ESA/Hubble

Introduction to Space

ELEC-E4210 (5 cr)

Teachers: Anne Lähteenmäki, Esa Kallio, Jaan Praks, Merja Tornikoski, Joni Tammi

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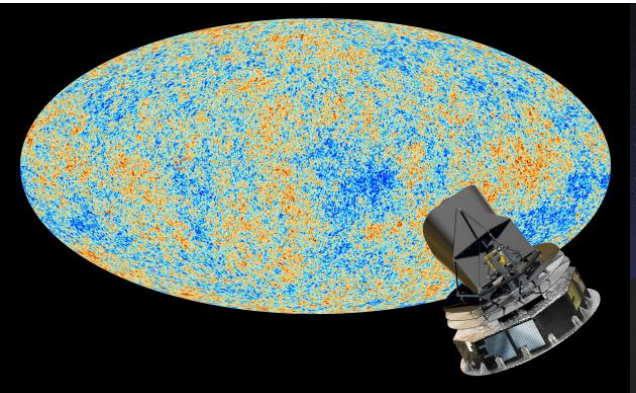
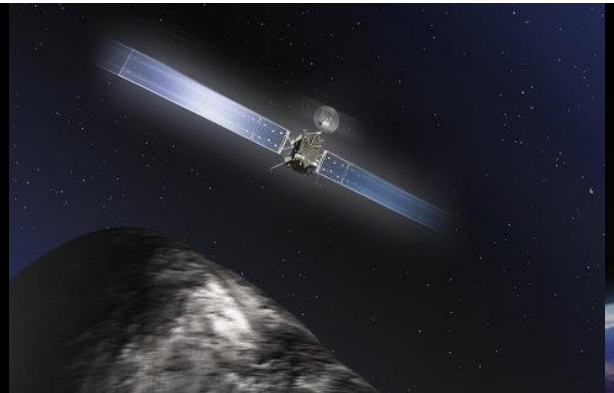
Today

- Course introduction and practicalities. (AL)
- Astronomy / space research activites in Finland and in Aalto.
- Content and dimensions of the Universe.
- Short introduction to space plasma physics. (EK)

ESA


Space science and technology courses

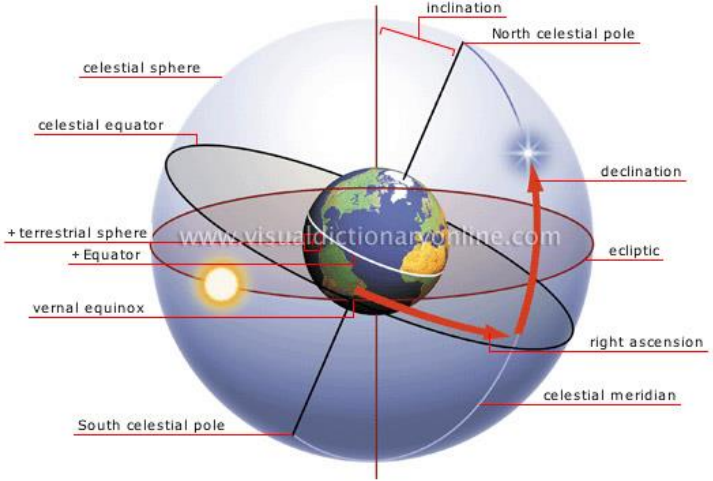
- ELEC-E4220 Space instrumentation
- ELEC-E4230 Microwave Earth Observation instrumentation
- ELEC-E4240 Satellite systems
- ELEC-E4520 Space physics
- ELEC-E4530 Radio astronomy
- ELEC-E4540 Space Climate
- ELEC-E4920 Space technology project (5 – 10 cr)
- ELEC-E4930 Special assignments (5 – 10 cr)

Feedback is welcome

- During and after the course:
  - E-mail
  - MyCourses
  - Talk to us
  - Take the course survey
- Your chance to make this a good course!

”Basics of space”

- Contents of the Universe and the solar system
- Space environment
- Space exploration
- Tools for understanding space
  - Celestial coordinate systems
  - Measurement of time
  - Celestial mechanics, orbits
  - Basics of emission mechanisms, plasma physics and astronomy



Merriam-Webster dictionary

Learning outcomes

- After the course the student has the basic knowledge of astronomy, space physics and space technology that are needed for further studies.
- The student knows the structure and central physical properties of the universe and the solar system, and the objects contained in them.
- She/he identifies the basic concepts and tools of astronomy and space physics, and is able to solve simple problems related to them.
- The student can list what kind of observations can be made of astronomical and solar system phenomena, and what is the motivation behind such efforts.
- She/he can compute simple orbits of satellites using celestial and orbital mechanics, and can apply various celestial coordinate systems.
- The student recognises the basic vocabulary used in space science and technology, and how Aalto University is situated in the national and international space research scenes.

Workload

Course structure

Follow the teaching session listings in section Course schedule in MyCourses. All you need to know is in MyCourses.

