

# Introduction à l'information et au calcul quantique - ACCQ

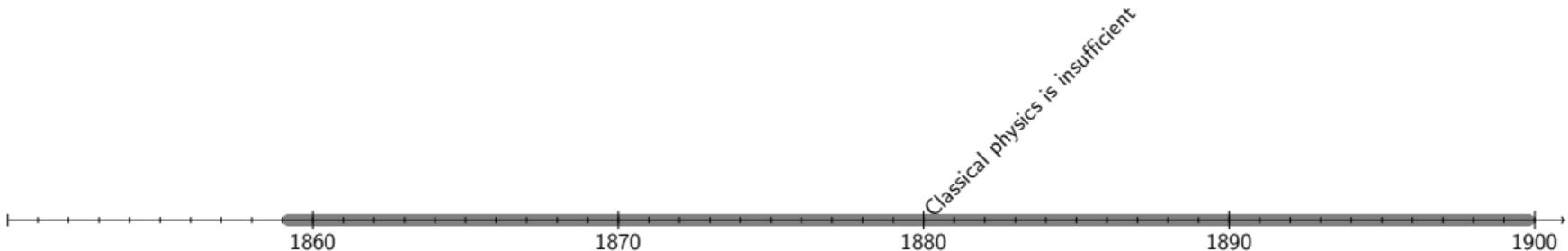
## 206

Alex Bredariol Grilo  
[Alex.Bredariol-Grilo@lip6.fr](mailto:Alex.Bredariol-Grilo@lip6.fr)

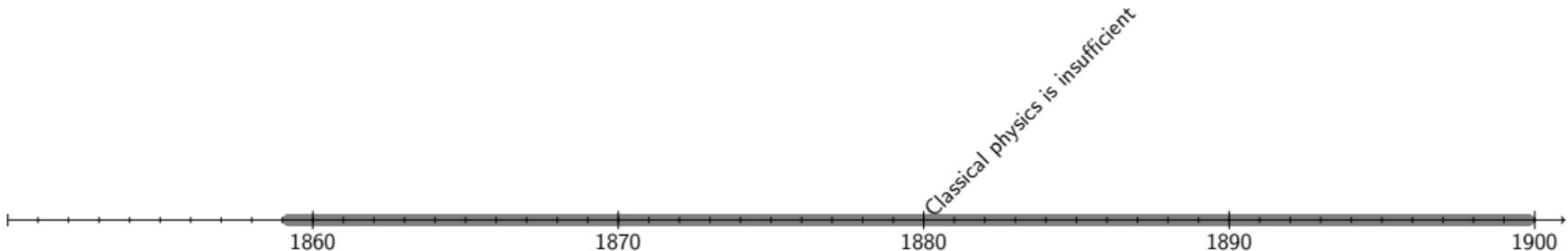


## A bit of History

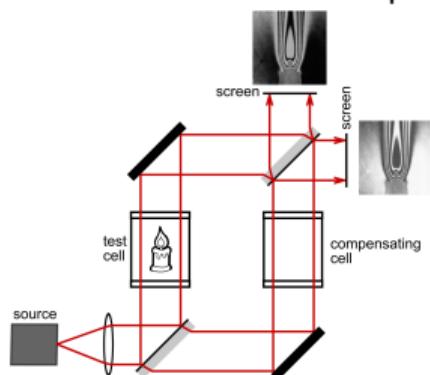
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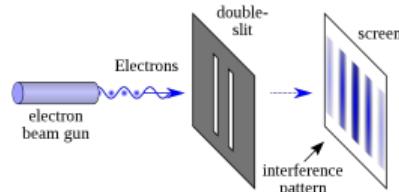
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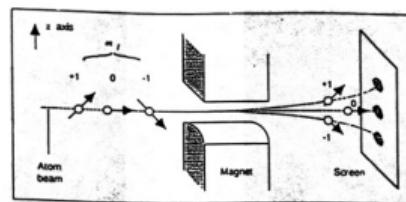
Mach-Zehnder experiment



