

Special Projects in Astronomy: Astronomy Research Techniques

Amy Lien

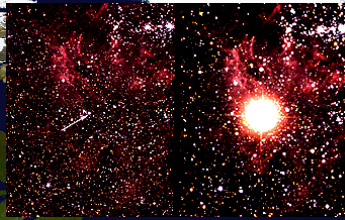
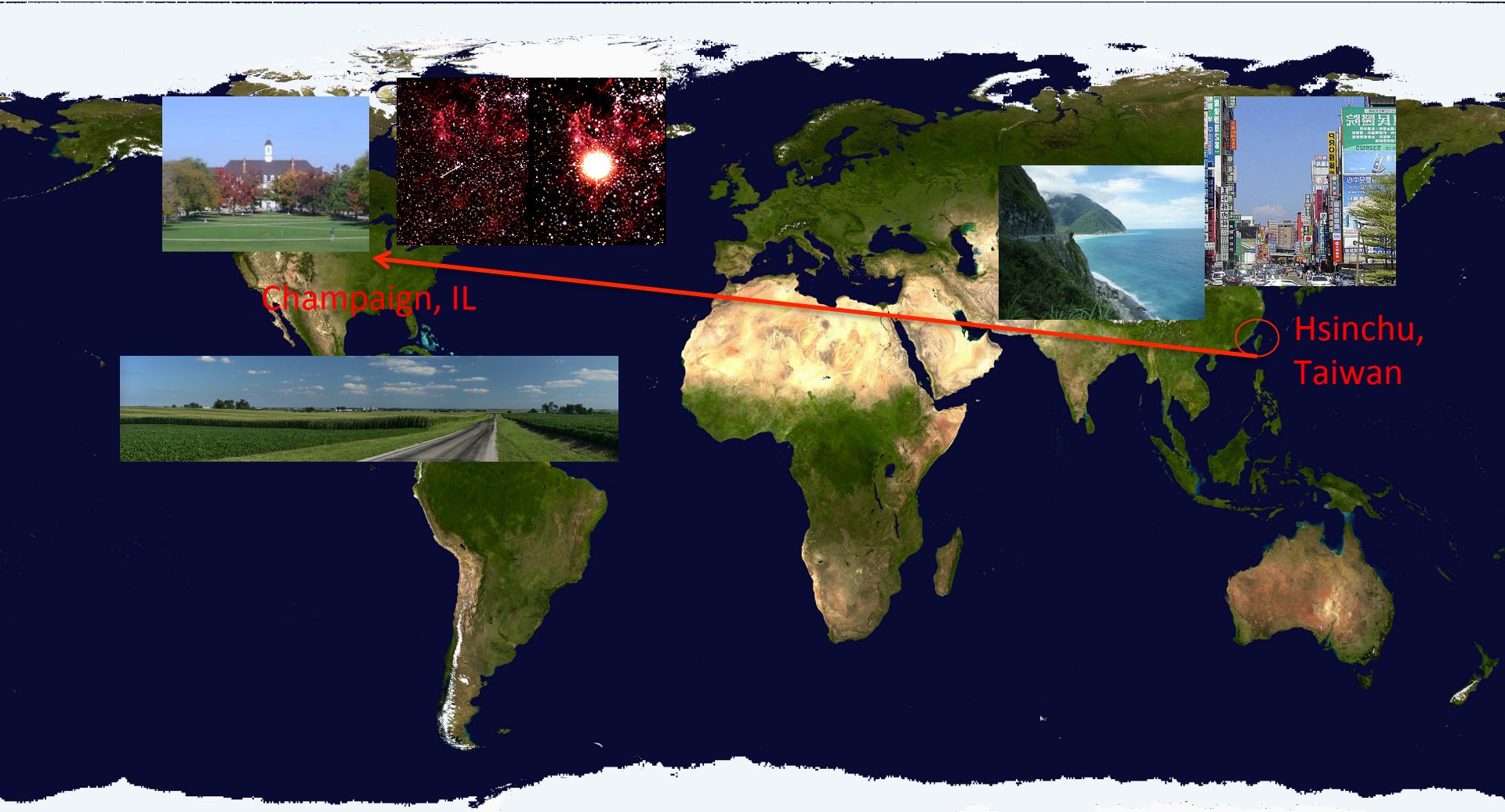
Goddard Space Flight Center



ASTR 288C, Lecture 1



A little history of me



Champaign, IL

Hsinchu,
Taiwan



A little history of me



About the class

- 0 Time: Monday 3:30-5:15 pm
- 0 Instructor: Amy Lien amy.y.lien@nasa.gov
- 0 Location: ATL 0224
- 0 Course webpage:
http://userpages.umbc.edu/~alien/ASTR_288C/Index.html
 - 0 Class info including lecture note and homework.
 - 0 Updated frequently
- 0 Office Hours: Monday 2:15 – 3:15 pm
 - 0 Option for alternative office hour:
<http://doodle.com/poll/mrfqbp259sraqsyq> (Multiple choices)
- 0 Textbook: None
- 0 Exam: None!
 - Written and oral presentation on research project
- 0 Your feedback during the semester is not only encouraged, it's important!

