



FACULTATEA DE
FIZICA



AGENTIA SPATIALA
ROMANA



ASTROPHYSICS AND COSMOLOGY : THE HISTORY OF THE UNIVERSE

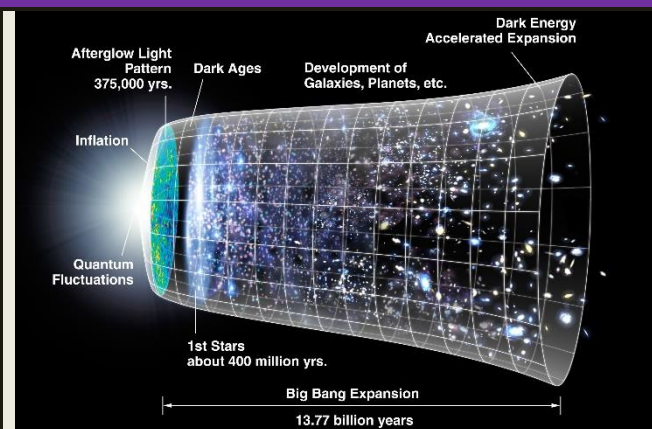
Prof.univ.dr. Dumitru Vulcanov

Lecture no. 1

Introduction. What is cosmology and what does it do? Astronomy and astrophysics as an experimental background of cosmology.

Cosmology is the study of the history of the universe, especially its origins and destiny. It is studied in astronomy, philosophy and religion. Etymologically, cosmology comes from the Greek words κόσμος (cosmos = world) and λογος (logos = science).

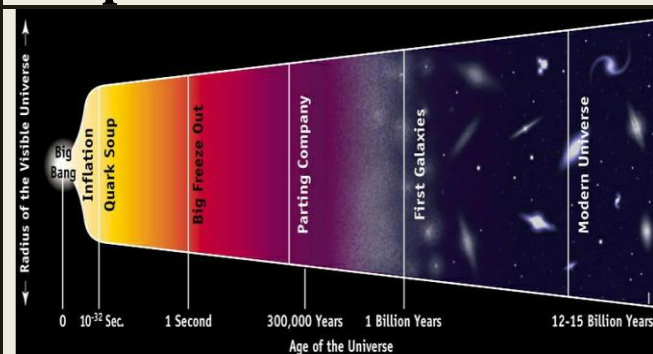
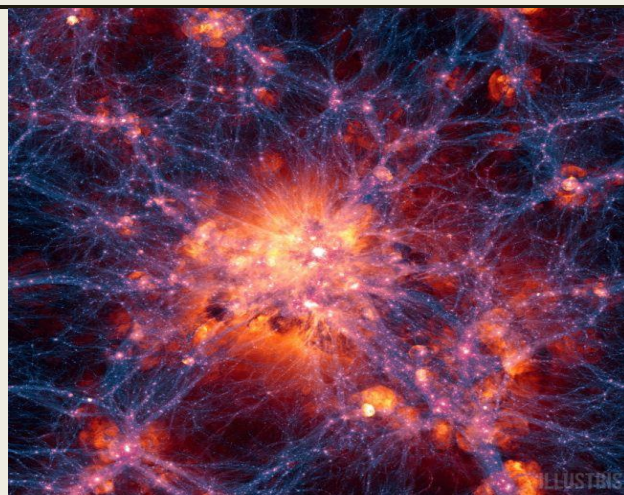
As a science, cosmology and part of physics (physical cosmology) has existed since the beginning of the 20th century with the advent of the theory of **general relativity** and of **astrophysics**!!!



The Big Bang theory has established itself in the scientific world as the most likely model of the birth of the universe..

Based on the theory and using the data provided by astrophysics, computer simulations can be performed by visualizing the evolution of the universe in different phases.

The animation shows the evolution of the Universe from 12 million years after the Big Bang until now: in the cube on the left the dark matter, and on the right the evolution of the gas temperature.



One can identify 7 so-called ages of the universe depending on the energy of matter contained or the temperature from the Big Bang to the present day.