We will have:

- Live teaching sessions via Zoom.
- Pre-recorded materials and other self-study materials.
- Assignments, quizzes…
- Possible preliminary work for lectures.

Course structure

- Theory sessions on Mondays 10-12 via Zoom.
- Practice sessions on Tuesdays 12-14 via Zoom.
  - *Complement the theory sessions*
  - First practice session: 15.9.2020. Check the deadlines!!!
  - **Obey the deadlines for submissions. This means you. Really!**
- Alternatively: pre-recorded and other self-study materials.
- Exam on Tuesday 8.12.2020.

How to participate in live teaching sessions

- Zoom room for the course can be found in MyCourses in the Course schedule section.
- Always use this link on this course, for both theory and practice sessions.
- We start quarter pass the hour, that is 10.15 or 12.15.
- It is difficult for the teacher to follow chat during lectures so please be patient with possible questions.

How to work with self-study materials

- Follow the instructions given for the teaching session. The materials are (usually) given in the order you should study them.
- Self-study materials typically include pre-recorded lectures, links to reading materials, videos, simulations and such, quizzes, assignments as usual…
  - In this case there is usually no live teaching session: always check the course schedule!

Is it live or not?

Yes

7.9.2020 Course introduction & information

Time: Monday 7.9.2020 at 10 -12

Teaching method: Live zoom lecture.

Assignments: No assignments this week yet.

Teachers: Anne Lähteenmäki and Esa Kallio

No

2.11.2020 Theory session: Emission mechanisms 1

Time:

Teaching method: lecture videos, textbook

Assignments: *Coming soon*

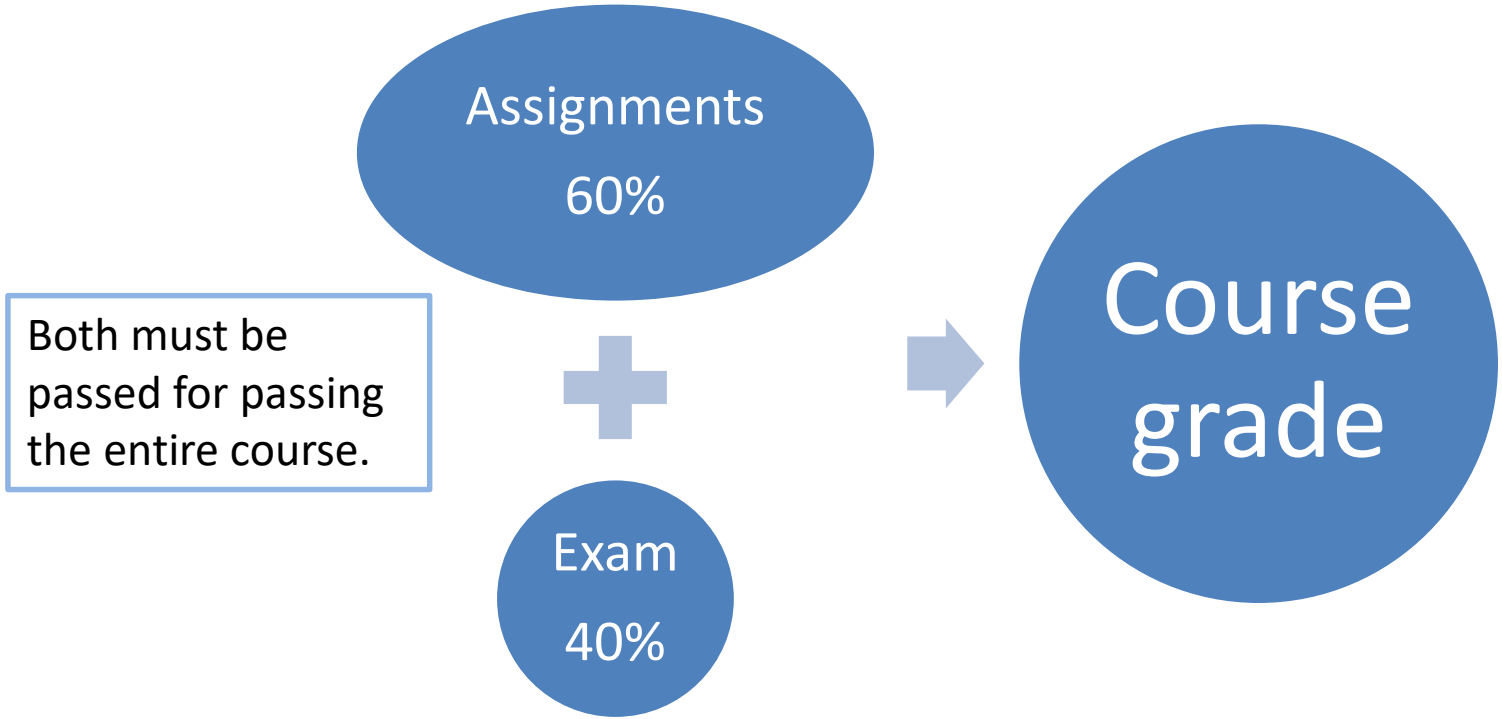
Teachers: Joni Tammi

Preliminary course schedule

All changes will be posted in MyCourses!

