

PHYS201 - Introductory Astronomy - Fall semester

Explore the whole universe: From our solar system to the most distant galaxies. From how it started to how it looks today.

*The course will be:
80% Notion based
20% Mathematics and Physics*

- *The tools of astronomy: Gravity, electromagnetism, telescopes and probes.*
- *History of astronomy: Ancient, Greek, medieval and modern.*
- *The solar system: Planets, moons and the search for water.*
- *Stars and galaxies: Lifecycle, properties, evolution.*
- *Black holes and neutron stars: Evidence, properties, formation.*
- *The big bang: Theory, evidence, predictions.*

The course is taught by Prof. Daniele Malafarina (SST, Physics) who is an astrophysicist specialized in black holes and cosmology.

A dark, atmospheric photograph of a landscape at dusk or dawn. In the foreground, dark hills are silhouetted against a lighter sky. On the left hill, a single figure stands on a peak. In the center, two smaller figures are visible on another hill. The sky above is filled with soft, horizontal clouds, with a bright, circular light source, possibly the moon or sun, partially obscured by them.

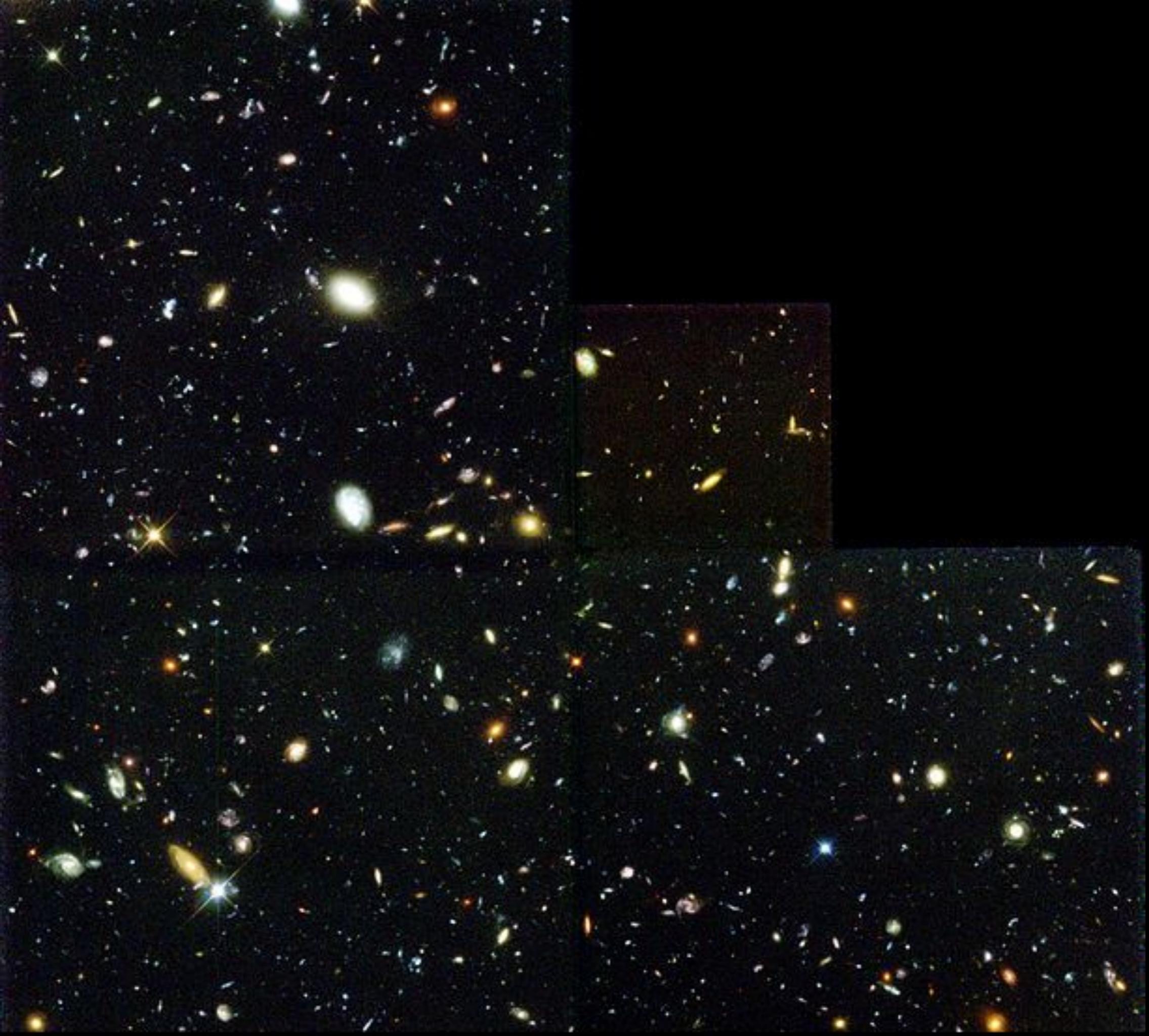
W A N D E R E R S

PHYS201 - Introductory Astronomy









Topics

- **Part I**

- Theoretical tools
- Experimental tools
- History of Astronomy

- **Part II**

- Solar system
- Stars
- Galaxies
- Neutron stars and Black holes
- Cosmology

I. 1 Theoretical tools

$$\frac{m n_i}{\sqrt{1-u^2}} \text{ Impuls}$$
$$m \left(\frac{1}{\sqrt{1-u^2}} - 1 \right) \text{ Kin. Energy.}$$
$$x = \frac{x' + u t'}{\sqrt{1-v^2}} \quad y = y' \quad z = z'$$
$$\sum \frac{1}{\sqrt{1-u_i^2}} = \frac{2}{\sqrt{1-u^2} \sqrt{1-v^2}}$$
$$\sum \frac{u_i}{\sqrt{1-u_i^2}} = \frac{2v}{\sqrt{1-u^2} \sqrt{1-v^2}}$$

