

The Evolving Universe

2024 - 2025

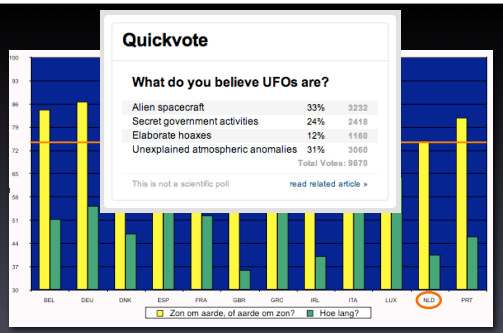
http://www.astro.rug.nl/EDUCATION/main_en.html

"A Journey of Discovery"

Fascination from facts,
but also from astrophysical processes,
the big picture, history, beauty .....

We are all part of 'our' Universe !

Astronomy is shaped by cultural, dynamical processes,
not without controversy…



transferring basic knowledge needs to improve

Course overview

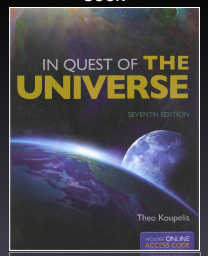
- 14 in-person lectures
  - Monday 11:00-13:00 Bernoulliborg, Friday 9:00-11:00 Aletta Jacobshal
    attendance is ***not mandatory*** but lectures will not be live streamed
- 6 on-campus tutorials
  - Wednesdays 15:00-17:00 (Grp 1&2), 17:00-19:00 (Grp 3), Thursday 15:00-17:00 (Grp 4&5)
    attendance is ***mandatory*** to receive/collect homework assignment
  - You are allowed to miss ***ONE*** tutorial with a well justified reason (please notify me in time)
- 5 individual homework assignments (40% of final grade)
  - each to be completed individually in between tutorial dates
- Exam (multiple-choice, 60% of final grade, exam grade ≥4.5 is required)
  - Tuesday 28 January 2023, 11:45 - 13:45, Aletta Jacobs exam hall



Estimated study load (5 ECTS = 140 hours)

Lectures	: 14x2 hours	= 28 hours = 1.00 ECTS
Tutorials	: 6x2 hours	= 12 hours = 0.45 ECTS
Homework	: 5x4 hours	= 20 hours = 0.75 ECTS
Reading book	: 8 pg/hr	= 60 hours = 2.05 ECTS
Exam prep	:	18 hours = 0.65 ECTS
Exam	:	2 hours = 0.10 ECTS
Total	:	140 hours = 5.00 ECTS

book



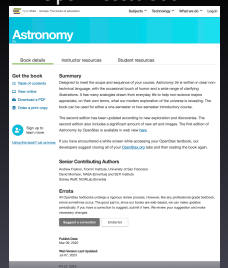
website



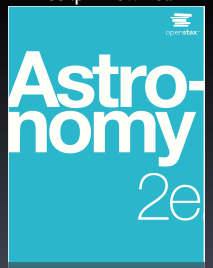
- fairly up-to-date with latest insights and HST pictures
- well-written with excellent illustrations
- practice questions & website with on-line material

OpenStax

Open Access book



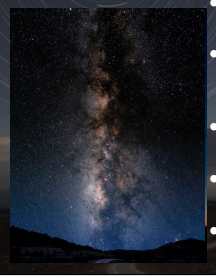
Free .pdf download



- https://openstax.org/details/books/astronomy-2e
- web-version is kept up-to-date
- practice questions & many links to online material and tools

