

# Advanced Topics in Theoretical Physics ( $\equiv$ Modern Cosmology) – Introduction

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**UNIVERSITÀ  
DI TRENTO**

**Dipartimento di  
Fisica**

## Practical information

**Timetable:** Wed 14:30-16:30 (A213), Thu 11:30-13:30 (A224)

**E-mail:** sunny.vagnozzi@unitn.it

**Office and office hours:** 2nd floor Povo 0, room 3-20 (the door says “Alessandro Casalino/Silvia Vicentini”), Tue 16:30-17:30 (please email me first, ideally at least  $\gtrsim$  24 hours before)

**Weight:** 6 CFU (48 hrs)

### Books

- Scott Dodelson, “Modern Cosmology” (1st Edition, 2003)
- (Daniel Baumann, Part III Mathematical Tripos Cosmology notes)

**Lecture notes:** my handwritten notes will gradually be posted on my website [www.sunnyvagnozzi.com/en/teaching](http://www.sunnyvagnozzi.com/en/teaching) and DidatticaOnline. These are **not** a substitute of the textbook and discussions in class.

**Attendance is highly recommended**

## Practical information

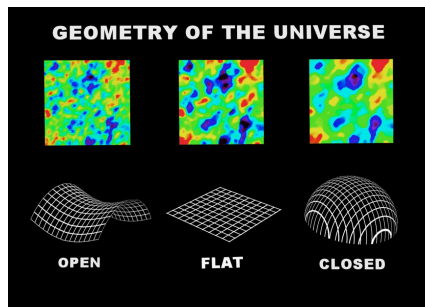
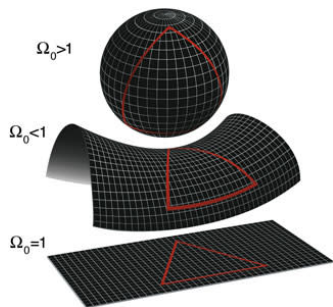
**Exam:** exclusively oral, general questions and broad discussions

**Useful info:** some of the mathematically more complex derivations will be deliberately left open (only quoting the final results), completing them left as (optional but highly recommended) homework for the student

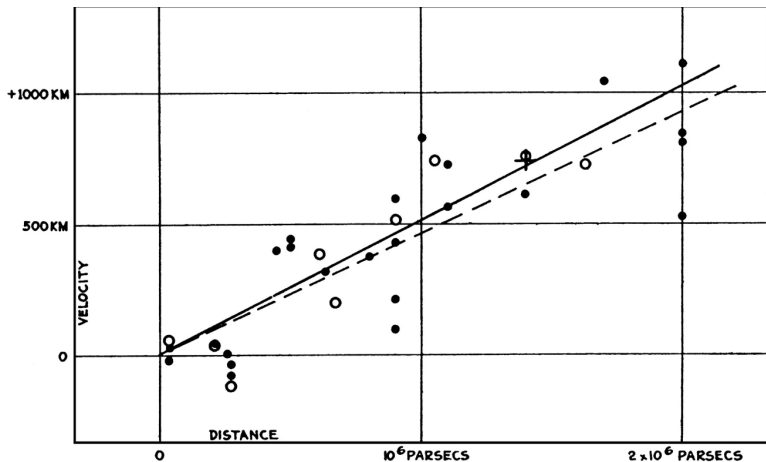
**7 tools/technical aspects you need to be comfortable with:**

- Integration by parts
- Integrals in spherical polar coordinates
- 4-vectors
- Expanding in small perturbations, recognizing same-order terms
- Chain rule for derivatives
- Switching integration variables repeatedly (Jacobians)
- Taylor expansion, especially binomial expansion  
 $(1 \pm x)^\alpha \simeq 1 \pm \alpha x + \mathcal{O}(x^2)$  for  $x \rightarrow 0$ , valid for  $\alpha \geq 0$