Hyp. $\sum j_\nu = \sum j_\nu \text{ Cons.}$

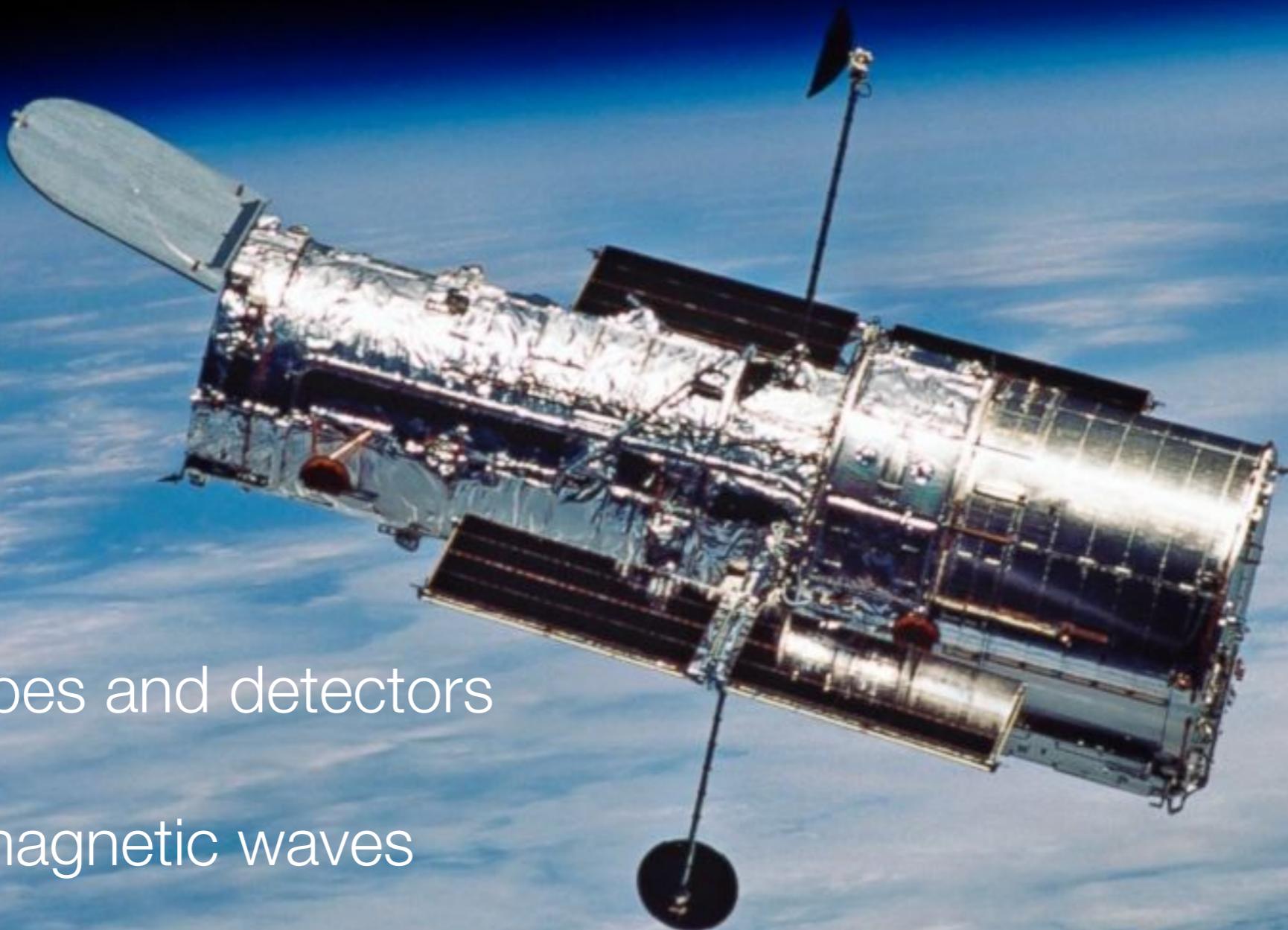
$$\sum \mathcal{E} = \sum \bar{\mathcal{E}} \text{ d}_i$$
$$j_\nu = m n_\nu f(u)$$
$$\mathcal{E} = \mathcal{E}_0 + m \bar{\mathcal{E}}(u)$$

- Gravity
- Electromagnetism
- Atomic physics



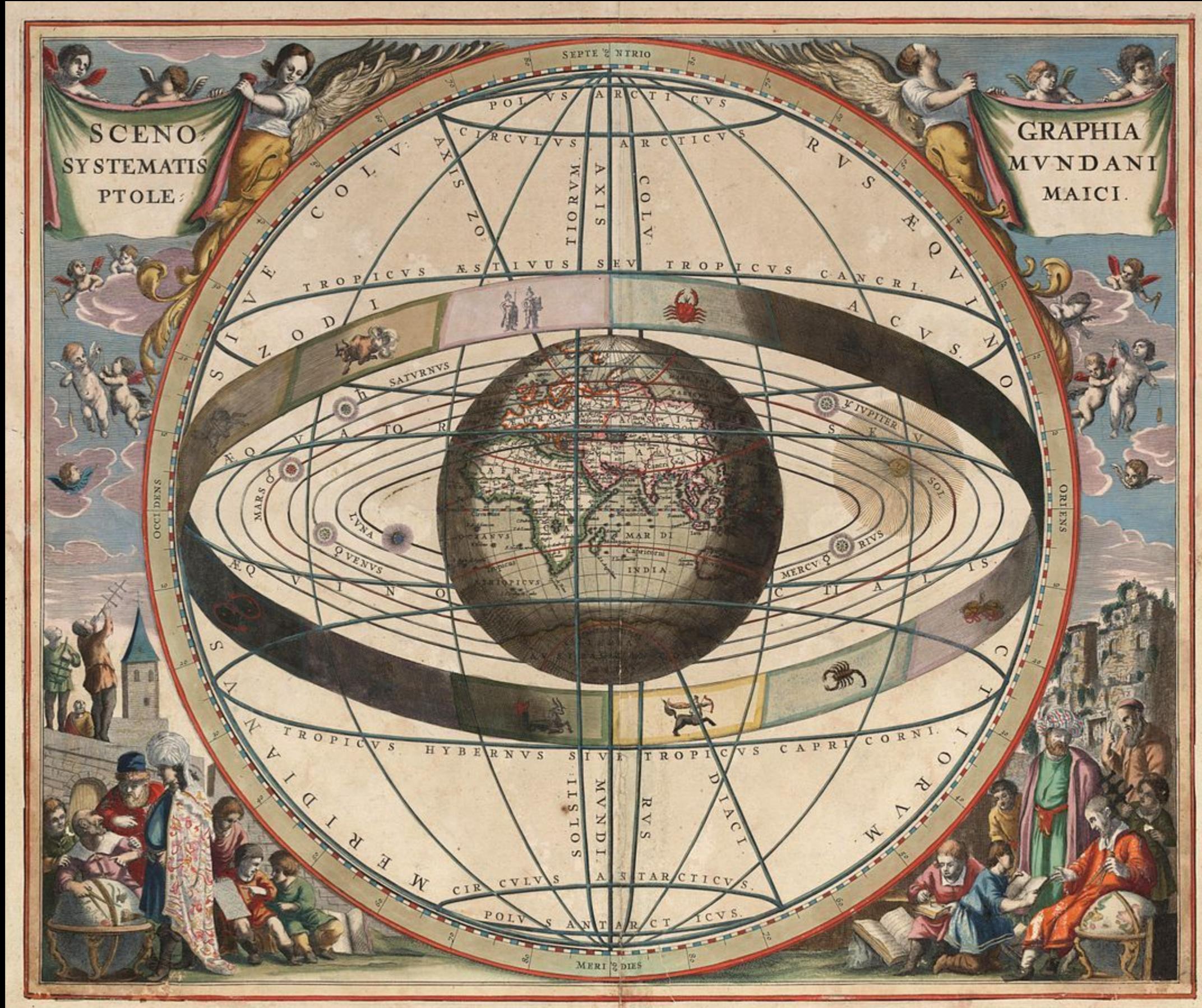
I.2 Experimental tools

- Telescopes and detectors
- Electromagnetic waves
- Multi-messenger astronomy
- Spacecrafts and satellites