Astrology

Astronomy = Astrophysics
or physics of all things extra-terrestrial

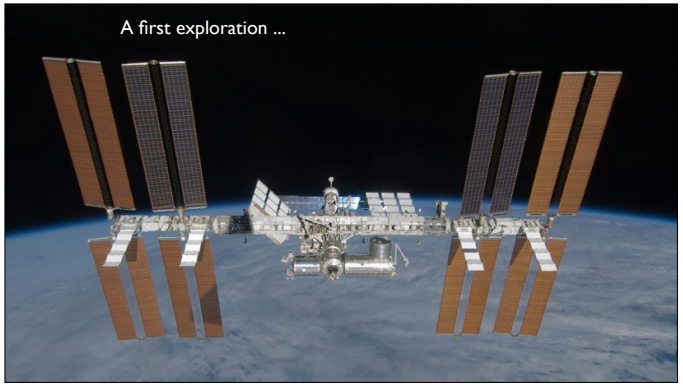


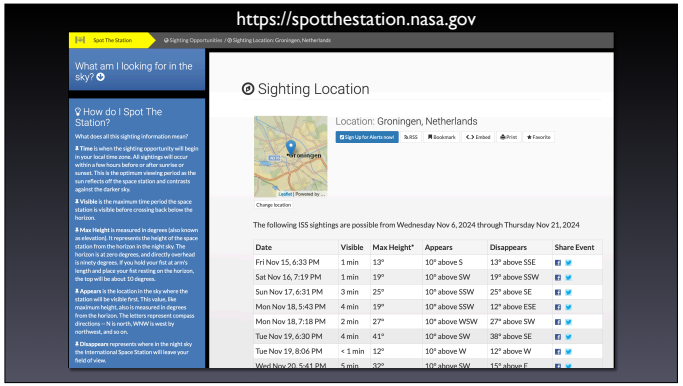
Some simple observations:

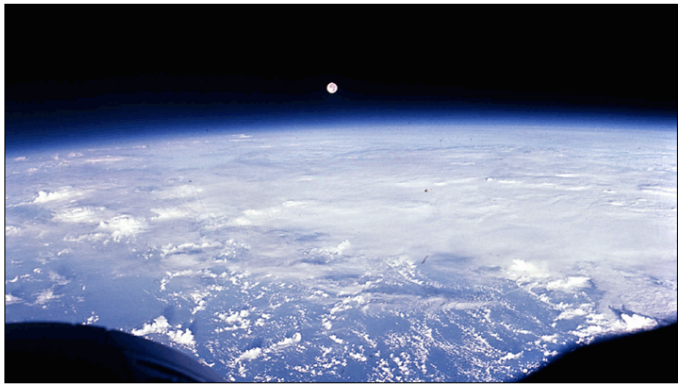
- stars rise and set, just like the Sun and the Moon
- the sky is divided in 88 'fantastic' constellations
- there are 'wandering' stars (planets) moving along the zodiac (ecliptic), just like the Sun and the Moon
- occasionally we see a comet or a shooting star (meteor)
- sometimes we witness a (partial) solar or lunar eclipse
- we see a Milky Way with dark spots and faint fuzzy patches

Let's take off !



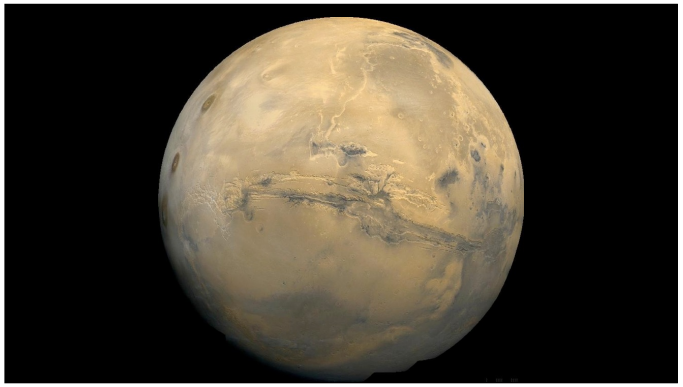

A first exploration ...

