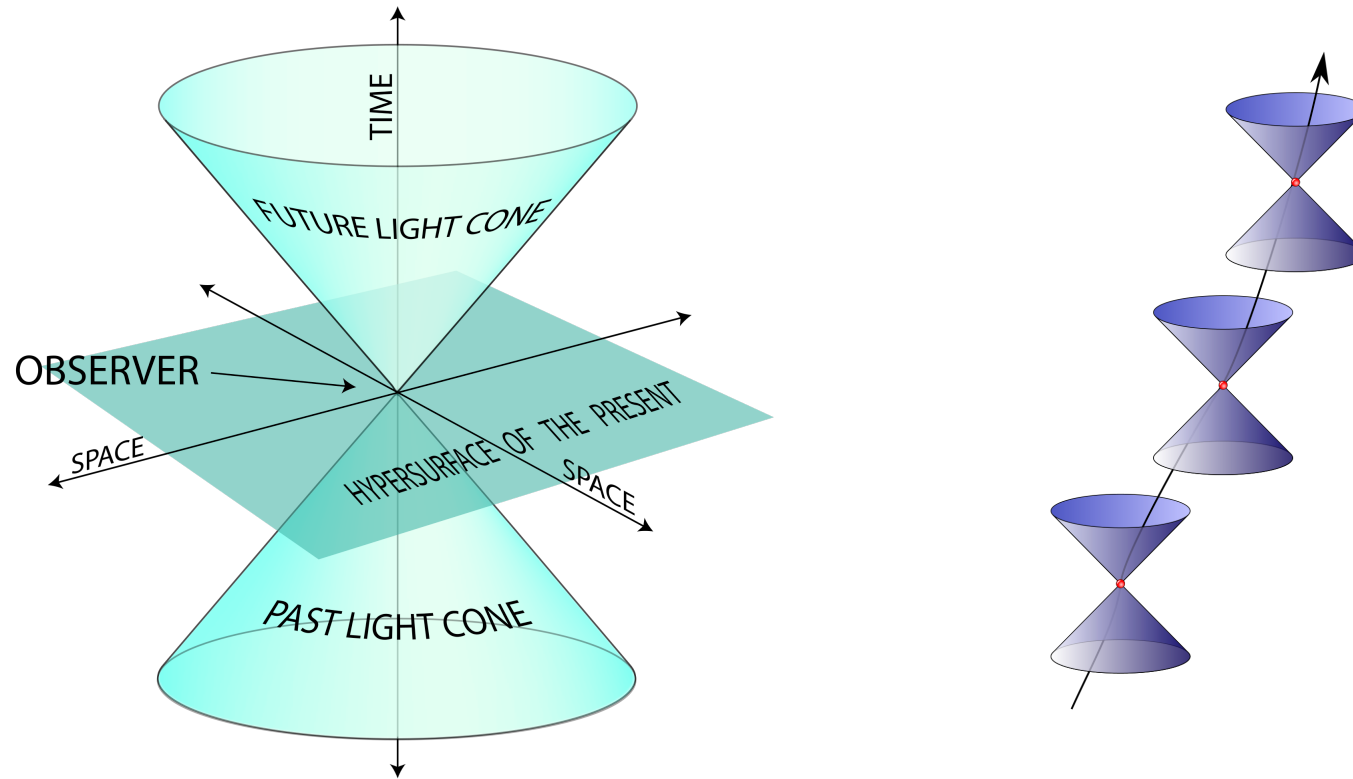# **Relativity**

Fiorenzo Bastianelli

48 hours − 6 CFU

- Special relativity

- General relativity

Special relativity

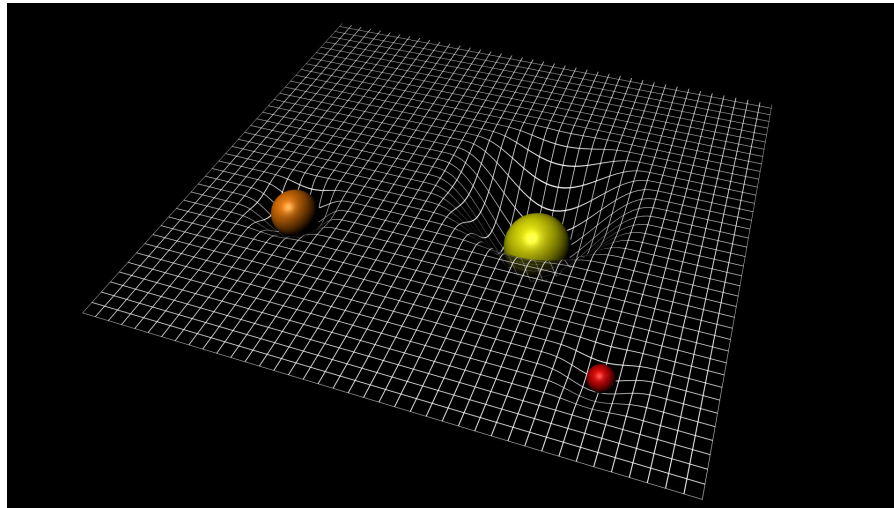Lorentz transformations $\rightarrow$ Minkowski spacetime

● Tensorial formalism to describe relativistic phenomena in flat spacetime (relativistic particles, Maxwell's equations in covariant form, etc.)

General relativity

Curved spacetime $\rightarrow$ Theory of gravitation

Spacetime tells matter how to move,

matter tells spacetime how to curve

- Tensor analysis in curved spacetimes, Einstein's field equations
- Applications: gravitational waves, Schwarzschild solution
and black holes

96397 - Relativity

ACADEMIC YEAR 2023/2024

Learning outcomes

At the end of the course, the student knows the main elements of special relativity and general relativity, the main experimental tests in their support, and the geometric interpretation in terms of spacetime. In particular, the student becomes familiar with relativistic mechanics as well as the use of Einstein's equations for studying gravitational waves, spherically symmetric solutions, and basic properties of black holes.

Course contents

1. Priniciples of special relativity and Lorentz transformations

2. Minkowski spacetime

3. Relativistic dynamics

4. Maxwell's equations in covariant form

5. Equivalence principle and physical foundations of general relativity

6. Curved spaces, Riemannian manifolds, geomety of space-time

7. Dynamics in a gravitational field, Einstein's equations

8. Gravitational waves

9. Schwarzschild metric and black holes

Readings/Bibliography

Lecture notes

S. Weinberg, *Gravitation and Cosmology,* Wiley, New York, 1972

H. Ohanian and R. Ruffini: *Gravitation and Spacetime*, CUP, 2013

Teaching methods

Lectures at the blackboard

Assessment methods

Oral exam

Office hours

See the website of Fiorenzo Bastianelli

Course Unit Page

> Teacher
> Fiorenzo Bastianelli

> Credits
> 6

> SSD
> FIS/02

> Teaching Mode
> Traditional lectures

> Language
> English

> Campus of Bologna

> Degree Programme
> Second cycle degree programme (LM) in Astrophysics and Cosmology (cod. 5828)

SDGs

This teaching activity contributes to the achievement of the Sustainable Development Goals of the UN 2030 Agenda.