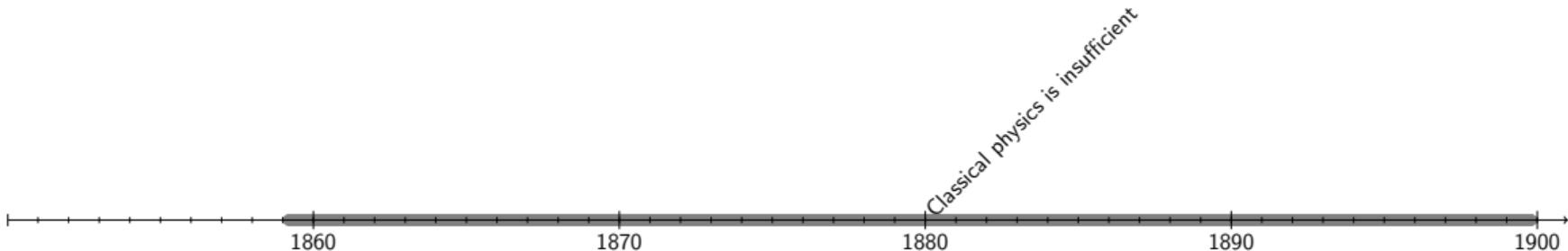
Double-slit experiment



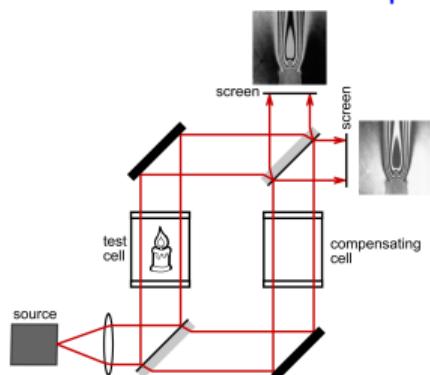
Stern-Gerlach experiment



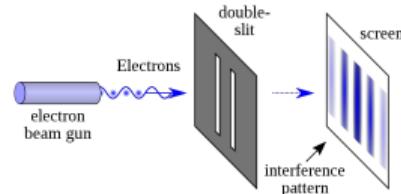
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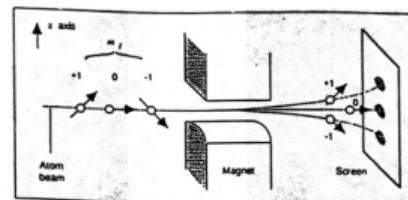
