同等).
- ⑤ If L is a line (直線), and $A \notin L$, then there is at most one line L' through A parallel (並行) to L .

1



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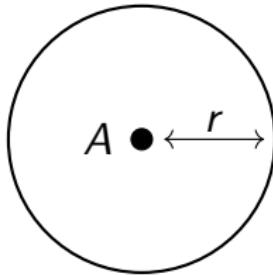
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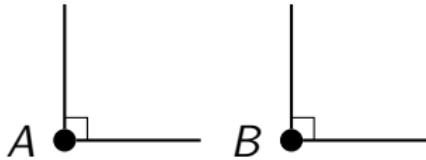
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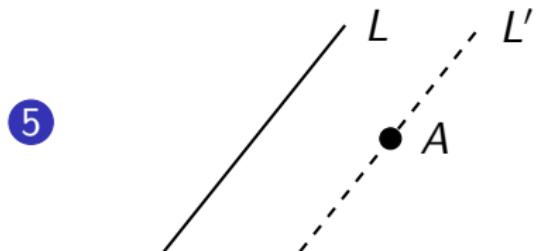


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The discovery of hyperbolic geometry

双曲幾何学の発見

For a long time, mathematicians thought that the fifth axiom was a **logical consequence** of the others:

- ⑤ If L is a line (直線), and $A \notin L$, then there is at most one line L' through A parallel (並行) to L .



János Bolyai



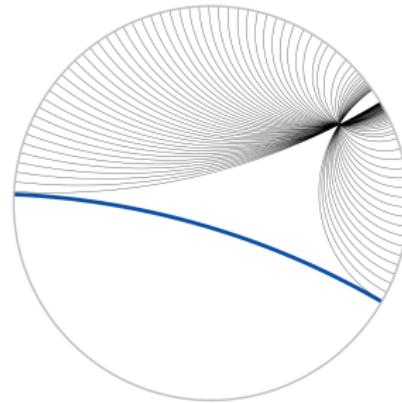
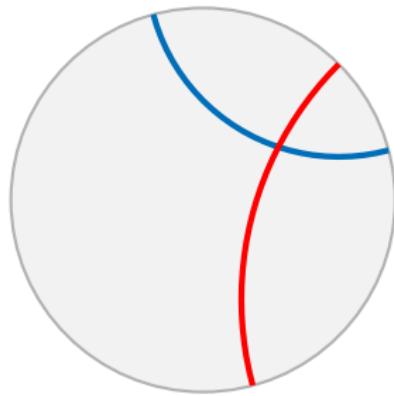
Nikolai
Ivanovich
Lobachevsky

But Hungarian mathematician **Bolyai** and Russian mathematician **Lobachevsky** invented a new geometry where the fifth axiom is false!

The rules of hyperbolic geometry

双曲幾何学の規則

We work in a **disc** (円板). It has a **boundary** (境界). **Lines** (also called **geodesics** (測地線)) are arcs of circles (弧線) which are perpendicular (垂直) to the boundary (境界).



Given a line L and a point $A \notin L$, there can be many lines through A parallel to L !

The strange hyperbolic world

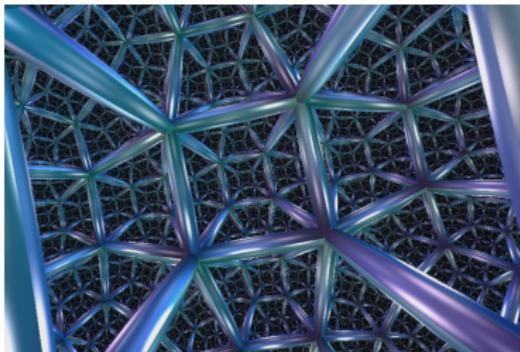
変な双曲幾何の世界

Fun fact: if you drive a car in hyperbolic geometry, and if you are not allowed to turn your wheels more than a certain angle, then you can never go back to your starting point!

A stroll in 3D hyperbolic geometry

三次元の双曲幾何の散歩

A software to visualise 3D hyperbolic geometry:



3-dimensional.space

Authors: Rémi Coulon, Sabetta Matsumoto,
Henry Segerman, Steve Trettel

The goal of my research 私の研究の目標

Understand symmetry in hyperbolic geometry and other similar geometries.



Circle Limit I, M. C. Escher

The daily life of a mathematician

数学者の日課

As a researcher, I...

- Try to solve **mathematical problems**.
- Attend **seminars** to learn about recent research.
- Read **articles** to learn new techniques.
- Speak with **other mathematicians** to exchange ideas.
- Write articles about problems I have solved.
- Give lectures to present my research.
- **Travel** to different places to meet other mathematicians.
- **Teach** university students.
- **Constantly learn new mathematics!**

Merci beaucoup !

ありがとうございました！

ご連絡下さい：

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