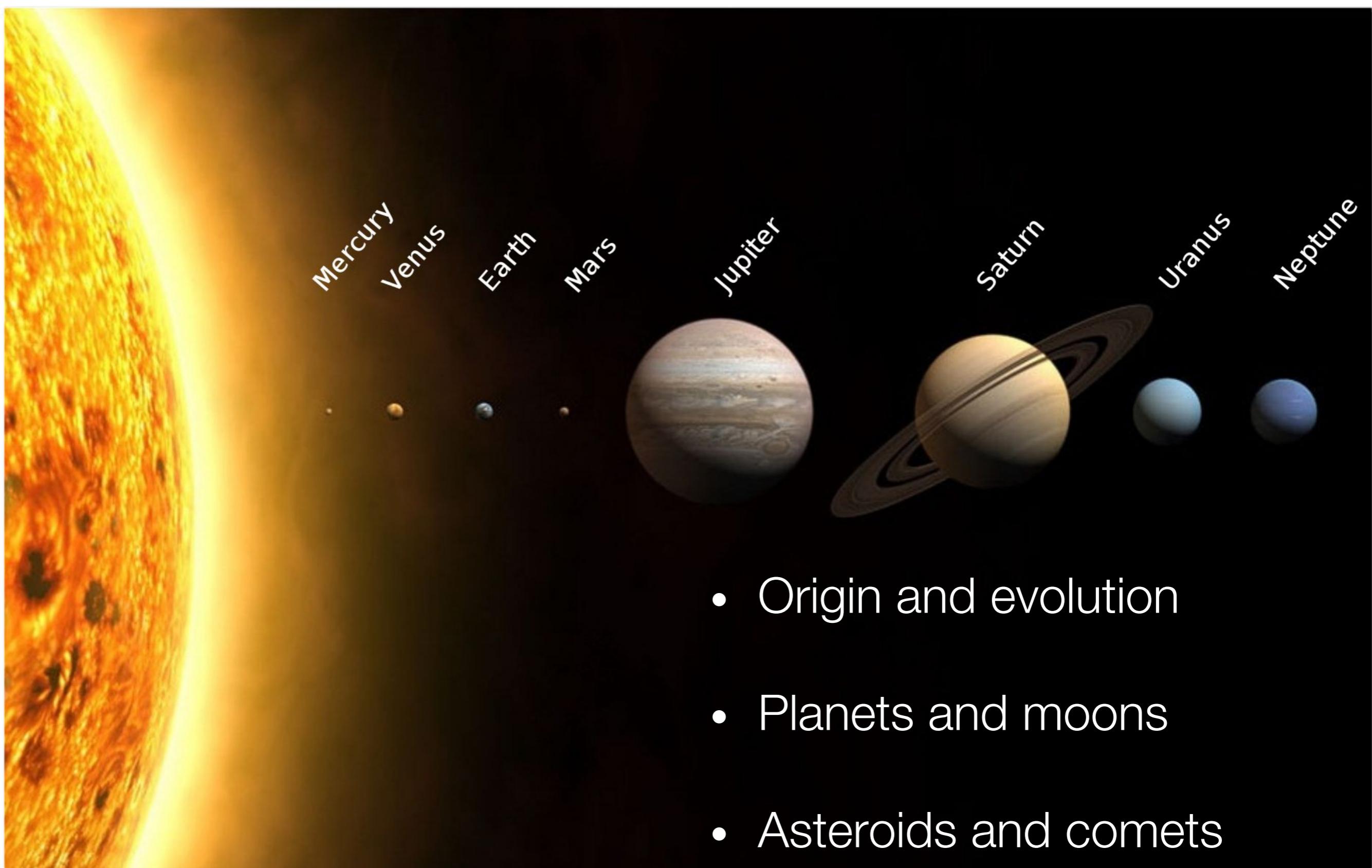


I.3 History

- Ancient
- Greek
- Arab
- Medieval
- Modern

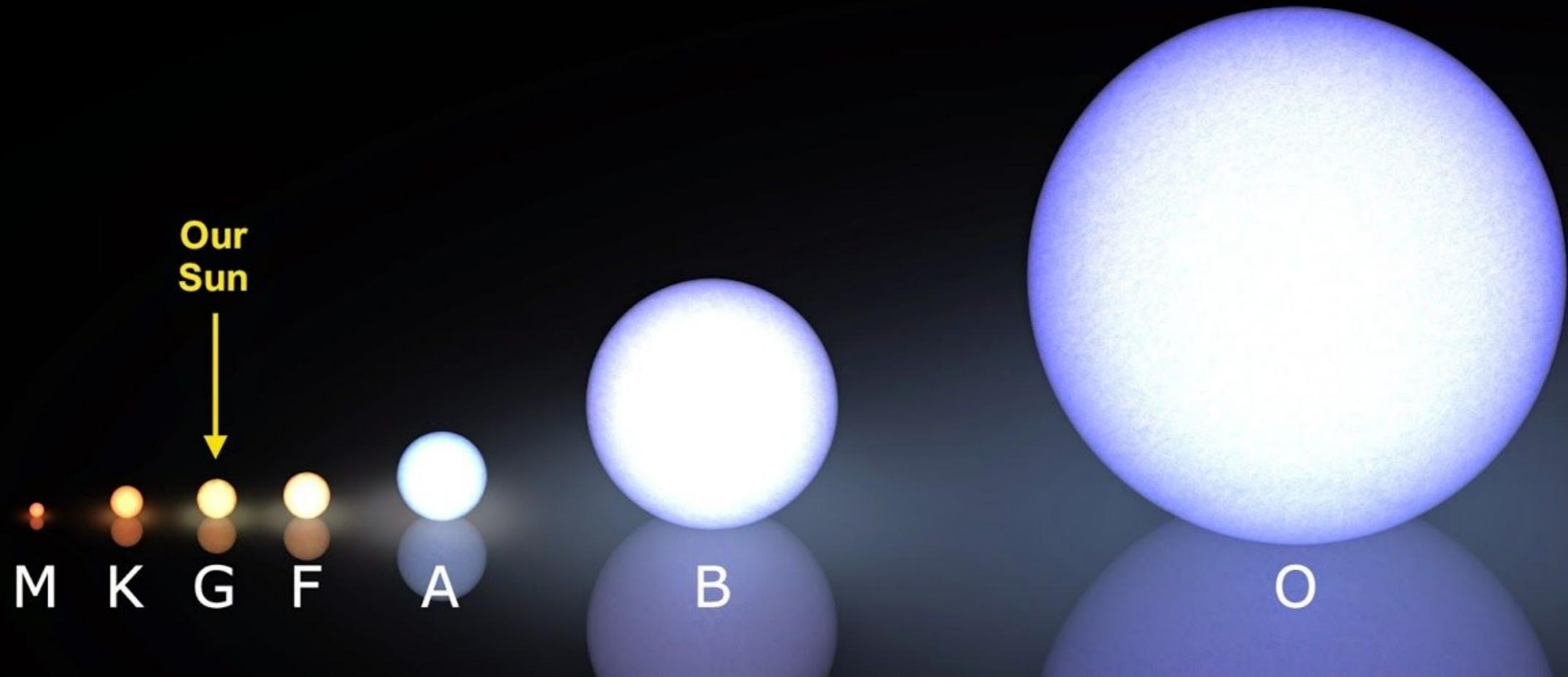


II.1 Solar system



II.2 Stars and interstellar medium

- Nebulae and star formation
- HR diagram
- Properties and classification
- Life cycle and supernovae



II.3 Galaxies

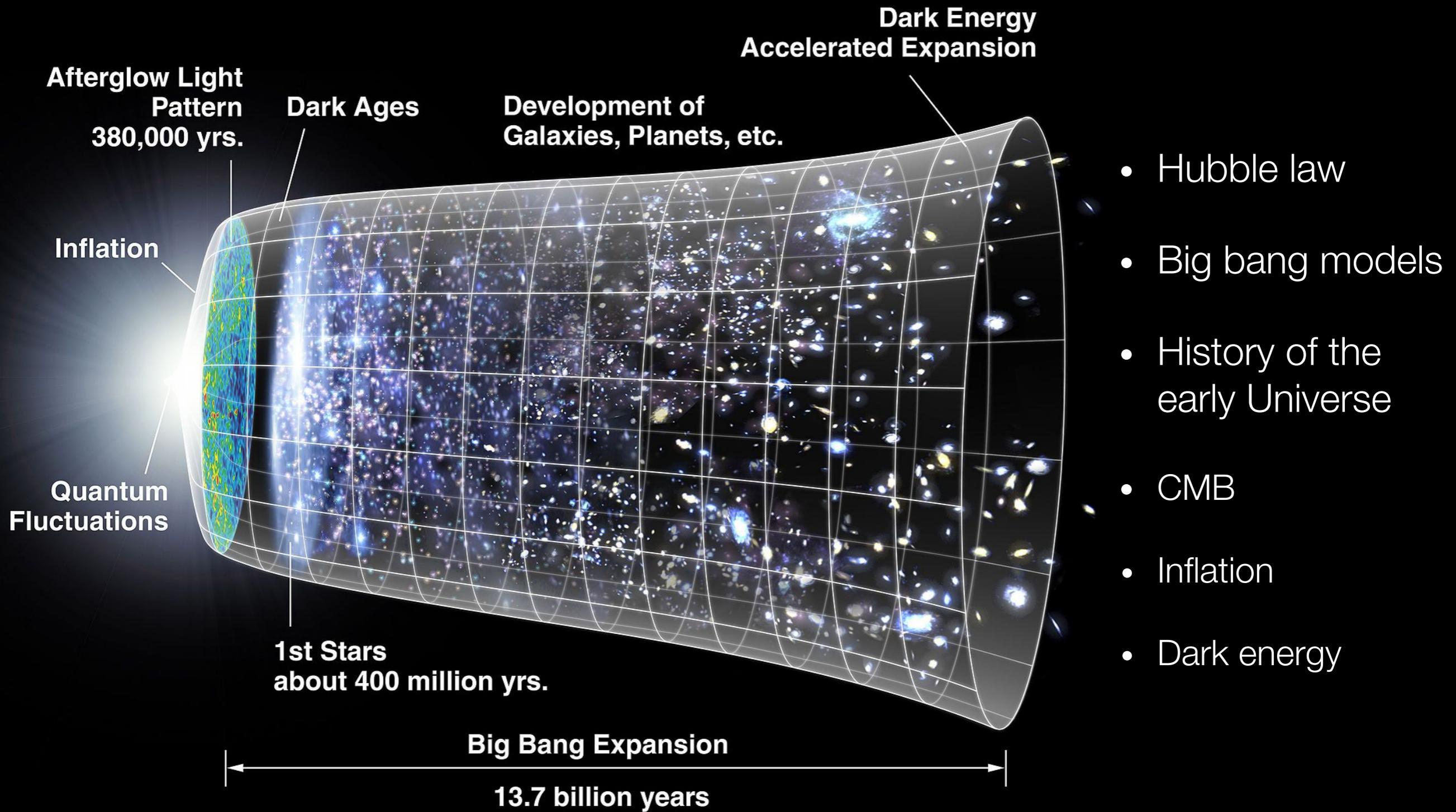
- Formation, properties and classification
- Active Galactic Nuclei
- Large scale structure