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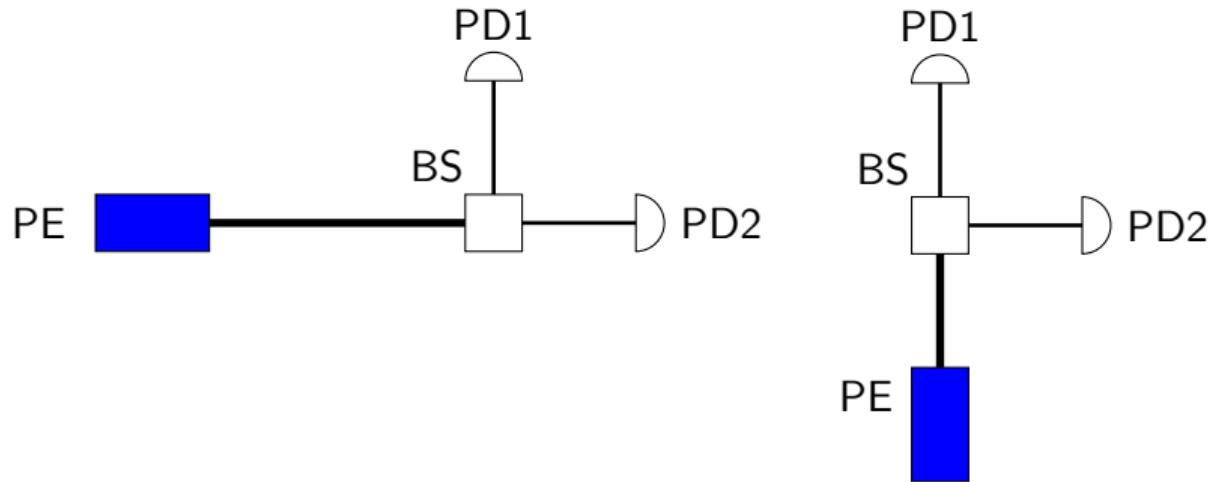
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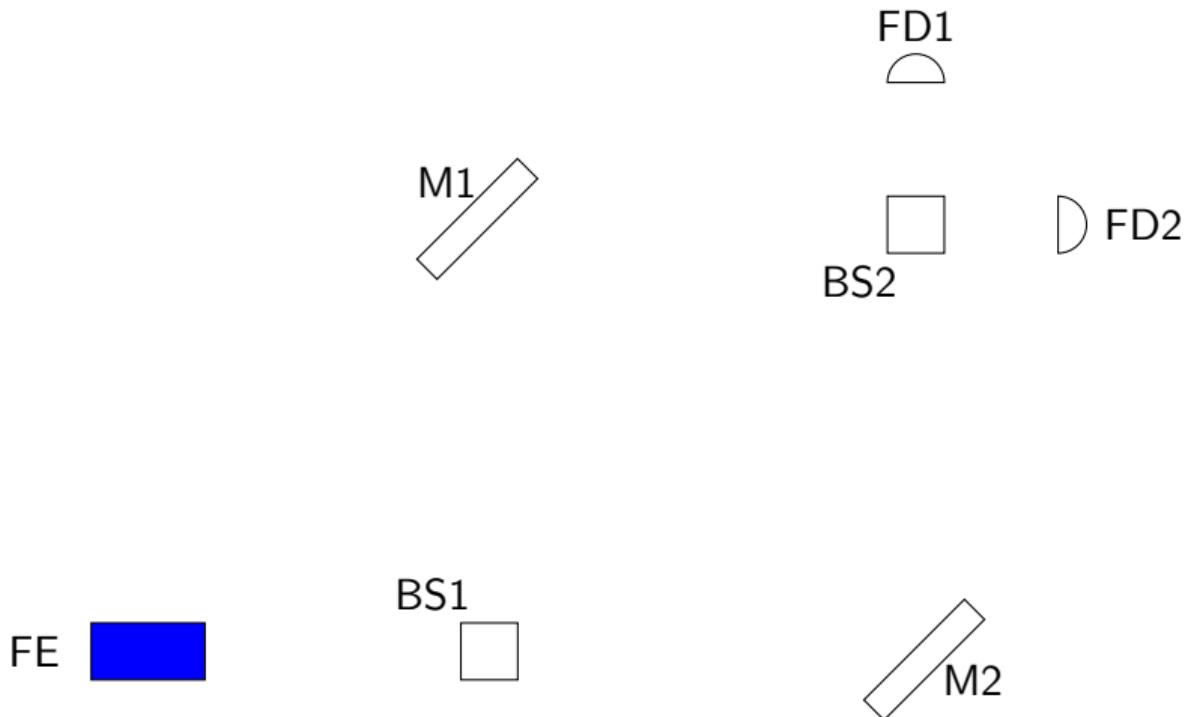
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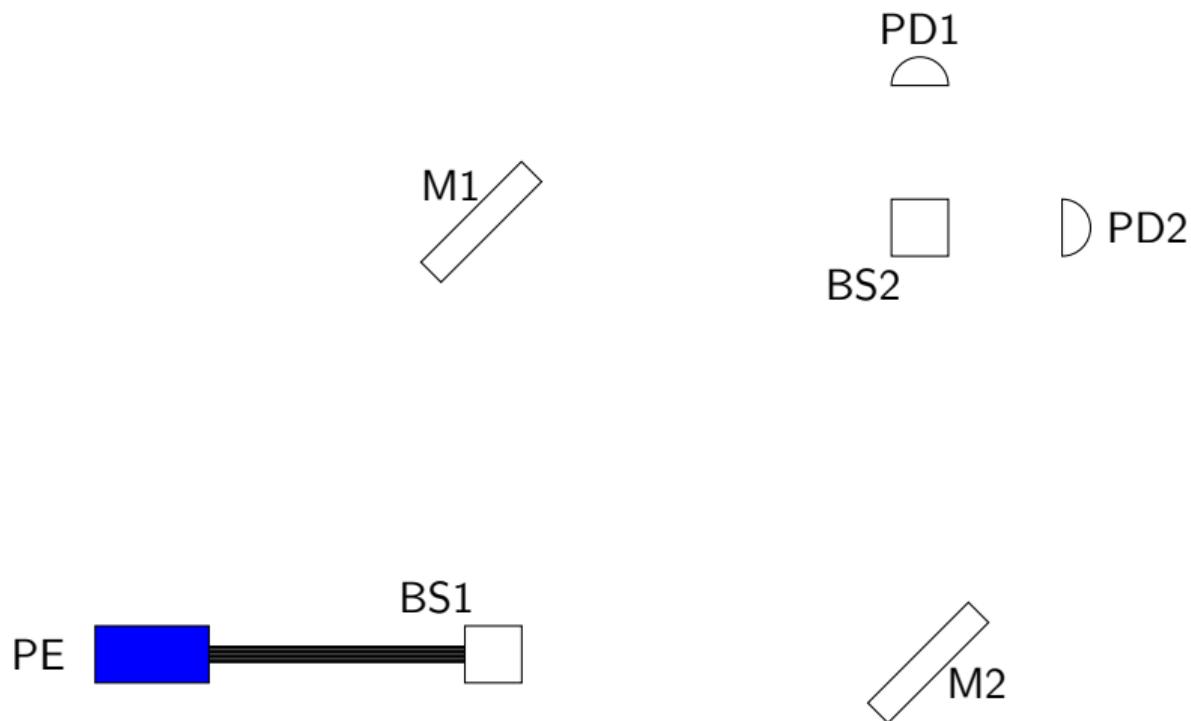
## Beam splitter