But how was this model of the universe constructed, considered the standard model today?

It all starts with the observation that the fundamental force that governs the entire universe and its dynamics is gravity. Gravity is described in modern physics by the theory of General Relativity.

The second premise comes from astrophysics: astrophysical observations have shown that the current universe is expanding, with galaxies moving away from each other at speeds proportional to the distance to them.

The course is a presentation, largely personal and subjective but as correct as possible from a scientific point of view of:

- The standard model of the universe as it is structured today**
 - - The history of the universe in its evolution from the Big Bang to today and not only as it results from the standard model**
 - - The scientists who built this model and the connections between them**

It can be rightly said that we live in the golden age of cosmology !!!!



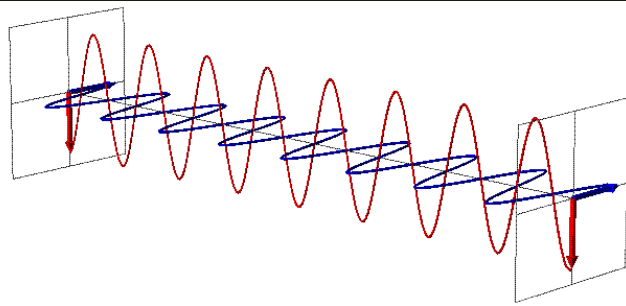
**Theme
for individual
study**

Identify 3 (three) of the above personalities if possible from different centuries and highlight their main contributions to astrophysics and cosmology.

These things will be discussed in this course !!!

Astronomy investigates the universe by studying the electromagnetic waves emissions from stars and all other objects in the universe

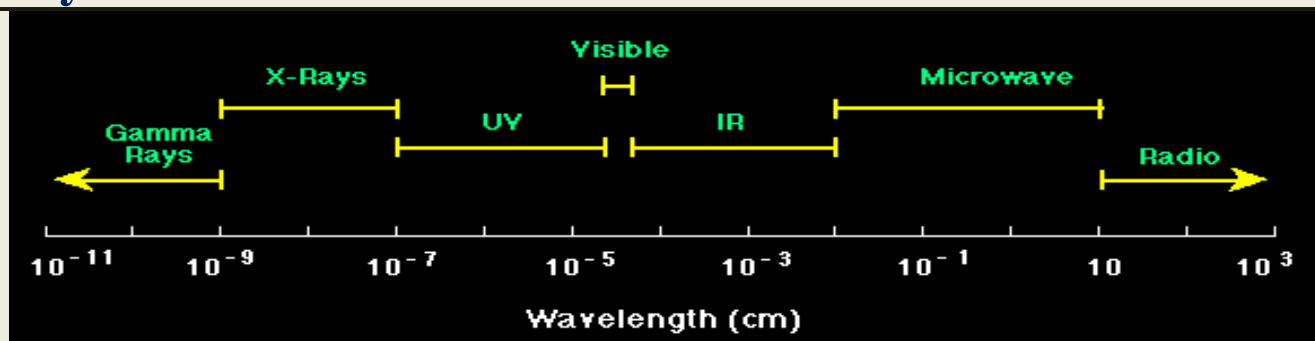
Electromagnetic waves propagate in the interstellar medium that is, even in a vacuum !!!



The properties of these waves give u information about the source (star, galaxy) or about the road traveled to us

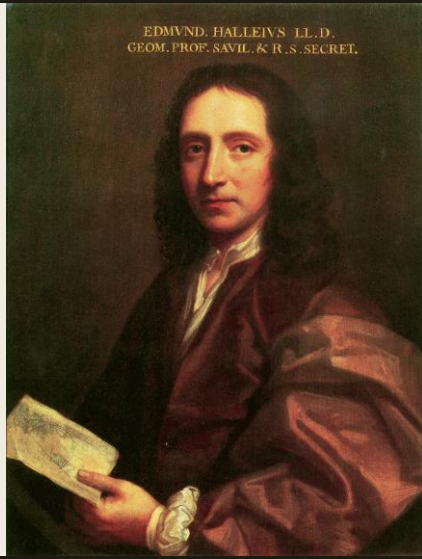
The spectrum of electromagnetic waves

It consists of all electromagnetic waves with higher or lower frequencies, between infrared waves to waves / X-rays or Gamma



Only a small part of the above electromagnetic spectrum is detectable with the naked eye (between 700 nm meaning red and 400 nm meaning purple wavelength) constituting the visible light used by classical astronomy.