Theory session	Practice session	Topic
7.9.	(8.9. **no teaching**)	Course introduction & information
14.9.	15.9	Solar system, planets & space environment
21.9.	22.9.	Plasma 1: Observations
28.9.	29.9.	Plasma 2: Modelling
	(6.10. **no teaching**)	
5.10.	13.10.	Coordinate systems & time
12.10.	27.10.	Orbits & celestial mechanics
(19.10.)	(20.10.)	Exam week, **no teaching**
26.10.	3.11.	Space technology and history
2.11.	10.11.	Emission mechanisms 1
9.11.	17.11.	Emission mechanisms 2
16.11.	24.11.	Galactic astronomy 1
23.11.	1.12.	Galactic astronomy 2
30.11.	(**no teaching**)	Extragalactic astronomy & cosmology
(7.12. **no teaching**)	8.12. **Exam**	Exam week, exam on 8.12.

Evaluation and grading



Why space?

- **Making living conditions on Earth better and safer**
- **Knowledge, science, innovation**
- **Resources**
- **Curiosity**
- **Space travel will become a necessity at some point**
- **…**

Space @Aalto

Earth Observation
Space Physics
Radio Astronomy
Space Technology
+Robotics

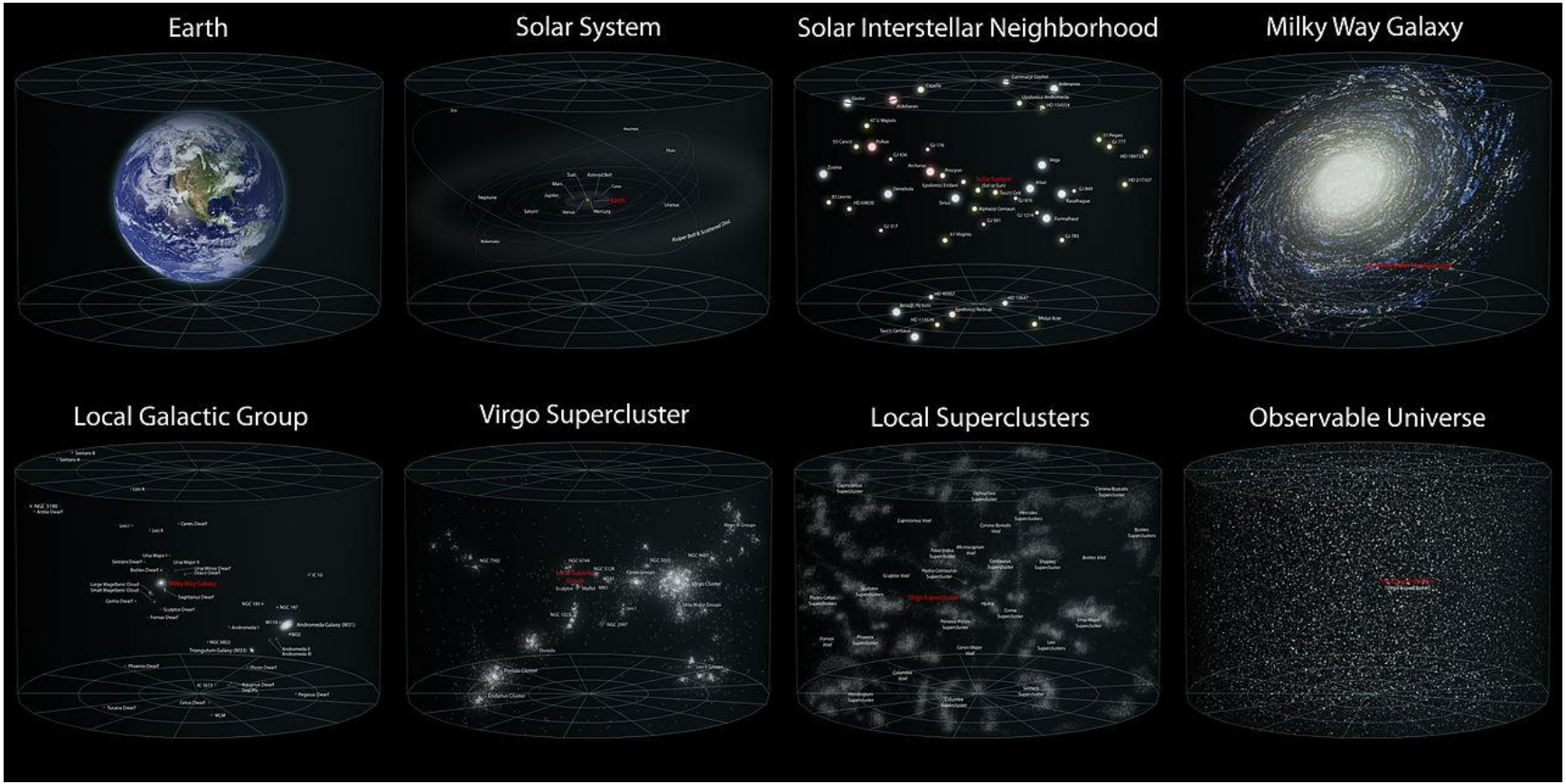
Science:
- Observations
- Theory

Technology:
- Design
- Construction

International community and cooperation

GOAL:
Engineers that understand science; scientists that understand engineering.

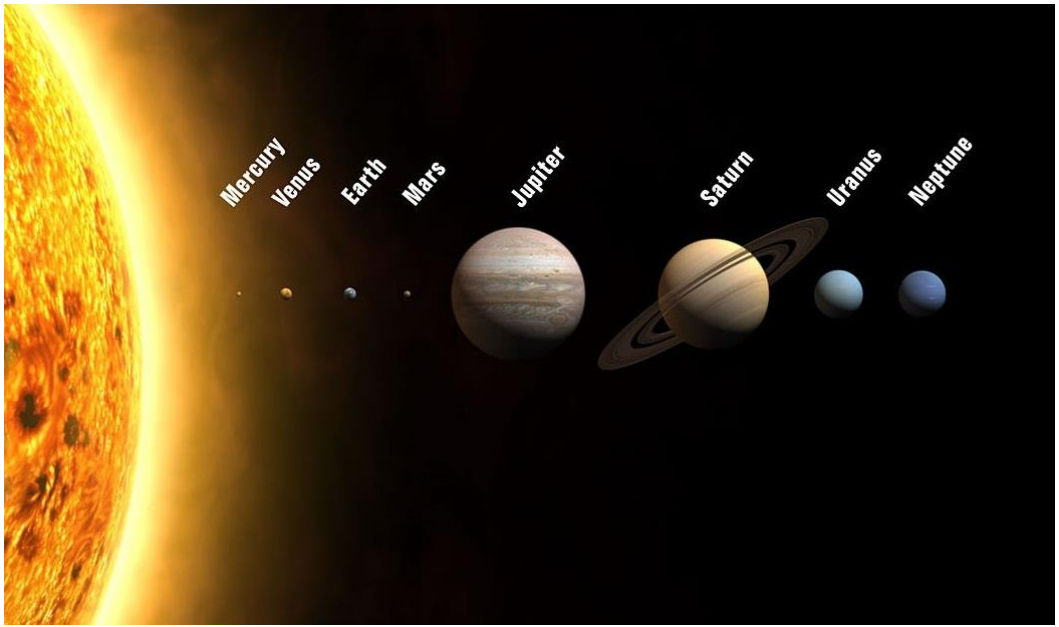
The Universe



Wikipedia

Solar system

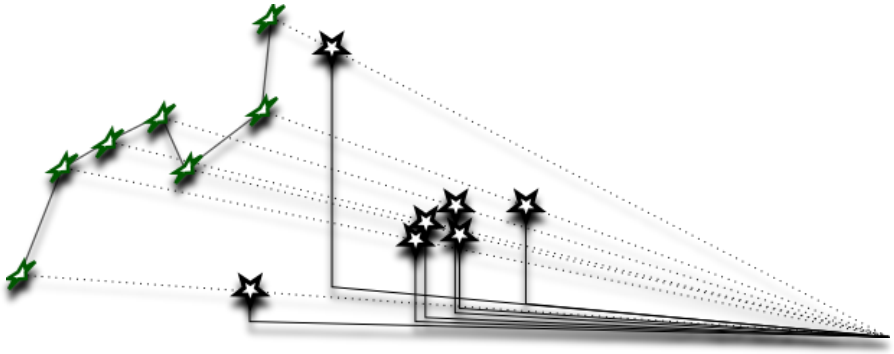
- The Sun
- Planets & moons
- Asteroids
- Meteoroids
- Comets
- Interplanetary dust
- Solar wind