II. 4 Neutron stars & black holes

- Relativistic astrophysics
- Neutron stars
- Stellar mass and supermassive black holes

II. 5 Cosmology

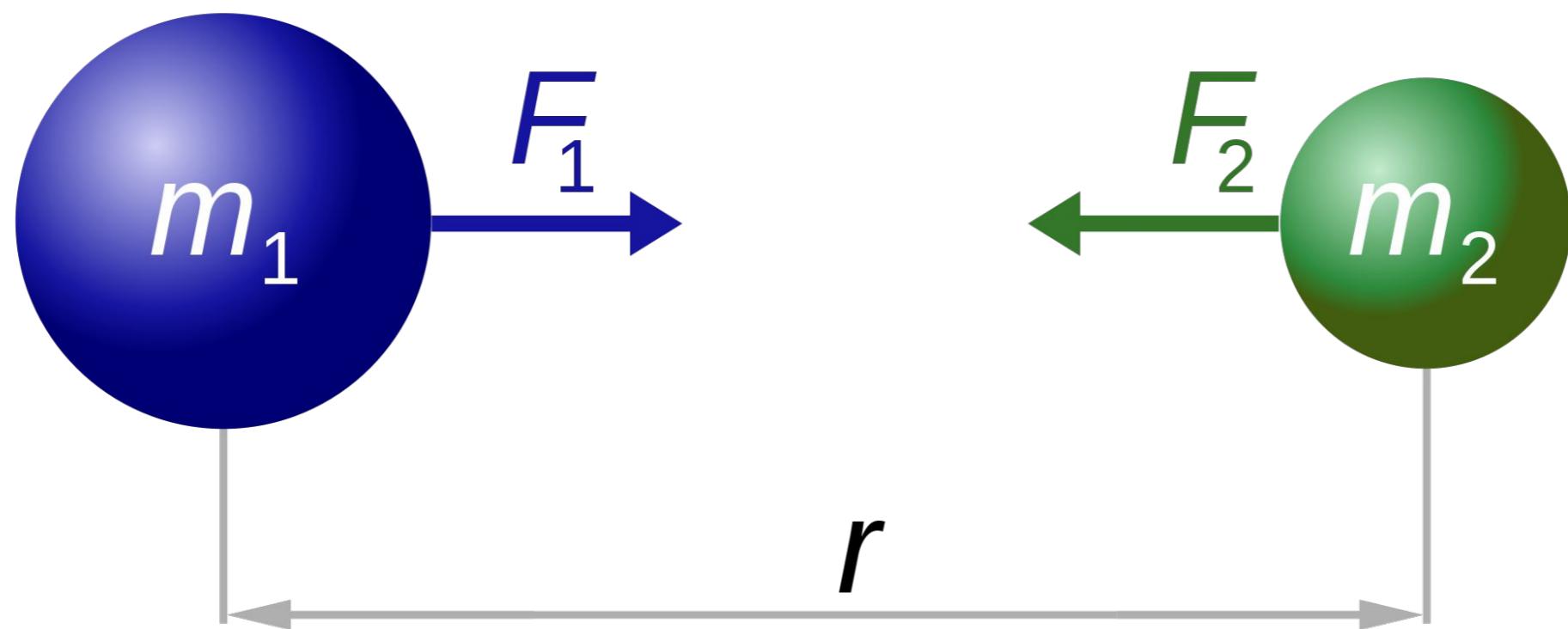


Some things you should already know

- Basic astronomy: What are planets, stars and galaxies. What is the difference between planets stars? What is a galaxy?
- Basic mechanics: Physics 1, there is a force called gravitation. Have you heard of it? What's the formula?
- Basic thermodynamics: Temperature, density, pressure. Do you know what they are? How does a gas behave?
- Basic particle physics: All things are made of particles. Do you know them? What is an atom made of?
- Basic chemistry: Elements. There is a thing called periodic table. How many elements can you name? Which one is the first?

Gravity

- It is the dominant force in the universe.
- Gravity determines the evolution of the universe, of galaxies, of stars and solar systems.