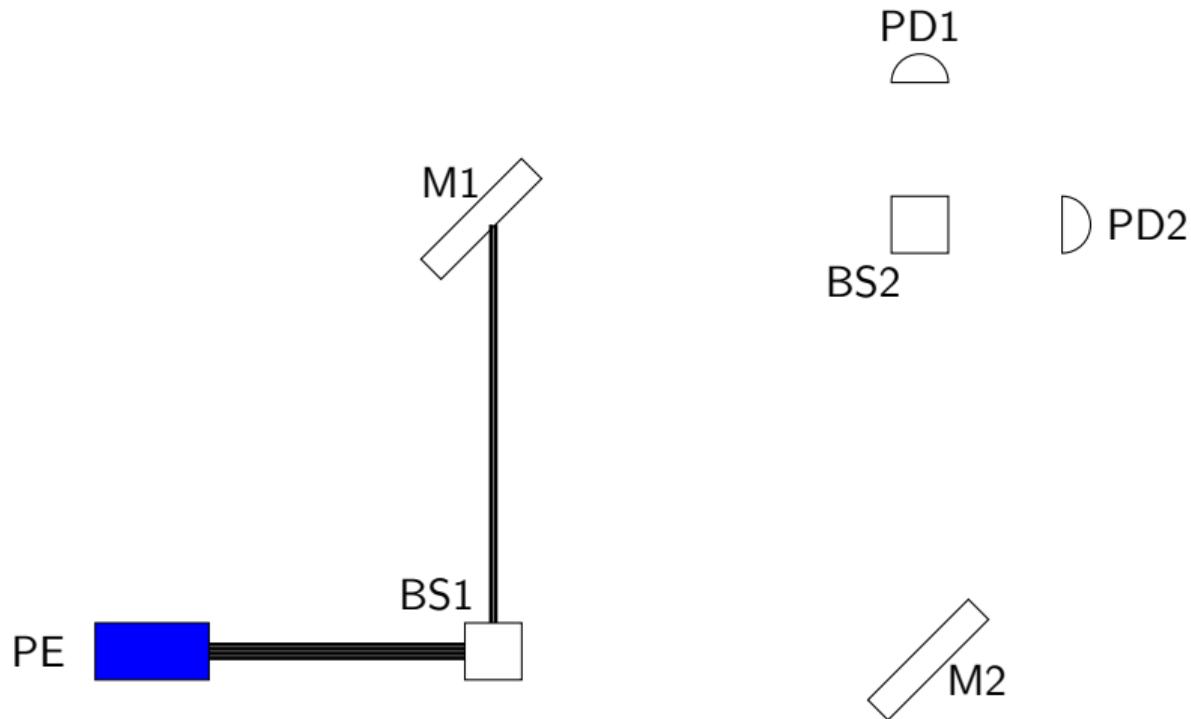
# Interferometer



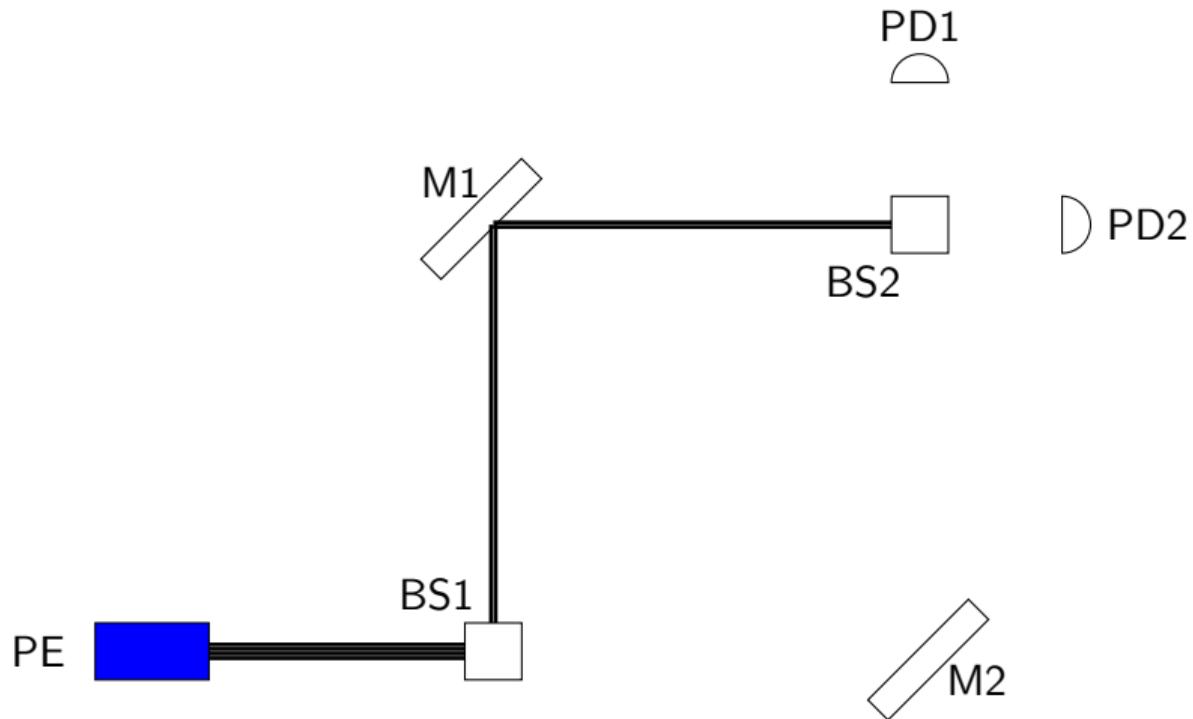
## Mach-Zehnder experiment (expected)