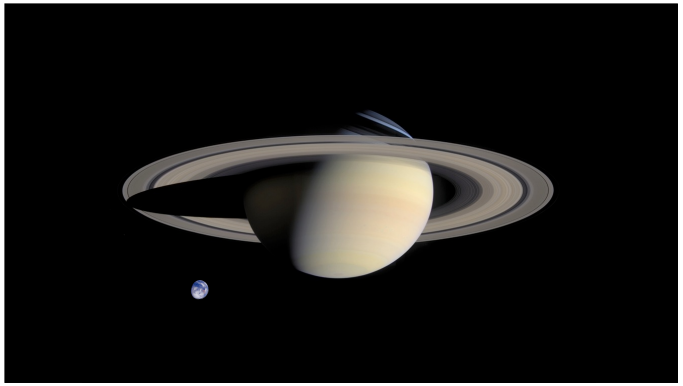

https://spotthestation.nasa.gov
Spot The Station
Sighting Opportunities / Sighting Location: Groningen, Netherlands
What am I looking for in the sky?
How do I Spot The Station?
What does all this sighting information mean?
Time is when the sighting opportunity will begin in your local time zone. All sightings will occur within a few hours before or after sunrise or sunset. This is the optimum viewing period as the sun reflects off the space station and contrasts against the darker sky.
Visible is the maximum time period the space station is visible before crossing back below the horizon.
Max Height is measured in degrees (also known as elevation). It represents the height of the space station from the horizon in the night sky. The horizon is at zero degrees, and directly overhead is ninety degrees. If you hold your fist at arm's length and place your fist resting on the horizon, the top will be about 10 degrees.
Appears is the location in the sky where the station will be visible first. This value, like maximum height, also is measured in degrees from the horizon. The letters represent compass directions – N is north, WNW is west by northwest, and so on.
Disappears represents where in the night sky the International Space Station will leave your field of view.
Sighting Location
Location: Groningen, Netherlands
Sign Up for Alerts now!
RSS
Bookmark
Embed
Print
Favorite
Groningen
Leaflet | Powered by ...
Change location
The following ISS sightings are possible from Wednesday Nov 6, 2024 through Thursday Nov 21, 2024
Date
Visible
Max Height*
Appears
Disappears
Share Event
Fri Nov 15, 6:33 PM
1 min
13°
10° above S
13° above SSE
Sat Nov 16, 7:19 PM
1 min
19°
10° above SW
19° above SSW
Sun Nov 17, 6:31 PM
3 min
25°
10° above SSW
25° above SE
Mon Nov 18, 5:43 PM
4 min
19°
10° above SSW
12° above ESE
Mon Nov 18, 7:18 PM
2 min
27°
10° above WSW
27° above SW
Tue Nov 19, 6:30 PM
4 min
41°
10° above SW
38° above SE
Tue Nov 19, 8:06 PM
< 1 min
12°
10° above W
12° above W
Wed Nov 20, 5:41 PM
5 min
32°
10° above SW
15° above E