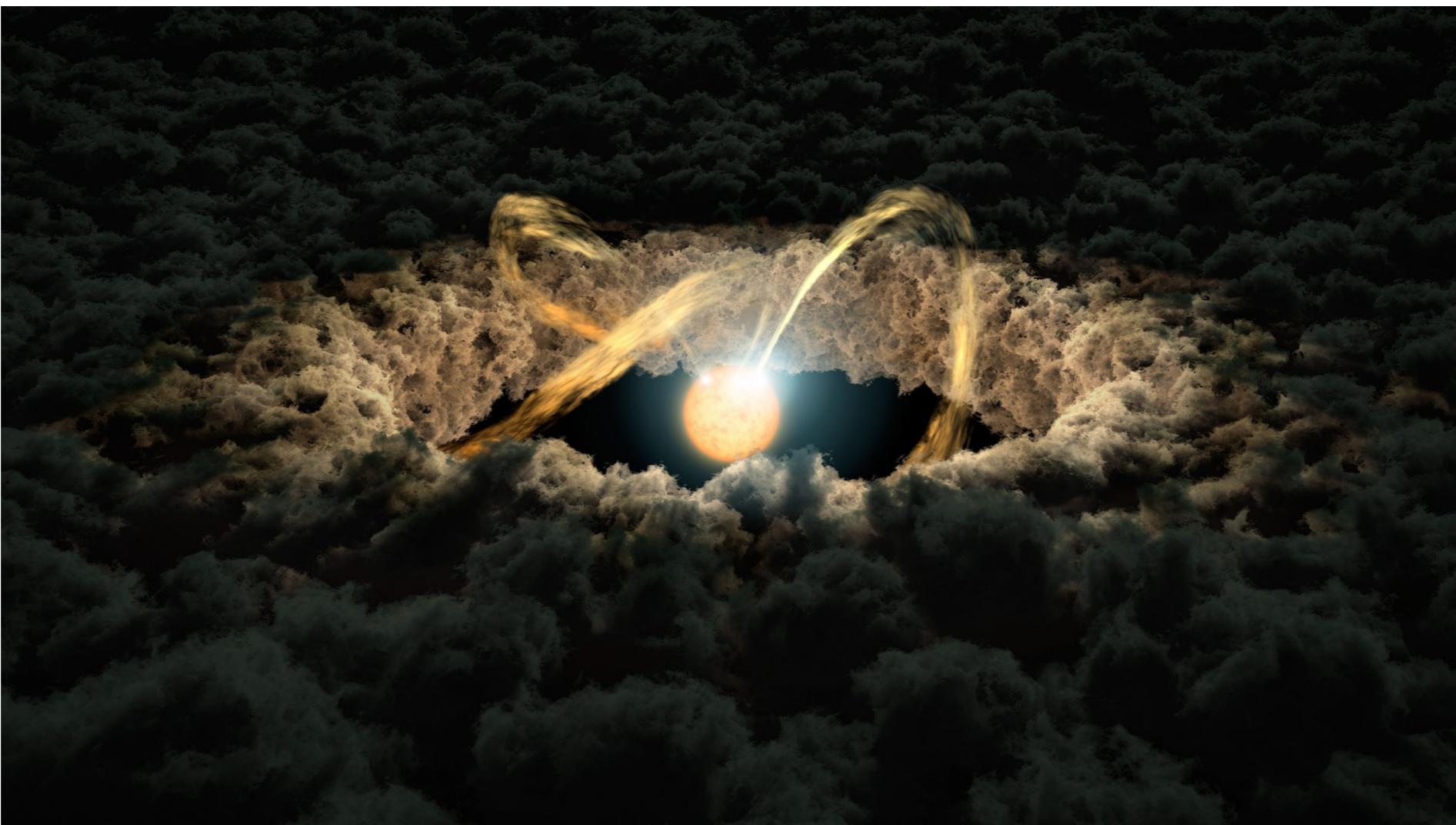
Electromagnetism

Light is an electromagnetic wave. Until recently all the information we had about the universe was obtained from light.



Thermodynamics

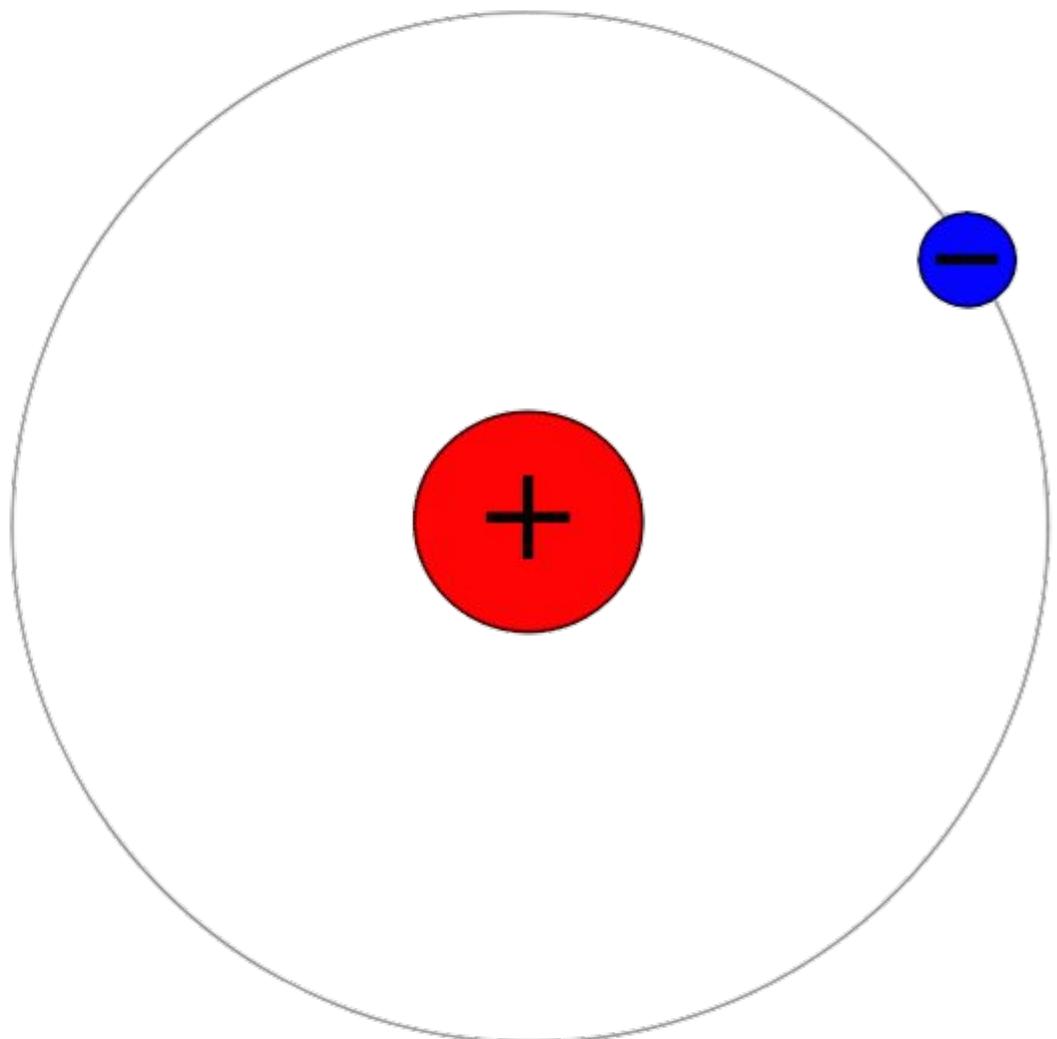
- It describes the properties and motion of gases.
- As a gas contracts due to gravity it becomes hotter and denser.