Until the 19th century it provided data on the motion of star planets, nebulae, their classification leading to Newtonian theory of gravity and the first cosmological models. Classical astronomy had some exceptional names such as Halley, LeVerier or Herschel.



**Theme
for individual study**

The laws of motion of the planets around the Sun were found by Johannes Kepler (1571-1630). Specify what these laws are



- Astronomy has become astrophysics since the twentieth century. 19 by:
- - Extension to the whole electromagnetic spectrum (radio telescope)
- - Photometric analysis of light from stars
- - Spectroscopic analysis of light and in general of electromagnetic radiation from stars
- - That is, the use of methods of investigation and analysis specific to the science of physics !!!!

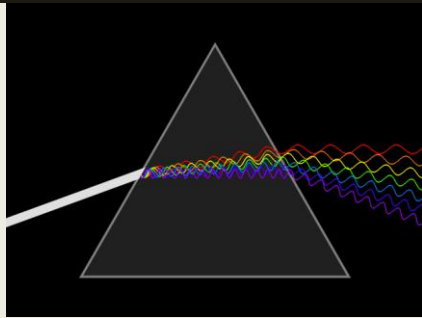
Here in the image below what the same galaxy looks like in different areas of the spectrum e.m.



Andromeda, the closest major galaxy, seen in different wavelengths. Observations from the visible spectrum, made with a ground-based telescope, show several hundred billion stars in the composition of this galaxy. Observations with far-infrared wavelengths from the Herschel Space Observatory reveal the mixture of cosmic gases and dust from which future stars will be born. X-ray observations from the XMM-Newton Observatory

show the brightness emitted by end-of-life or remaining stars from stars that have already died.

Astrophysics and spectroscopy

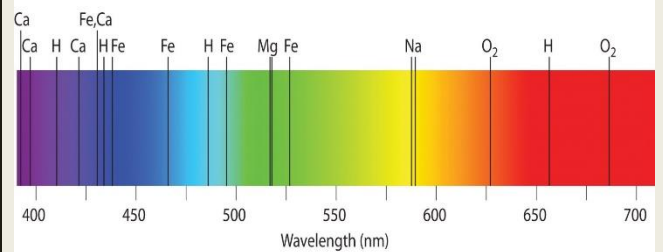


What is spectroscopy?

The passage of light (electromagnetic radiation) through a prism (spectroscope) breaks it down



By first passing the analyzed radiation through a substance that absorbs some of the radiation, we obtain the absorption spectrum with dark lines

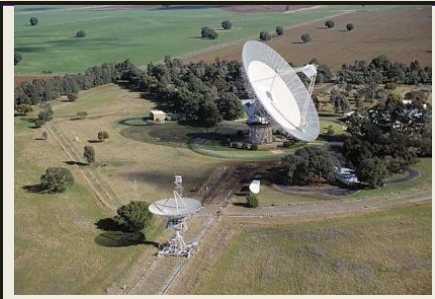


Telescope + spectroscope = true astronomy !!

- Thus the whole 19th century witnessed enormous accumulations in astronomy:
 - - The Milky Way and its size
 - - - stars, classification and their properties
 - - - star movement (Doppler effect)
 - - - nebulae are actually other galaxies

All this prepared the revolution in cosmology of the 20th and 21st century

This revolution in astronomy I is due to Joseph von Fraunhofer (1787-1826) inventor of spectroscopy



**Theme
for individual study**

State the main properties of stars that can be determined using spectroscopic astronomy

Back 