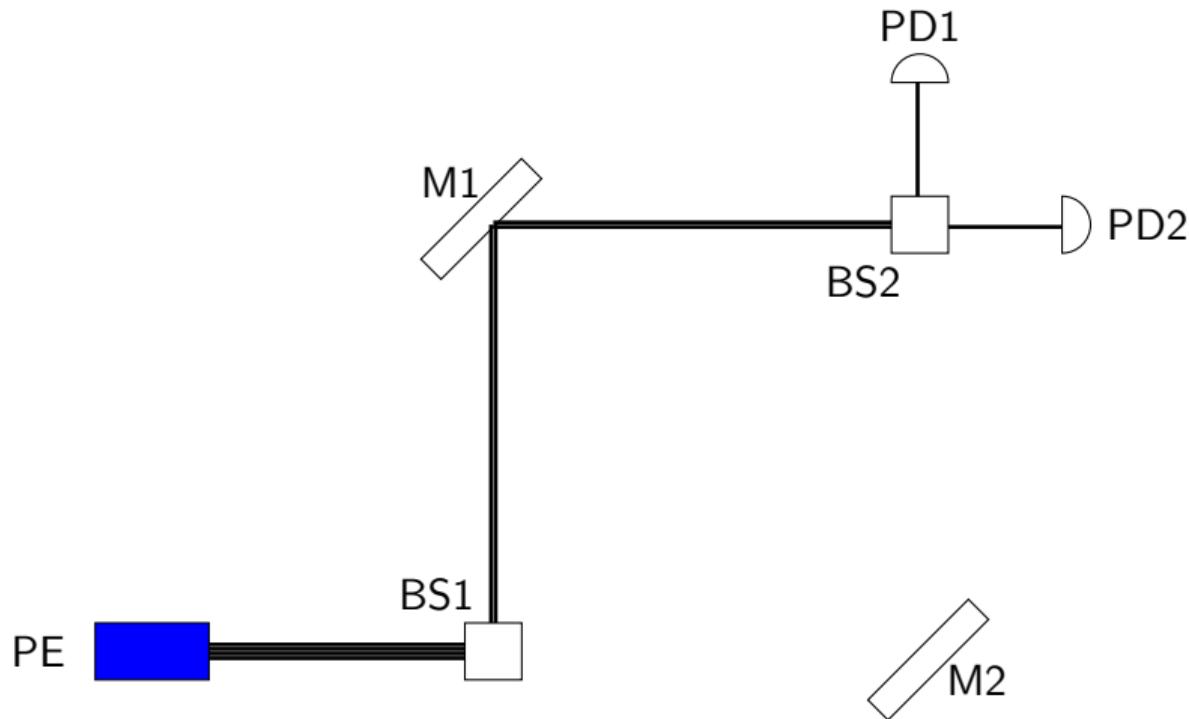
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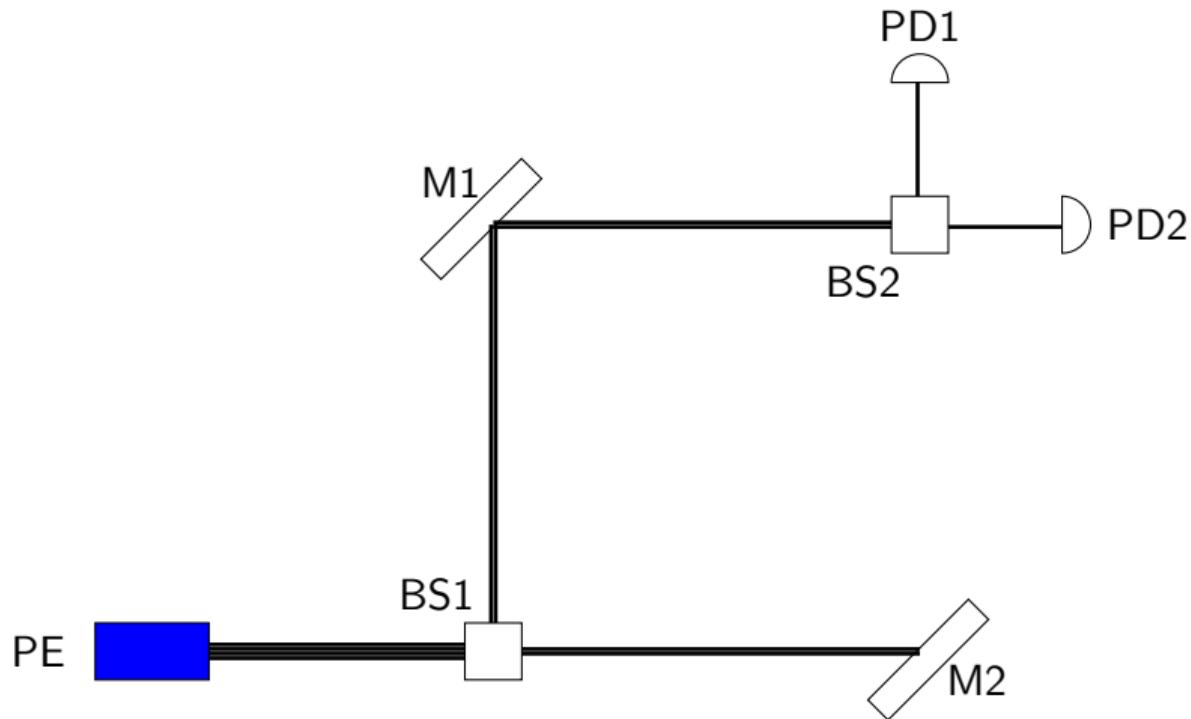
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