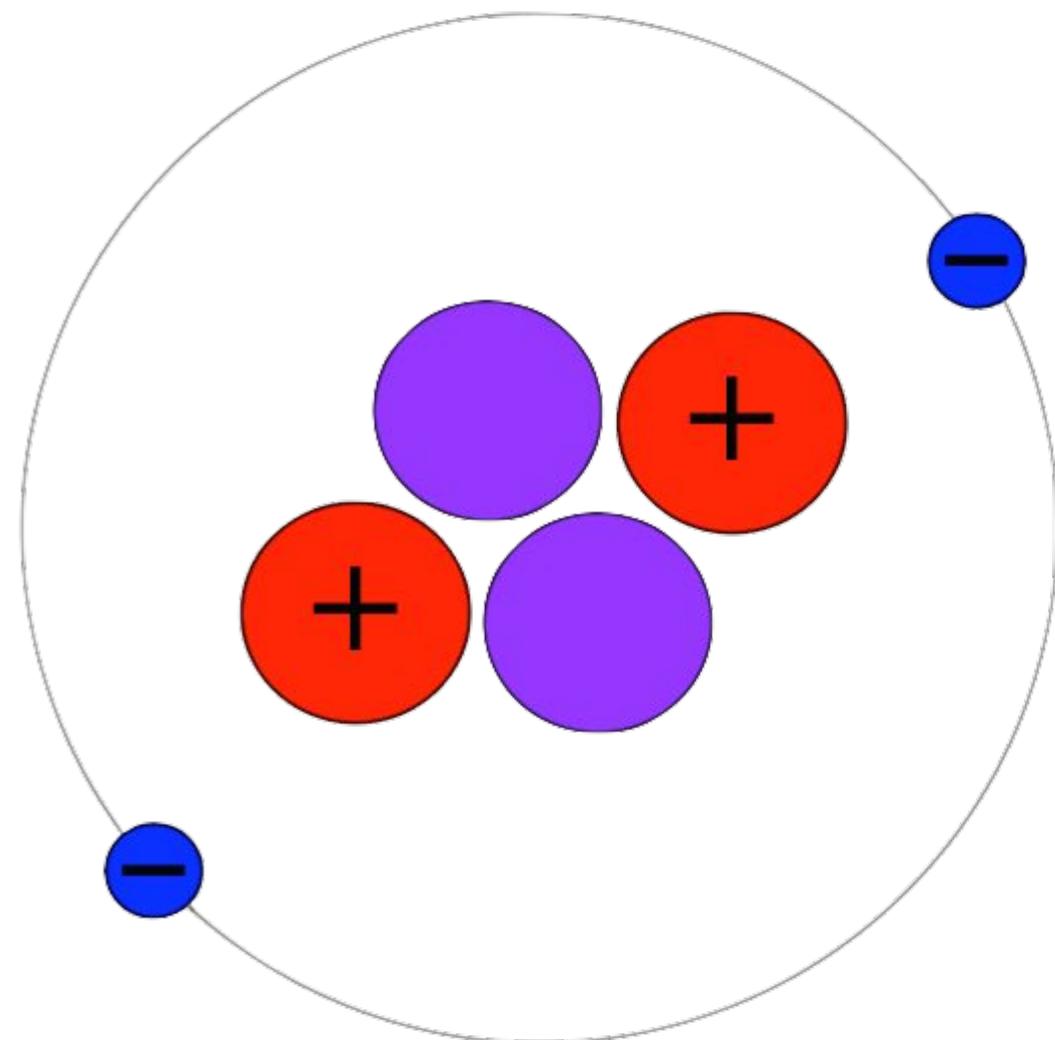
Particle physics

- Proton: Massive, positive charge, inside the nuclei of atoms.
- Electron: Not very massive, negative charge, ‘orbits’ around the nuclei of atoms.
- Neutron: Massive, neutral, inside the nuclei of atoms.
- Photon: Zero mass, neutral, carries the electromagnetic force.
- Neutrino: Not very massive, neutral, interacts very little with other matter.

