



UNIVERSITÀ  
DEGLI STUDI DI MILANO-BICOCCA

## SYLLABUS DEL CORSO

### Relativistic Astrophysics

2122-1-F5802Q003

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#### Aims

Application of fundamental concepts of special and general relativity to the field of astrophysics

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#### Contents

1- Basics of special and general relativity

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#### Detailed program

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### **III- GRAVITATIONAL LENSING**

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### **IV- GRAVITATIONAL WAVE (GW) EMISSION**

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### **V- TIMING OF MILLISECOND PULSARS**

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### **VI- FORMATION, EVOLUTION AND DYNAMICS OF MASSIVE BLACK HOLES (MBHs)**

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#### **2- MBH growth along the cosmic history**

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#### **3- Formation and evolution of massive black hole binaries (MBHBs)**

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### **Prerequisites**

None, besides the basic classes of the bachelor

### **Teaching form**

56 hours of frontal lectures, mostly at the blackboard, occasionally with the support of slides.

Lectures will be in English.

### **Textbook and teaching resource**

Supporting material will be uploaded on e-learning during the course of the semester, in any case here follows an (incomplete) list of useful references.

## I- SUMMARY OF SPECIAL AND GENERAL RELATIVITY

Barbara Ryden, "Introduction to cosmology", Chapter  
12: [http://carina.fcaglp.unlp.edu.ar/extragalactica/Bibliografia/Ryden\\_IntroCosmo.pdf](http://carina.fcaglp.unlp.edu.ar/extragalactica/Bibliografia/Ryden_IntroCosmo.pdf)  
Abraham Loeb, "First Light": <https://arxiv.org/abs/astro-ph/0603360>

### 2-First baryonic structures: seed black hole formation

Marta Volonteri, "Formation of supermassive black holes": <https://arxiv.org/abs/1003.4404>

### 3-MBH growth along the cosmic history

Celoria et al., "Lecture notes on black hole binary  
astrophysics": <http://adsabs.harvard.edu/abs/2018arXiv180711489C>

King et al., "Aligning spinning black holes and accretion  
discs": <http://adsabs.harvard.edu/abs/2005MNRAS.363...49K>

J. Binney & S. Tremaine, "Galactic Dynamics", 1987 (dynamical friction, loss cone theory, stellar hardening)

D. Merritt, "Dynamics and Evolution of Galactic Nuclei", 2013 (dynamical friction, loss cone theory, stellar  
hardening)

## V- GRAVITATIONAL WAVES FROM BINARY SYSTEMS

## **Semester**

First semester.

## **Assessment method**

Oral examination. The student will first be asked to elaborate on a topic of his choice for about 15-20 minutes. In

the rest of the exam, the lecturer will ask other questions covering any of the topics treated in class.

There will be no intermediate examinations nor homework.

## **Office hours**

Any day is possible, so long as an appointment is requested via email. I generally use Google Meet for remote meetings.

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