Wikipedia

Stars

- Constellations, asterisms

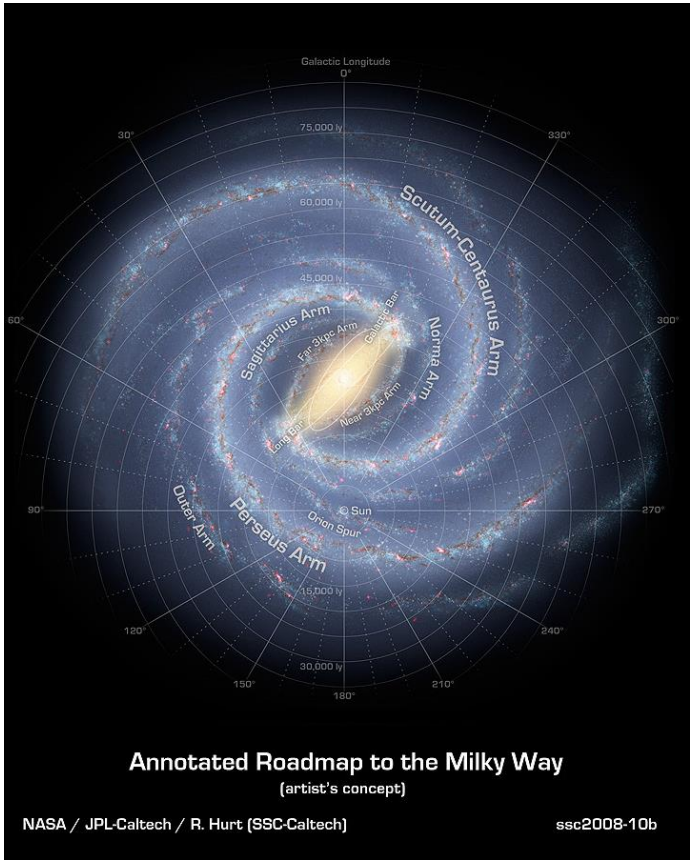


- Star clusters
  - Globular clusters
  - Open clusters

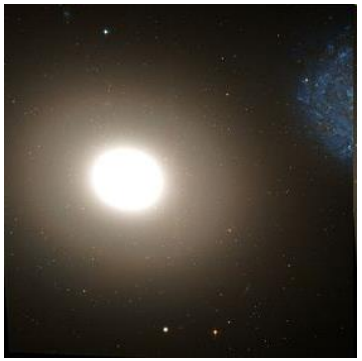
Galaxies

ESO

The Galaxy aka Milky Way

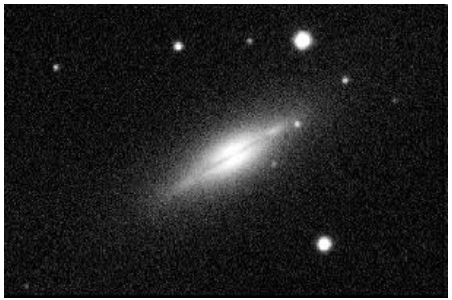


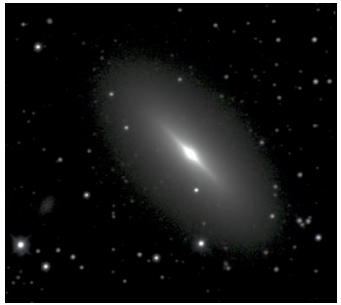
Elliptical galaxies



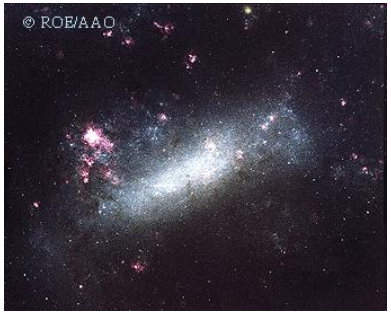
Spiral galaxies

Lenticular galaxies

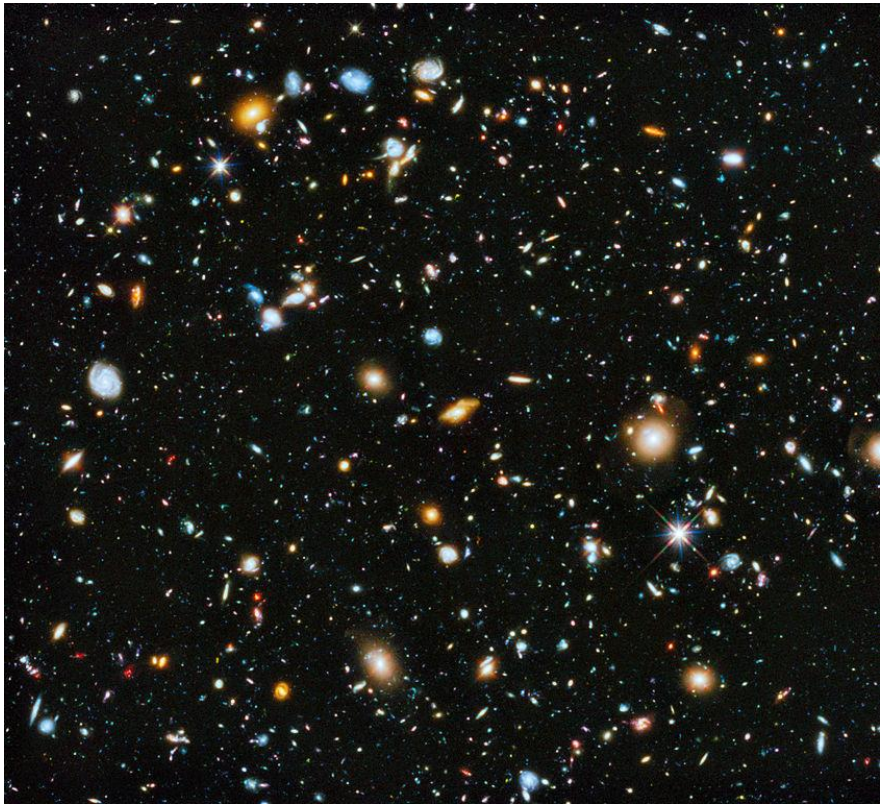




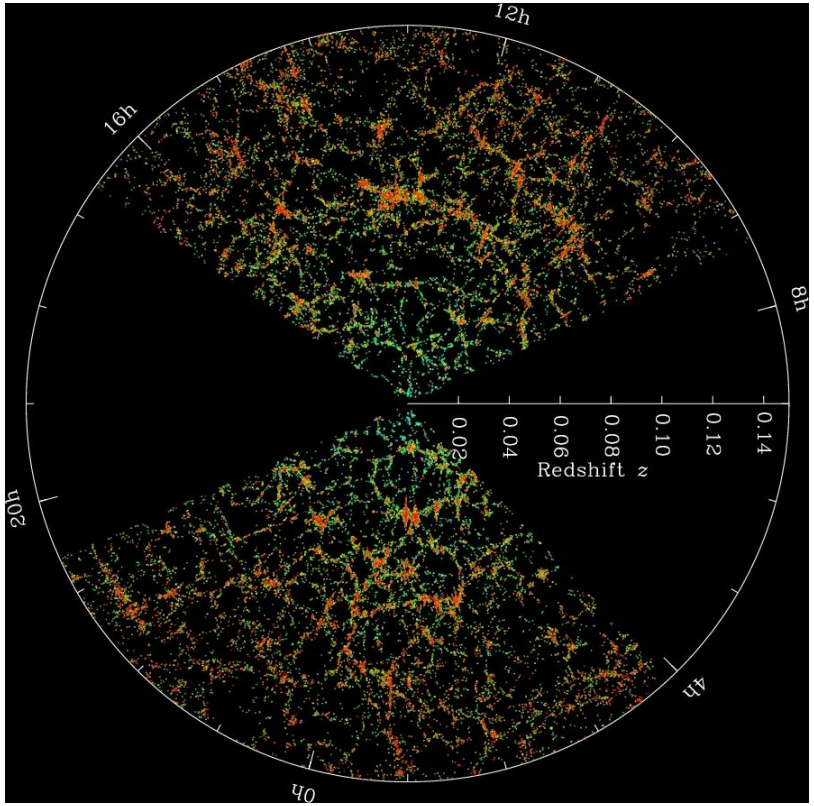