Atoms

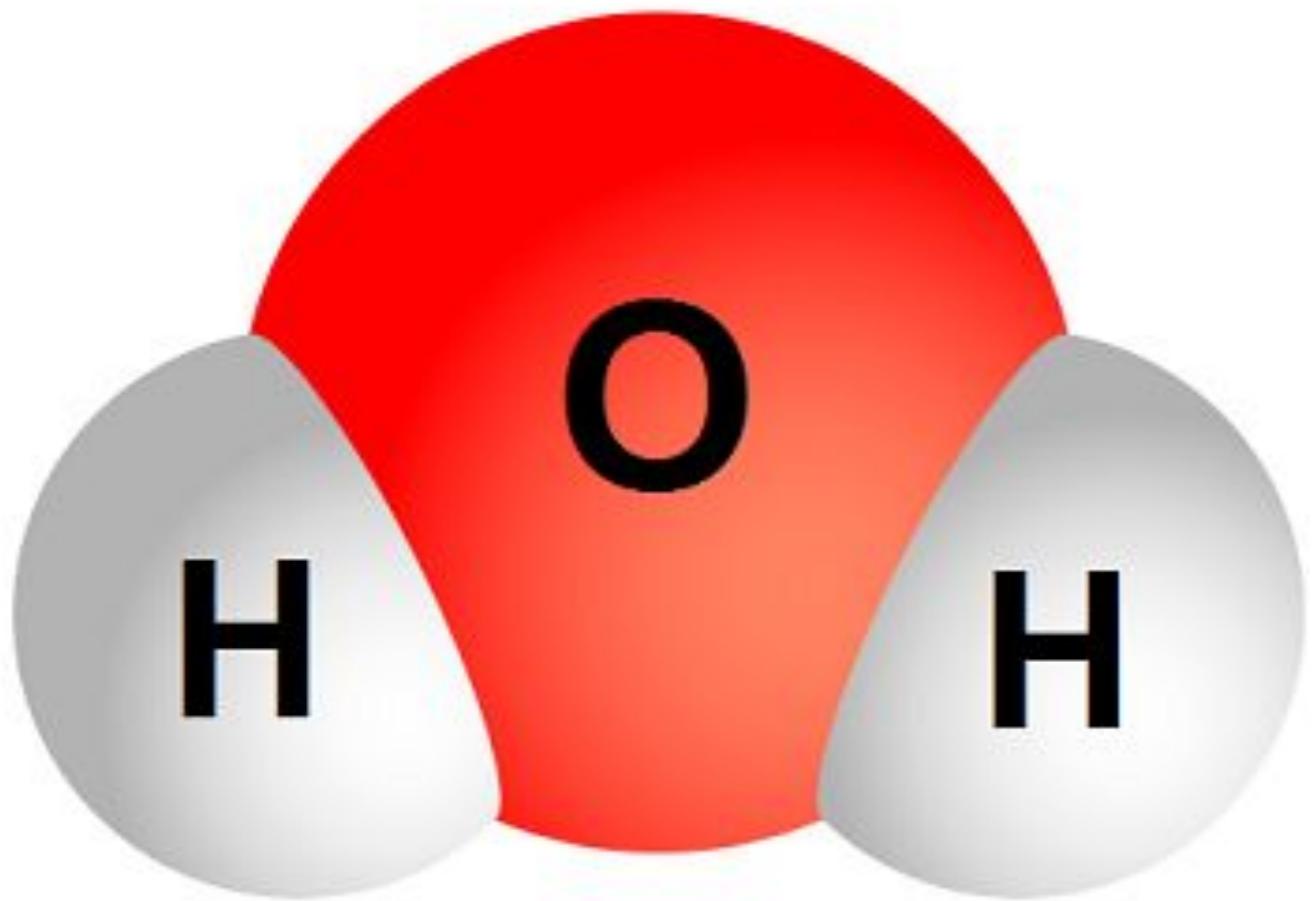


Hydrogen

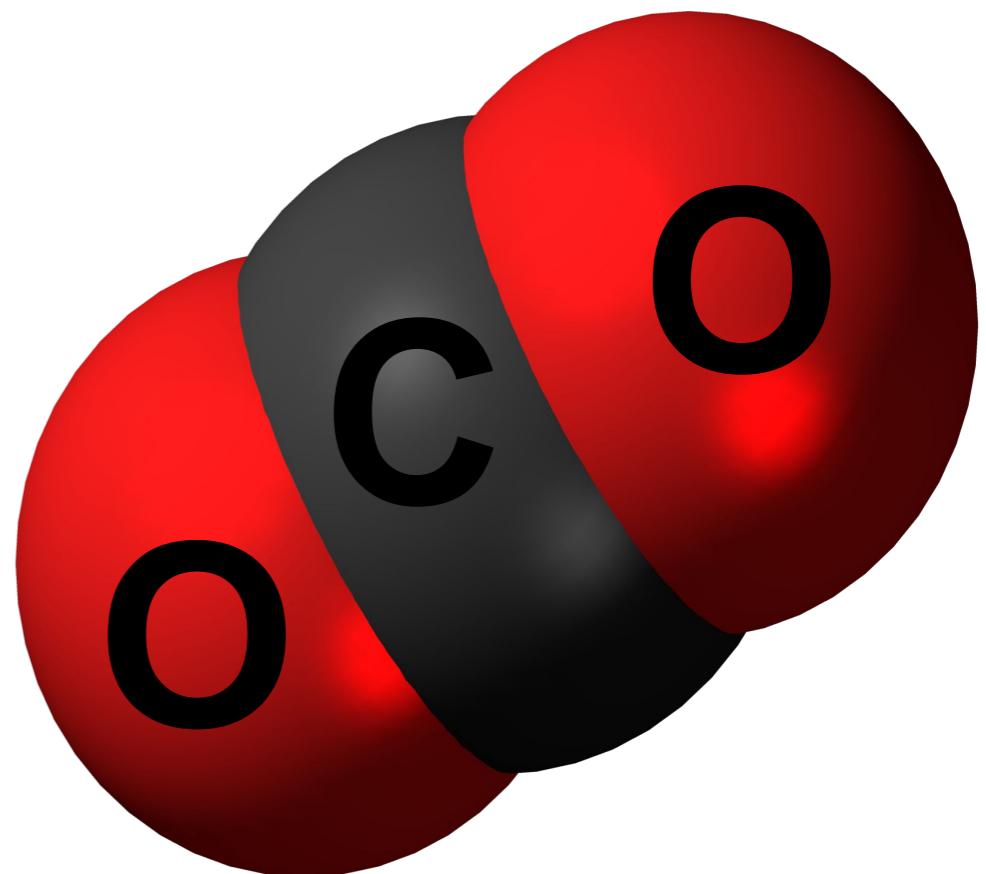


Helium

Chemistry - Molecules



Water

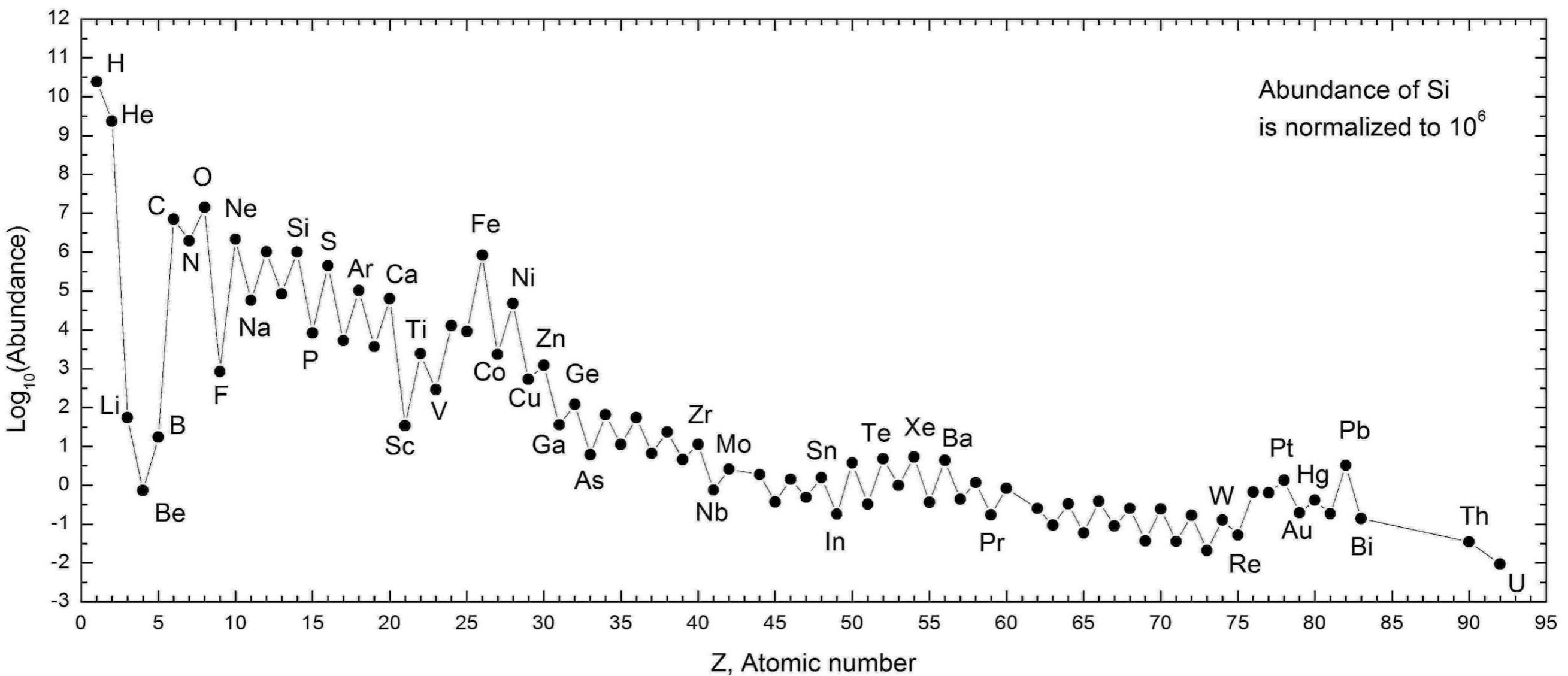


Carbon dioxide

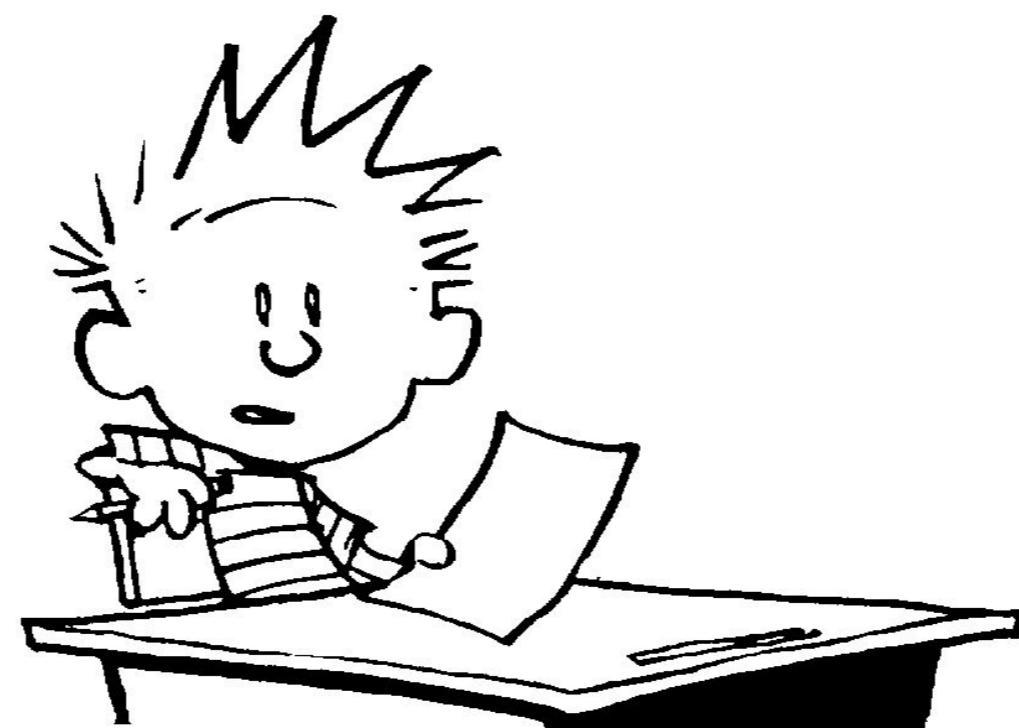
Chemistry - Elements

| | |
|-----------|-----------|
| 1 H | 2 He |
| 3 Li | 4 Be |
| 11 Na | 12 Mg |
| 19 K | 20 Ca |
| 37 Rb | 38 Sr |
| 55 Cs | 56 Ba |
| 87 Fr | 88 Ra |
| 57 La | * |
| 89 Ac | * |
| 104 Rf | * |
| 105 Db | 106 Sg |
| 107 Bh | 108 Hs |
| 72 Hf | 73 Ta |
| 74 W | 75 Re |
| 76 Os | 77 Ir |
| 78 Pt | 79 Au |
| 80 Hg | 81 Tl |
| 82 Pb | 83 Bi |
| 84 Po | 85 At |
| 86 Rn | 87 Ts |
| 109 Mt | 110 Ds |
| 111 Rg | 112 Cn |
| 113 Nh | 114 Fl |
| 115 Mc | 116 Lv |
| 117 Ts | 118 Og |
| * | 58 Ce |
| * | 59 Pr |
| * | 60 Nd |
| * | 61 Pm |
| * | 62 Sm |
| * | 63 Eu |
| * | 64 Gd |
| * | 65 Tb |
| * | 66 Dy |
| * | 67 Ho |
| * | 68 Er |
| * | 69 Tm |
| * | 70 Yb |
| * | 71 Lu |
| * | 90 Th |
| * | 91 Pa |
| * | 92 U |
| * | 93 Np |
| * | 94 Pu |
| * | 95 Am |
| * | 96 Cm |
| * | 97 Bk |
| * | 98 Cf |
| * | 99 Es |
| * | 100 Fm |
| * | 101 Md |
| * | 102 No |
| * | 103 Lr |

What is the universe made of?