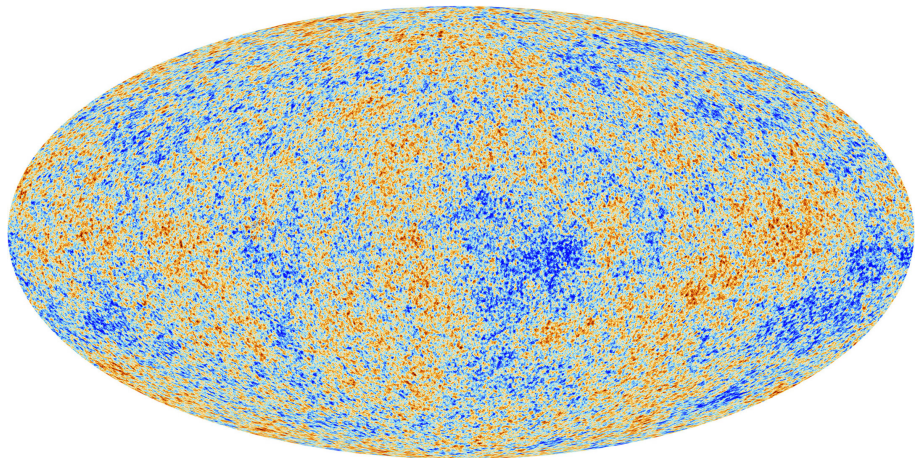
# Geometry of the Universe



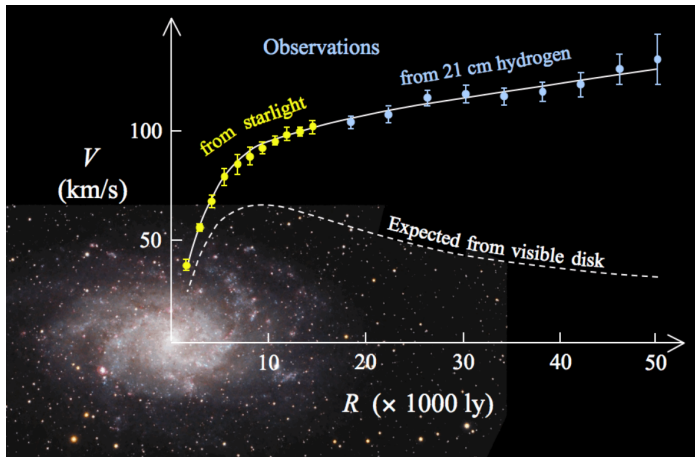
# The first Hubble diagram (published in 1929)



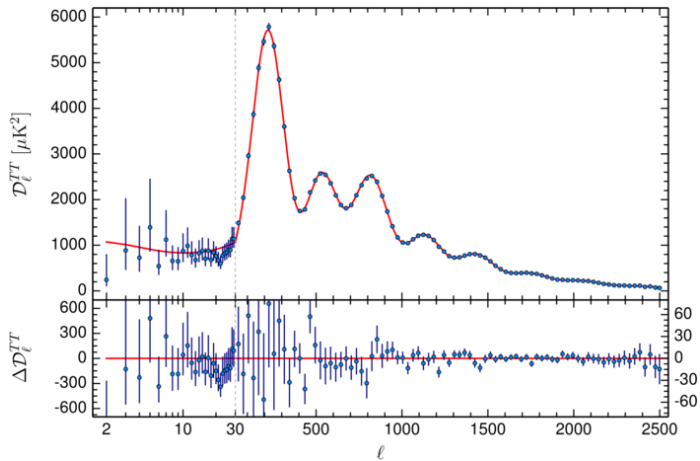
# CMB



# Galaxy rotation curves (M33)

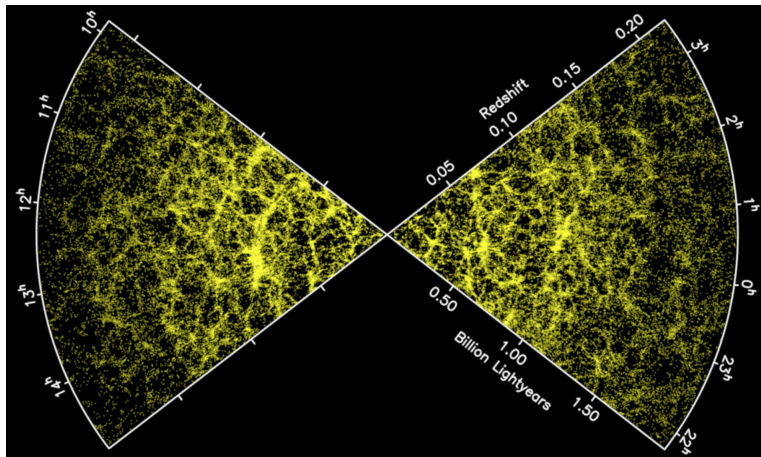


# CMB power spectrum

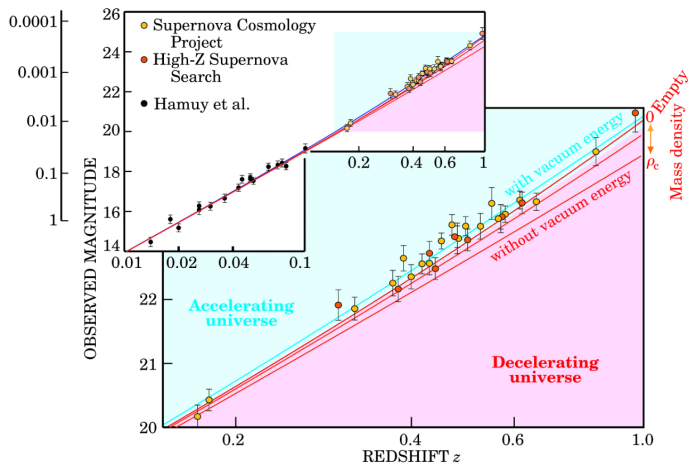




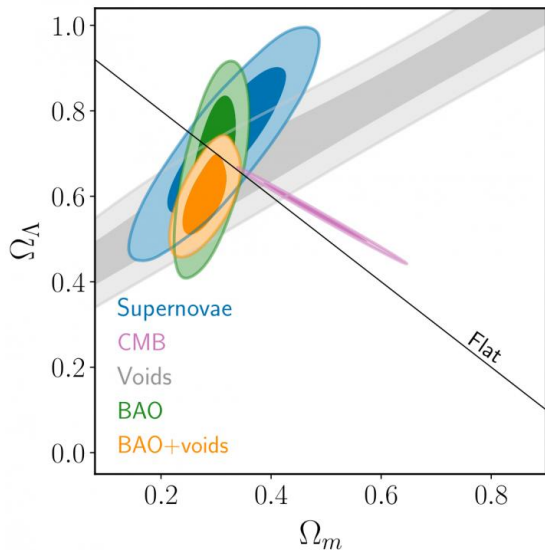
# Galaxy surveys



# Type Ia Supernovae



# Combined measurements point towards cosmic acceleration



# The $\Lambda$ CDM model