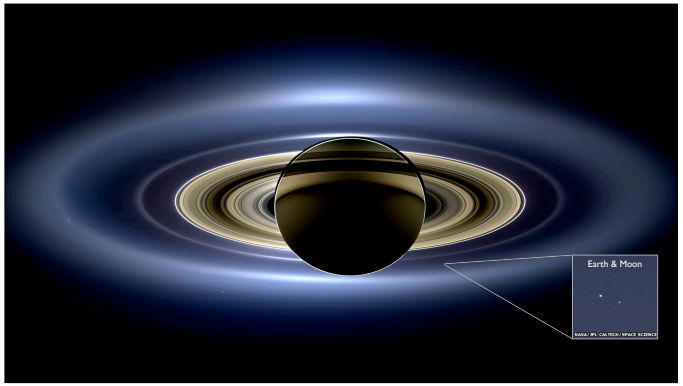




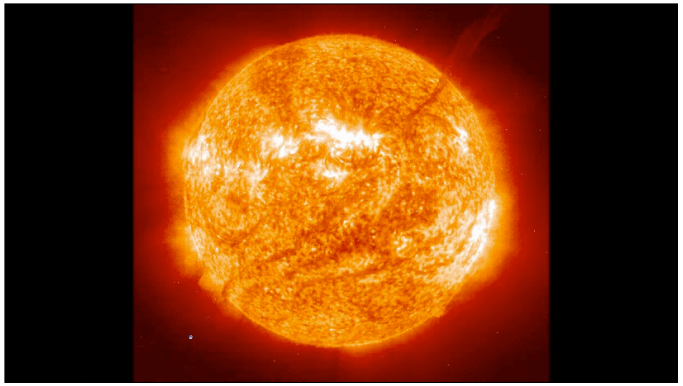




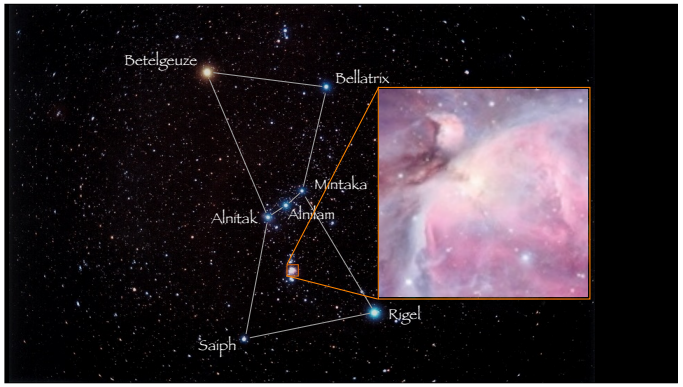



Earth & Moon





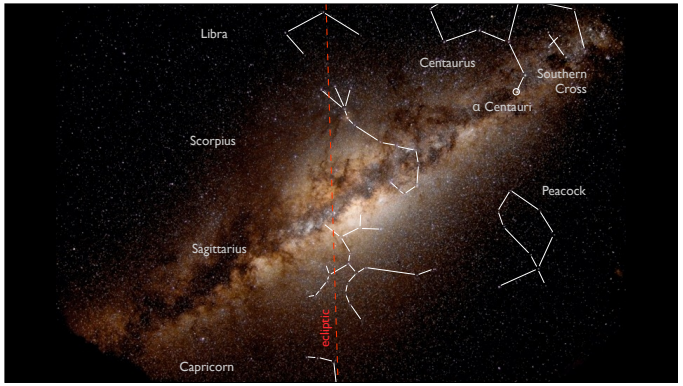

Today


Betelgeuze
Bellatrix
Mintaka
Alnitak
Alnilam
Rigel
Saiph








Libra
Centaurus
Southern
Cross
α Centauri
Scorpius
Peacock
Sagittarius
ecliptic
Capricorn



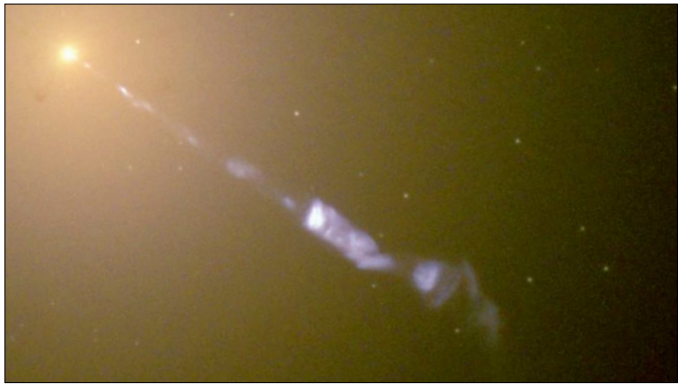








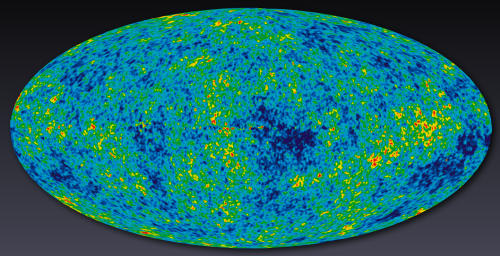








The 'edge' of the visible Universe



cosmic background radiation

The Universe is *very* empty

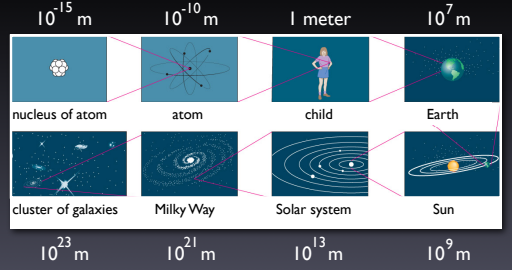


Imagine the Sun,
the size of a football
with a diameter of 22 centimeters.
To scale, the Earth would be a 2mm
pinhead at a distance of 24 meters.