And...



...some useful information

- My name: Daniele Malafarina (Physics department)
- My office: 7E.342
- Office hours: Monday from 10:00 to 11:00
Wednesday from 10:00 to 12:00
- Classroom: Green Hall, C2 building.
- Regularly check moodle for material.
- Important information in the syllabus and in the pdf with the tentative schedule.

Do not come and ask information that was
already provided!

I am not a baby sitter and you are not toddlers!

Advise

- Come to classes (and take notes). After each class take some time to revise what has been done.
- Learn through: Lectures, book, slides, additional material on moodle.
- Ask questions if something is not clear.
- Use the slides as a guideline on what to study on the book. Slides alone are not enough!
- Try to understand how things work rather than memorizing everything.



Do not cheat

- For yourself! My life won't change if you cheat.
- With a bit of effort you can learn a lot about the universe... and about yourself.
- If you cheat you just miss an opportunity to improve... and to learn some cool things about the universe.



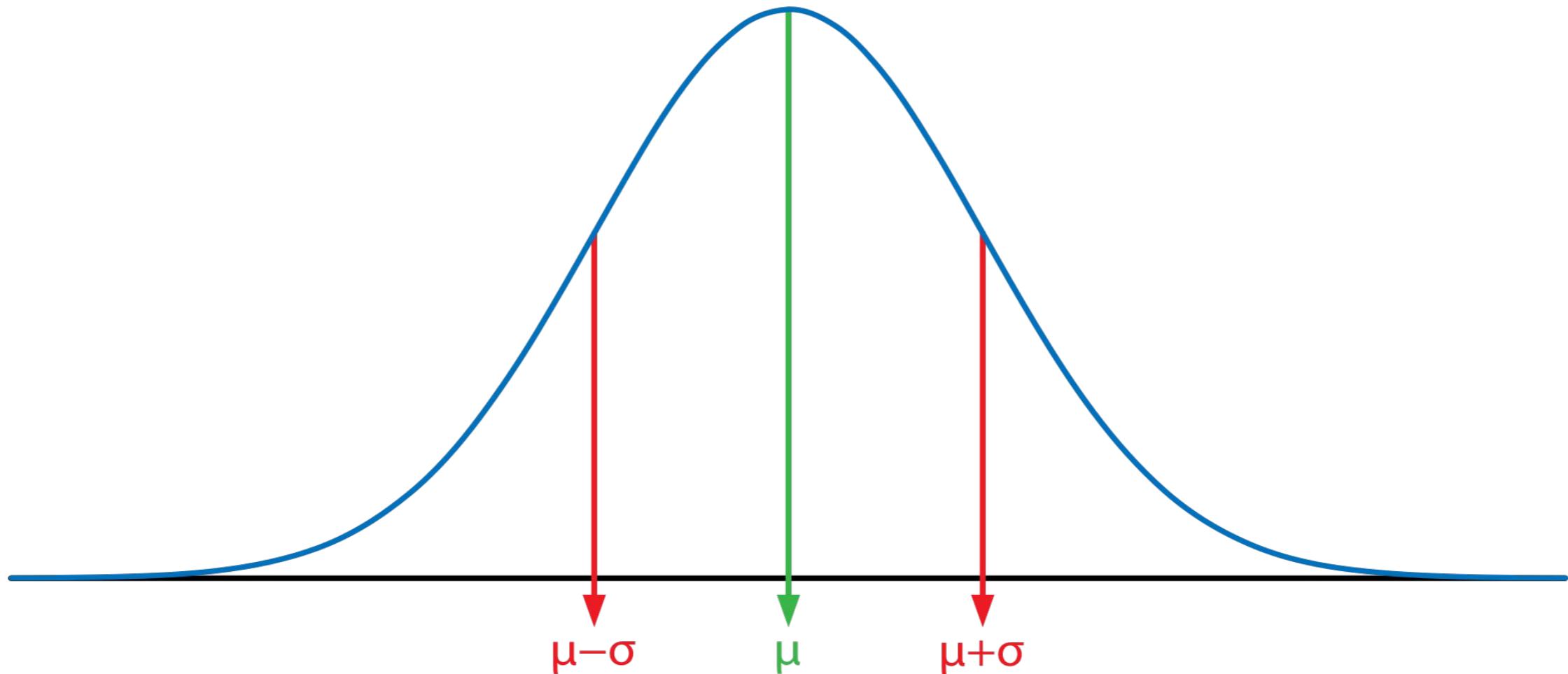
One complaint from last year:

“Tell students what information should we take from textbooks, due to the fact that there is a lot of information in the book.”

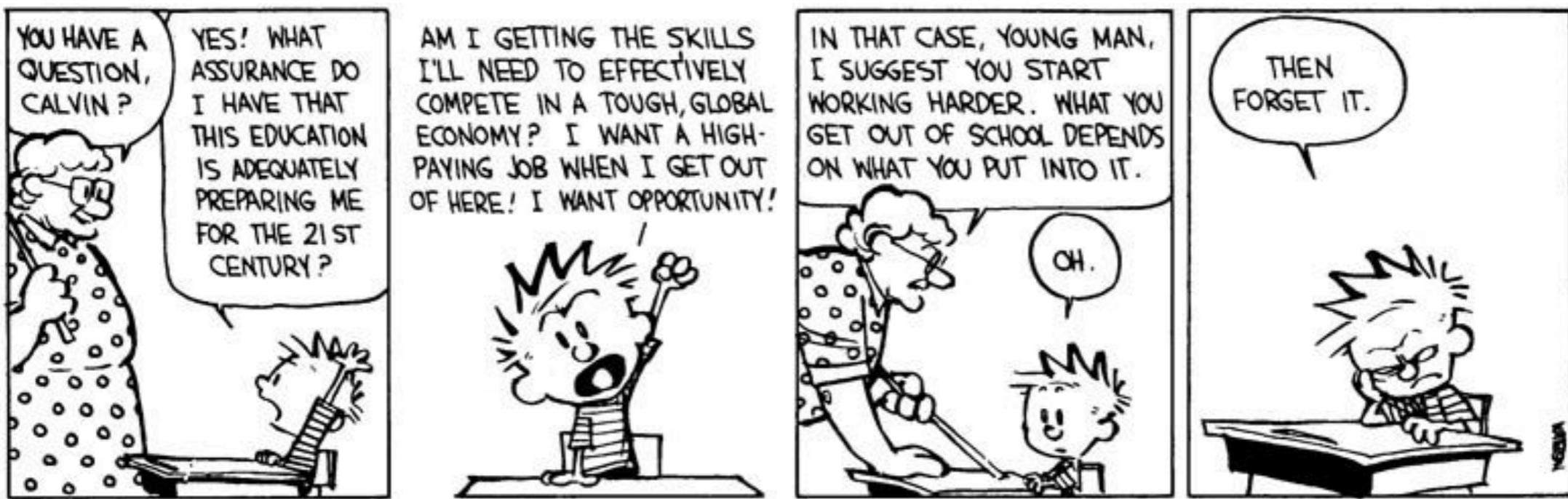
I do it, it is called LECTURE!

- If something was never mentioned in lectures probably it is not so important.
- If something was mentioned then it is worth remembering.
- If something was mentioned multiple times there is a good chance that it is important!

This is a gaussian curve



Where you stand in it is your job!



Grades

- 4 tests, about 20 minutes. (20%)
 - Each test has 10 multiple choice question.
 - Topics covered from the previous test to the last lesson.
- 2 mid-term exams, 50 minutes. (40%)
 - Each mid-term has 20 multiple choice questions.
 - Each mid-term has 2 questions to answer.
 - Topics covered from the previous mid-term to the last lesson.
- Final exam, oral exam with two questions. (40%)

Finally

Try to use logical reasoning:

What do we observe in the universe?

Why do we observe that?

How does it work?

Do not waste time calculating grades.

Make sure you learn some things and everything will be fine.