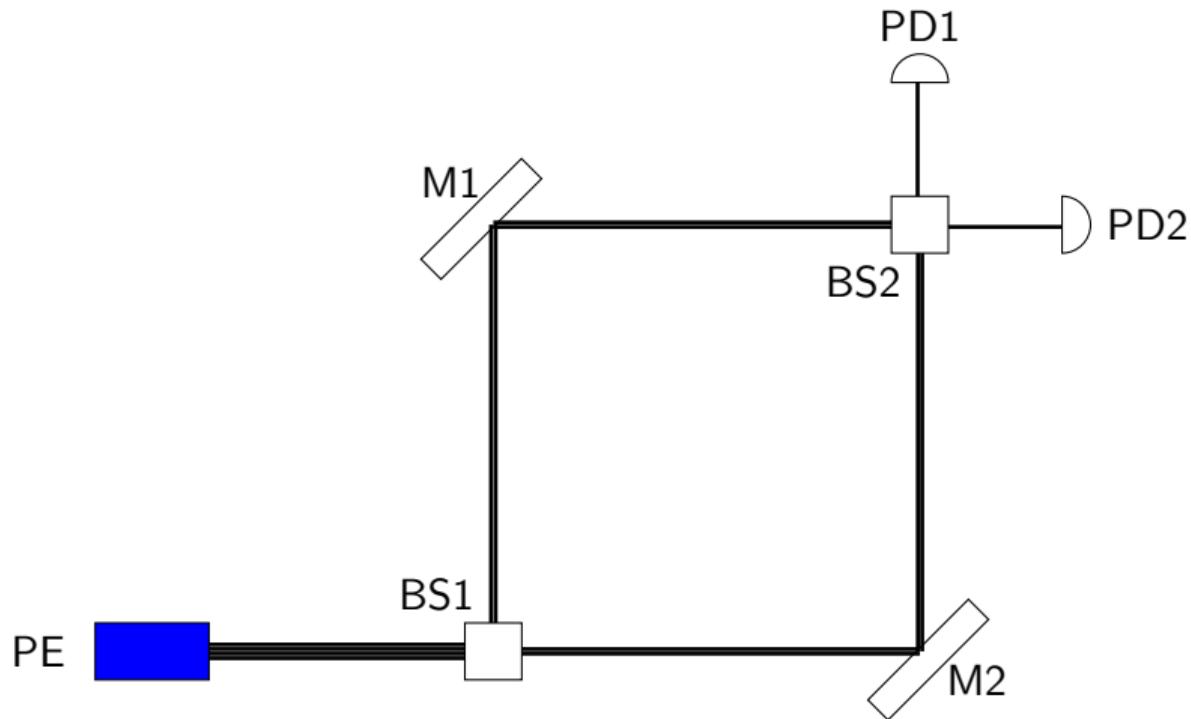
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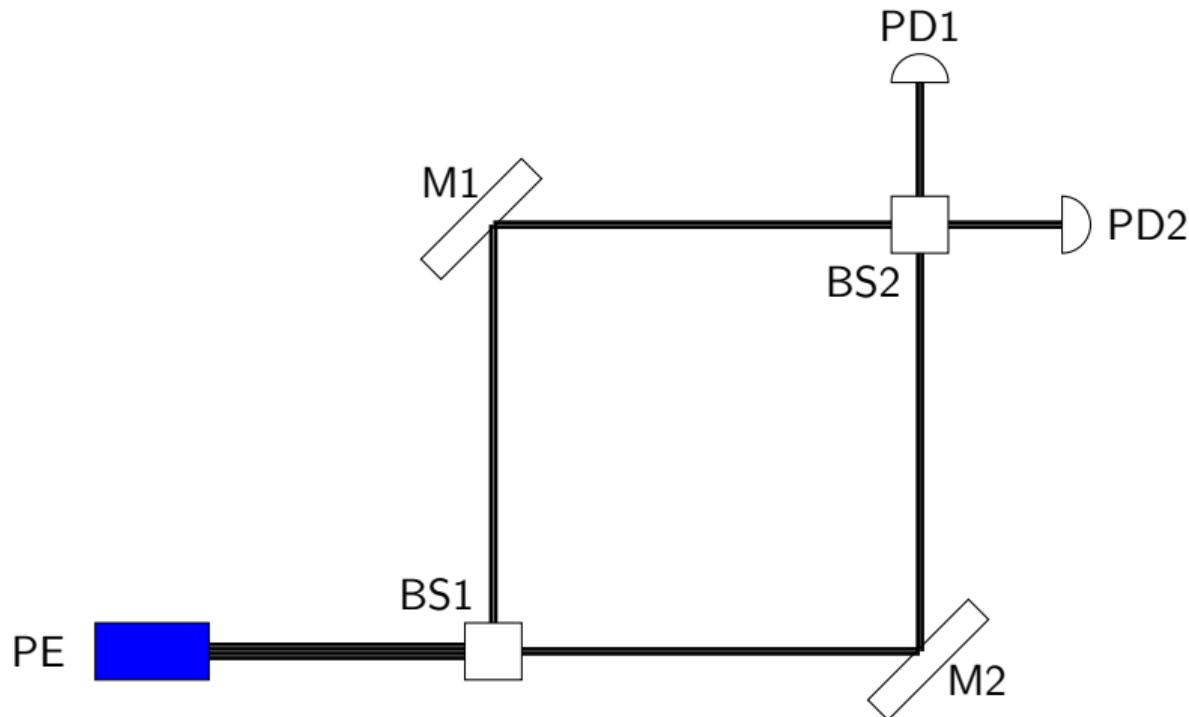
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