Irregular galaxies



Galaxy clusters & large-scale structure



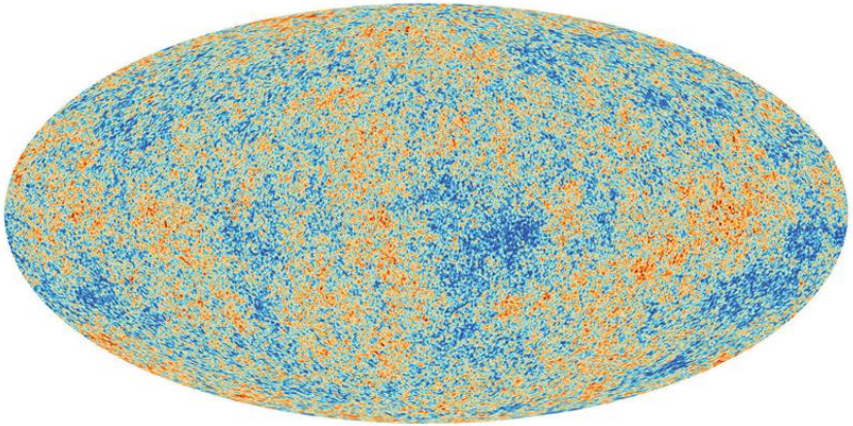
Hubble



SDSS

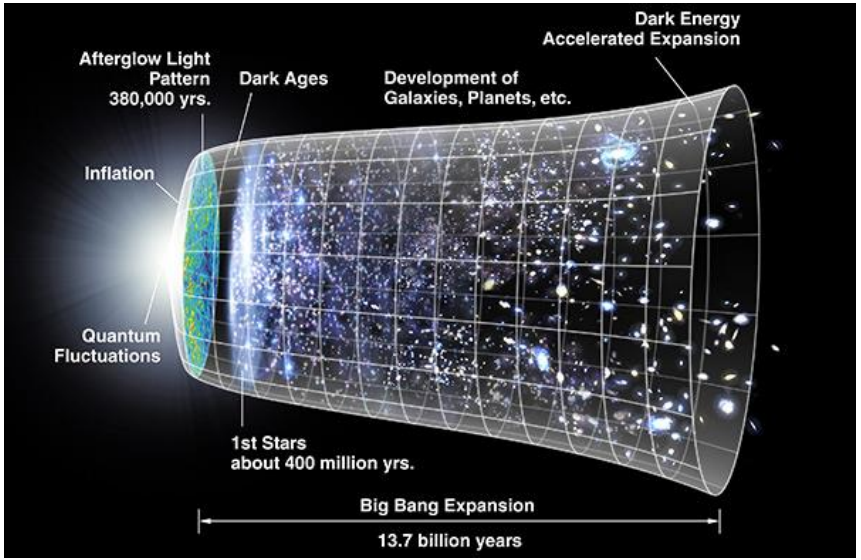
Cosmology

- Cosmic microwave background, CMB



ESA/Planck

- The age of the Universe is 13.8×10^9 years



NASA/WMAP

Dimensions of the Universe:

Angular measurements

Arcminute (’)

- $1/60^{th}$ of a degree

Arcsecond (’’)

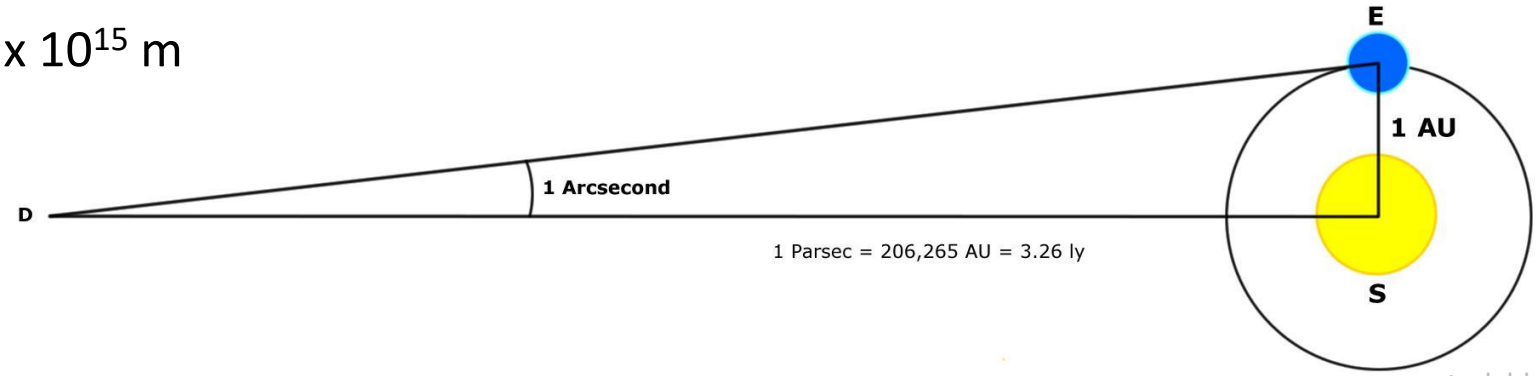
- $1/60^{th}$ of an arcminute

For example:
Moon 0.5° or 30’
Proxima Centauri 0.001’’

Dimensions of the Universe

- Astronomical Unit, AU
  - 149.6×10^9 m
- Light year
  - 9.5×10^{15} m
- Parsec, pc
  - 31×10^{15} m

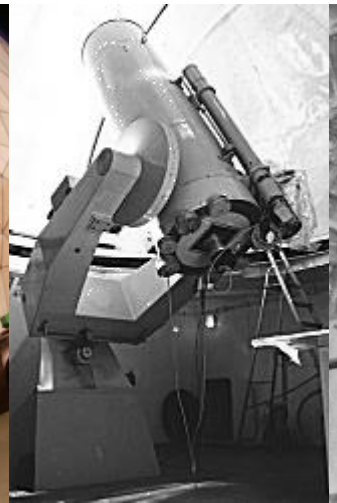
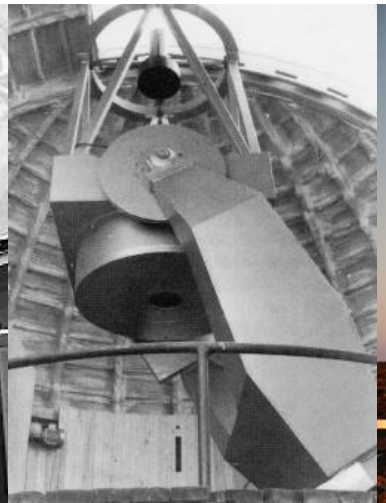
- Distance to the Sun 8.3 light minutes
- Distance to Pluto 5.5 light hours
- Distances between stars ~pc
- Diameter of the Milky Way ~30 kpc
- Largest galaxies ~100 kpc
- Distances between galaxies ~Mpc
- Observable Universe > 28×10^9 pc