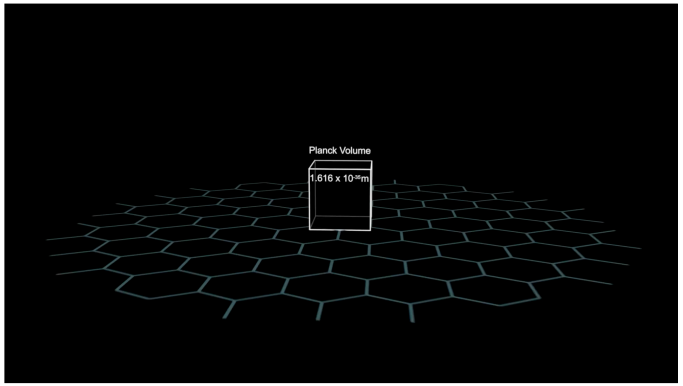
Pluto, the size of a grain of sand,
would be at a distance of 926 meter.

At the same scale, the nearest star, Proxima Centauri,
would be at a distance of 6300 km.

The Universe is also *very* big



Diameter of the visible Universe: 10^{27} meter



Instead of 'normal' measures (km) and scientific notations (powers of 10), we rather use light travel times to express distances.

!! the speed of light c is 299,792.458 kilometers/second !!

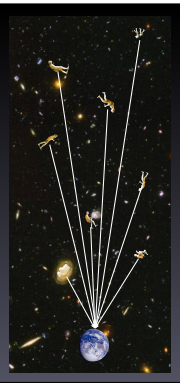
	kilometers		light travel time
Moon	384.400	3.84×10^{5}	1,3 seconds
Sun	149.597.900	1.50×10^{8}	8,3 minutes
Neptune	4.498.252.900	4.50×10^{9}	4,2 hours
Proxima Centauri	39.953.000.000.000	4.00×10^{12}	4,2 years
Milky Way diameter	946.000.000.000.000.000	9.46×10^{17}	100.000 years
Andromeda galaxy	21.800.000.000.000.000.000	2.18×10^{19}	2.3 million years
most distant object	271.000.000.000.000.000.000.000	2.71×10^{23}	12.8 billion years
background radiation	434.000.000.000.000.000.000.000	4.34×10^{23}	13.7 billion years

nothing moves faster than light → space & time are coupled !

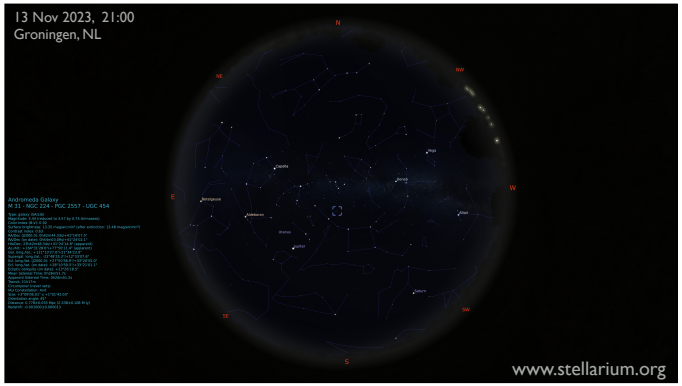
This leads to an important concept:

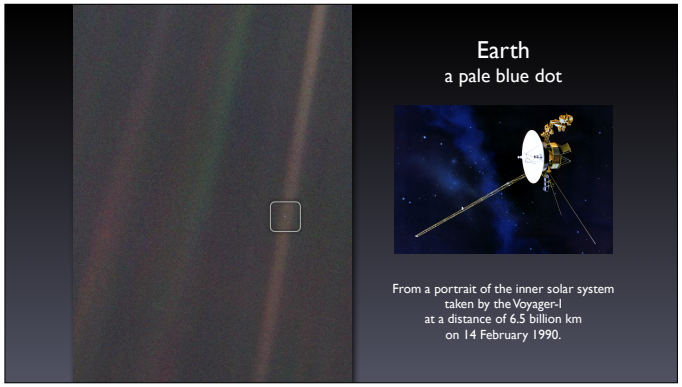
More distant objects are seen further back in time…

→ astronomy is also historical research, investigating the cosmic evolution of astronomical objects such as galaxies!









Earth
a pale blue dot

From a portrait of the inner solar system
taken by the Voyager-1
at a distance of 6.5 billion km
on 14 February 1990.



Next lecture

- Early developments in astronomy
- From a geocentric to a heliocentric world view
- Kepler's laws