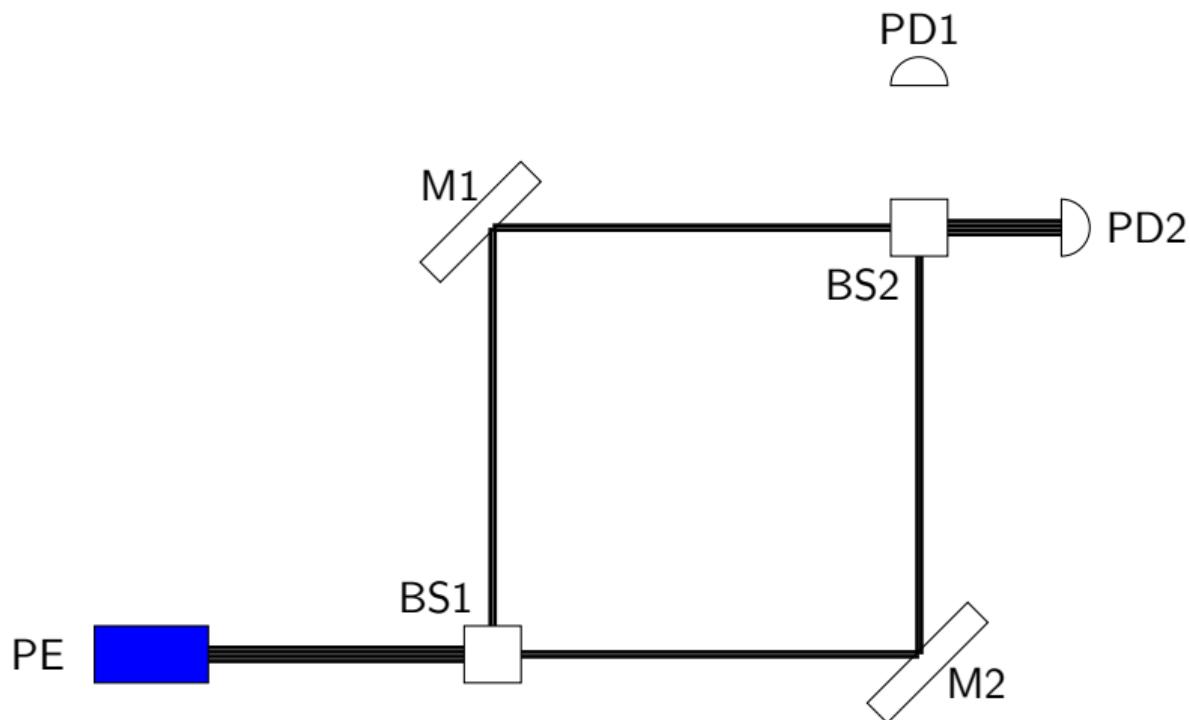
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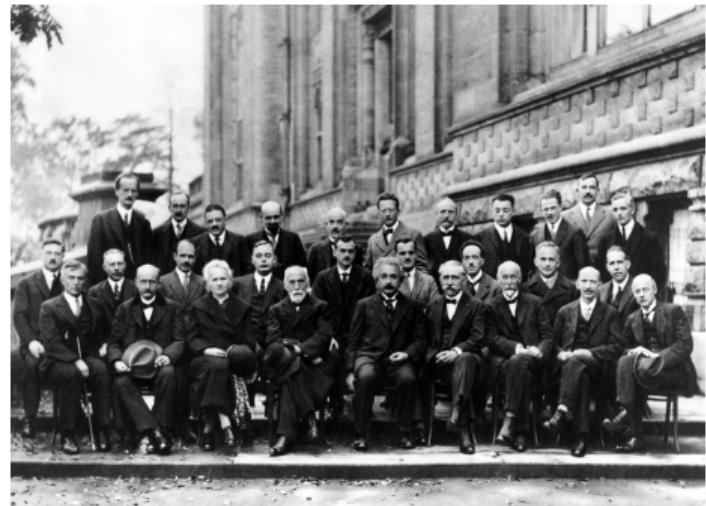
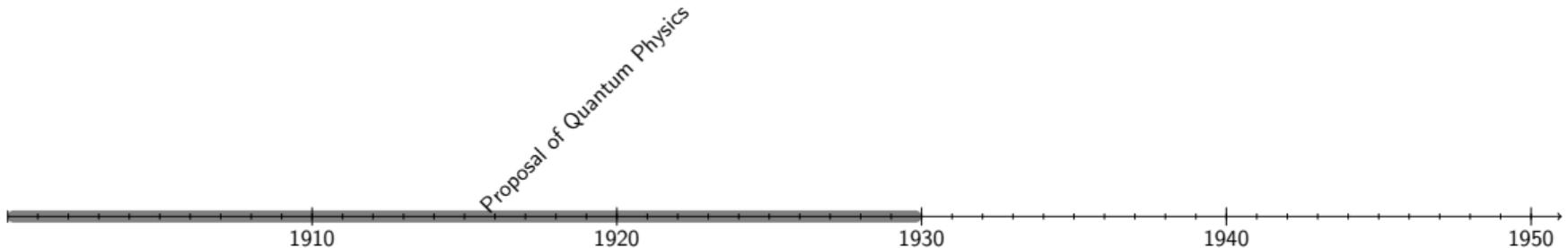