Astronomy in Finland

- Aalto, Universities of Turku, Helsinki and Oulu
- Astronomy/astrophysics, planetary science, cosmology
  - Instrumentation: radio, optical (+TeV)

Metsähovi (KVA) (Tuorla) MAGIC

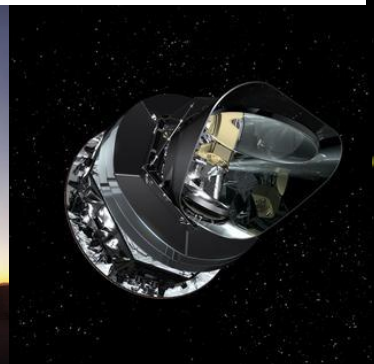

Astronomy in Finland

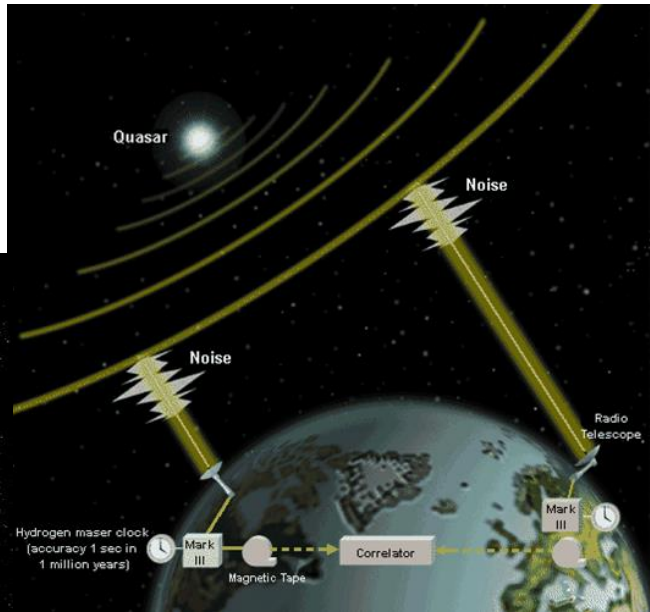
- International instrumentation: radio, optical, IR, UV, X-rays, gamma-rays, TeV
- Ground-based, satellites (ESA, NASA…) , networks (such as Very Long Baseline Interferometry, VLBI)

Fermi

VERITAS

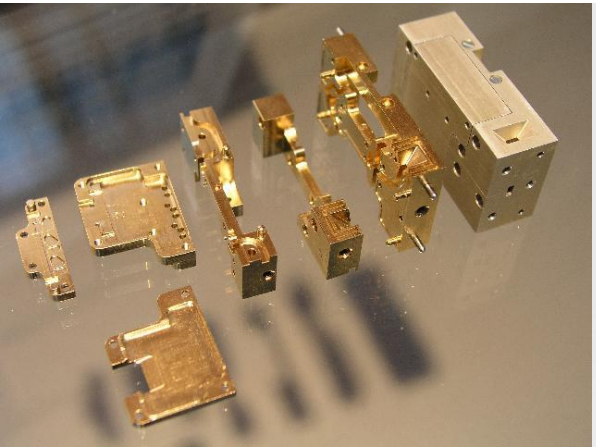
Planck

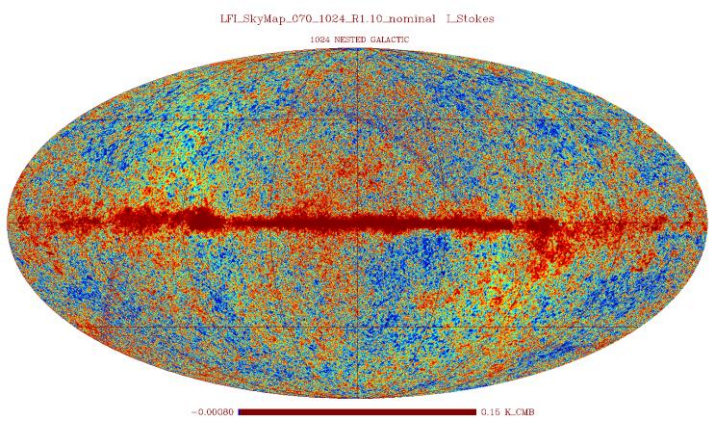




Astronomical instrument building

- Receivers, software and data transfer technology at Metsähovi
- Planck 70 GHz receiver at Millilab, DA-Design, Metsähovi etc
- X-rays (Helsinki)
- Solar system (FMI, Aalto, Helsinki, Oulu, Turku; Esa K!)





European Southern Observatory ESO

- Three observatory sites in Chile: La Silla, Paranal, Chajnantor

ESO

- Finnish Centre for Astronomy with ESO, FINCA
- Research, careers, training

SEST: until 2003

APEX

E-ELT: 2025