## Mach-Zehnder experiment (empirical results)

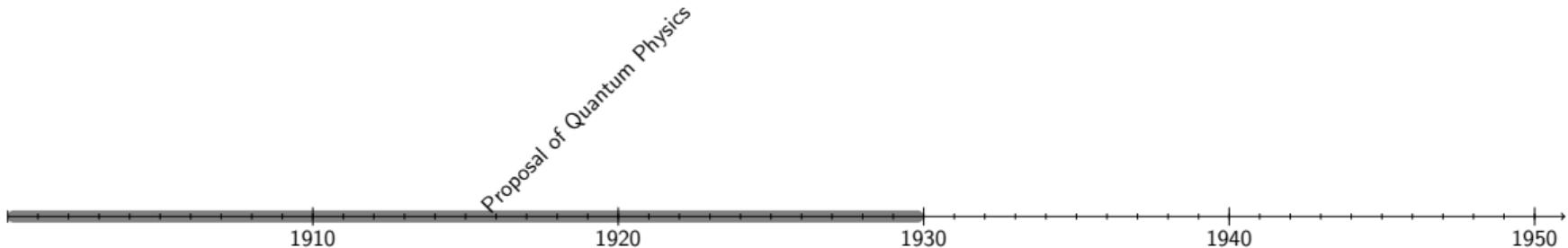


## First quantum revolution

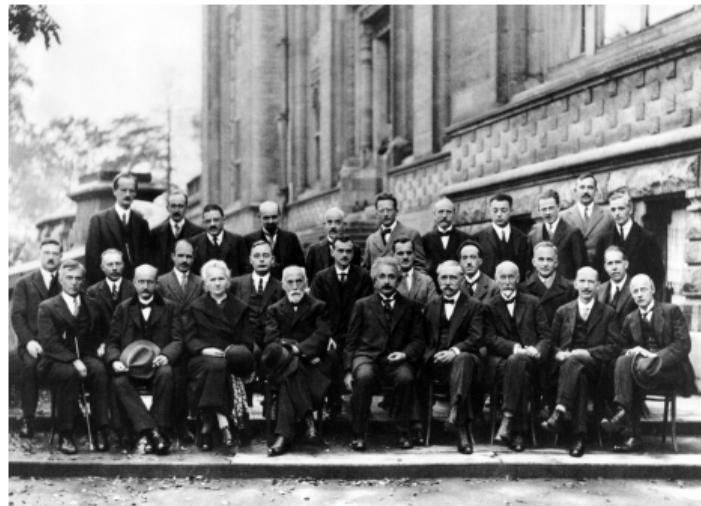
# First quantum revolution



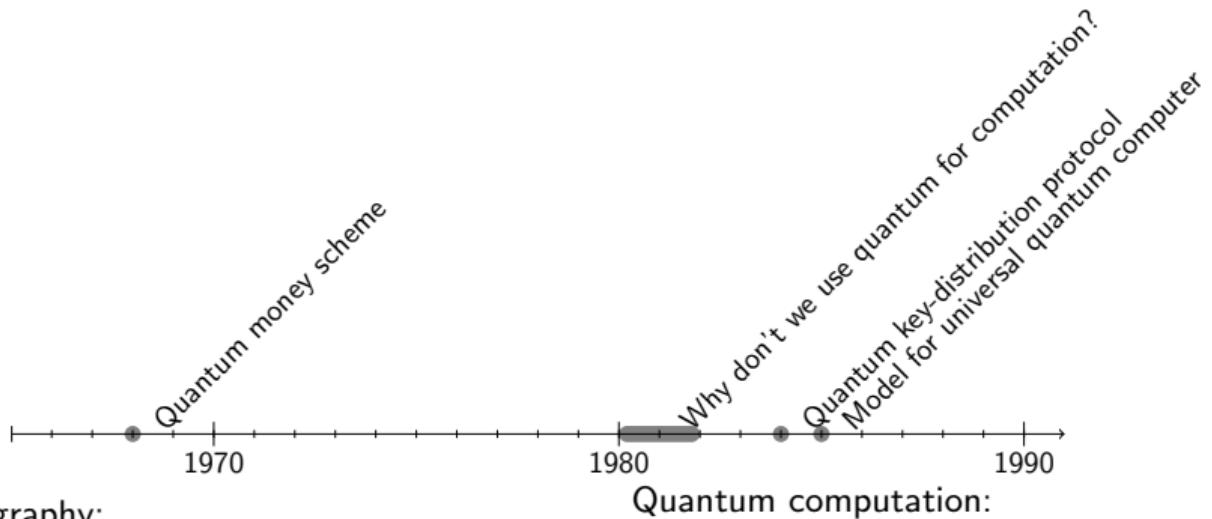
# First quantum revolution



- energy quanta
- wave-particle duality
- Heisenberg's uncertainty principle
- ...



# Quantum properties as computational resources

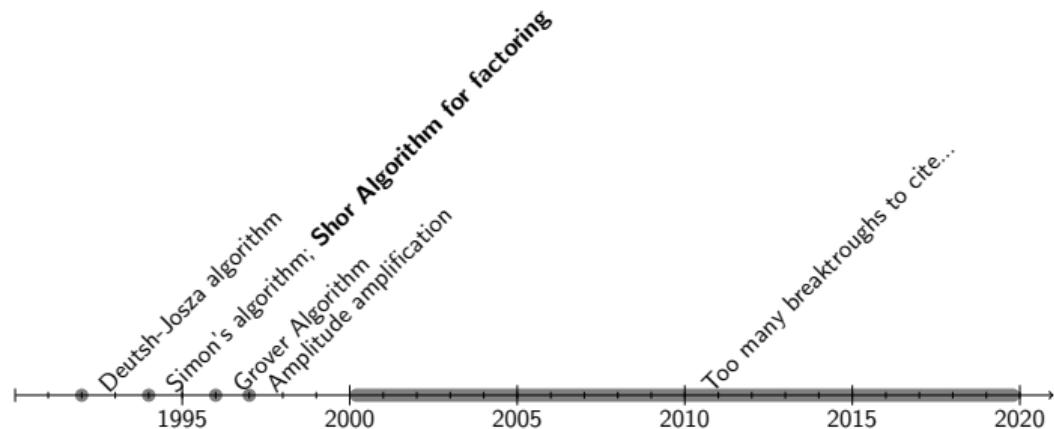


## Quantum cryptography:

- quantum states cannot be generally copied
- use quantum states as money
- protocols for sharing secret keys

- Classical computers do not seem to be able to simulate quantum systems efficiently
- Proposals of quantum devices to perform computation

# Boom of quantum computing (theory)



# Physical implementation

Quantum crypto is a reality...



... and quantum computing may be not too far



# This course

- **Goal:** Introduce quantum computing and an overview of types of problems that are studied in this field (theory)
  - 1 Introduction: qubits, quantum circuits, entanglement
  - 2 Quantum complexity and algorithms
  - 3 Quantum cryptography
  - 4 Quantum information and communication theory
  - 5 Theoretical aspects of implementation (error-correction, quantum advantage)
- **Lecturers:**
  - 1 Romain Alléaume ([romain.alleaume@telecom-paris.fr](mailto:romain.alleaume@telecom-paris.fr))
  - 2 Alex Bredariol Grilo ([Alex.Bredariol-Grilo@lip6.fr](mailto:Alex.Bredariol-Grilo@lip6.fr))
- **Pre-requisite:** Linear algebra and basic probability

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- **Zoom lectures:**

- ▶ Interact
- ▶ Ask questions (en français, si vous préferez)
- ▶ If you need breaks, let me know

# This course

- **References:**

- ① Kaye, Laflamme, Mosca, An introduction to Quantum Computing
- ② Nielsen and Chuang, Quantum Computation and Quantum Information
- ③ de Wolf's lecture notes, Quantum Computing: Lecture Notes  
<https://arxiv.org/abs/1907.09415>
- ④ Preskill's lecture notes, Quantum Computation  
<http://www.theory.caltech.edu/~preskill/ph219/>
- ⑤ Any (reliable) resource that you might find useful...