About the class

0 The first step into research

- 0 Research method

- 0 Research technique

 - 0 Unix, programming, statistics, common astronomy tools...

- 0 Problem solving

- 0 Presentation (written and oral)

- 0 Science communication and collaboration

About the class

0 **Lectures:**

- 0 introduce basic concepts, and present examples, often from our own research experience

0 **Labs:**

- 0 illustrate these with hands-on applications

0 **Homework:**

- 0 address the material in more depth and detail

0 **Research project:**

- 0 put it all together by carrying out a project from the analysis stage all the way through the presentation of results.

Student evaluation

0 Grades:

- 0 Lab/participation – 15%
- 0 Homework – 45%
- 0 Research project – 40% (paper 20%, presentation 20%)

0 Lab/participation

- 0 **No more than one unjustified absence is permitted.**
- 0 Finish worksheet during the lab.
 - 0 If running out of time, inform the instructor during lab and turn in at the beginning of the next class.
 - 0 If absence from class, complete and turn in worksheet at the beginning of the next class.

0 Homework

- 0 Due at 3:30 pm on Monday (beginning of class).
- 0 Late homework will be accepted within one week after the original due date, but the grade will be decreased by 50%.
- 0 Lowest homework grade will be dropped.

Research Project

0 Proposal

- 0 Choose from a list of possible topics

- 0 Find your own topic

- 0 ~ 2 pages

0 Paper

- 0 Draft → referee report

- 0 Final paper

- 0 ~ 5 pages

0 Oral presentation

- 0 Final week

- 0 ~ 10 min

Week	Lecture	Lab
1	Introduction and overview	Unix environment
3	Stellar explosion	Literature search
4	Gamma-ray bursts	Latex
5	The research process	Proposal discussion
6	Gamma-ray and X-ray astronomy	BAT and XRT database
7	Simulation and programming I	Python I
8	Simulation and programming II	Python II
9	Statistical analysis	Likelihood analysis
10	Temporal analysis	Burst duration and light curve
11	Spectral analysis	Making spectrum
12	Spectral modelling	Spectral fitting
13	Scientific proposal	Student proposal
14	Science communication	Project discussion
15	Dedicated time for research projects	Individual research
16	Dedicated time for research projects	Individual research
17	Oral presentation	

*Schedule may subject to minor revision based on class progress

Week	Lecture	Lab
1	Introduction and overview	Unix environment
3	Stellar explosion	Literature search
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5	The research process	Proposal discussion (Proposal draft)
6	Gamma-ray and X-ray astronomy	BAT and XRT database
7	Simulation and programming I	Python I
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9	Statistical analysis	Likelihood analysis
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11	Spectral analysis	Making spectrum (Final proposal)
12	Spectral modelling	Spectral fitting
13	Scientific proposal	Student proposal (Project start)
14	Science communication	Project discussion
15	Dedicated time for research projects	Individual research (Paper draft)
16	Dedicated time for research projects	Individual research
17	Oral presentation	(Final paper submission)

*Schedule may subject to minor revision based on class progress

Academic Integrity

- 0 Students must be fully familiar and comply with the University Code of Academic Integrity, as detailed at <http://www.president.umd.edu/policies/iii100a.html>
- 0 There is a **zero tolerance** policy with respect to incidents of academic dishonesty, including cheating, fabrication, facilitation, and plagiarism.

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Definition of academic plagiarism

“Plagiarism is presenting someone else’s work or ideas as your own, with or without their consent, by incorporating it into your work without full acknowledgement. All published and unpublished material, whether in manuscript, printed or electronic form, is covered under this definition. Plagiarism may be intentional or reckless, or unintentional. Under the regulations for examinations, intentional or reckless plagiarism is a disciplinary offence.”

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(<https://www.ox.ac.uk/students/academic/guidance/skills/plagiarism?wssl=1>)

Academic Integrity

0 Students must be fully familiar and comply with the University Code of A

Collaboration ✓

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(<https://www.wisc.edu/students/academic/guidance/skills/plagiarism-work-1/>)

Academic Integrity

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Collaboration ✓

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- Discuss with your classmates
 - Help each other
 - Share ideas
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Plagiarism ✗

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- Reports with exact same sentences.
 - Publishing other's ideas as your own
 - Using other's idea in your report without proper references/citations/acknowledgment.
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or

(<https://www.montclair.edu/students/academic/guidance/skills/plagiarism-work-1/>)

Academic Integrity



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Library

We gratefully acknowledge support from
the Simons Foundation
and member institutions

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All papers



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Detecting Text Overlap with Work in arXiv

Submissions are sometimes marked with an "arXiv admin note" indicating text overlap with other arXiv articles. Determination of significant text overlaps is based on a statistical analysis of the existing arXiv corpus, with overlaps classified according to whether the overlapping articles have coauthors in common and whether one cites the other.

Ref: <https://arxiv.org/help/overlap>

About you

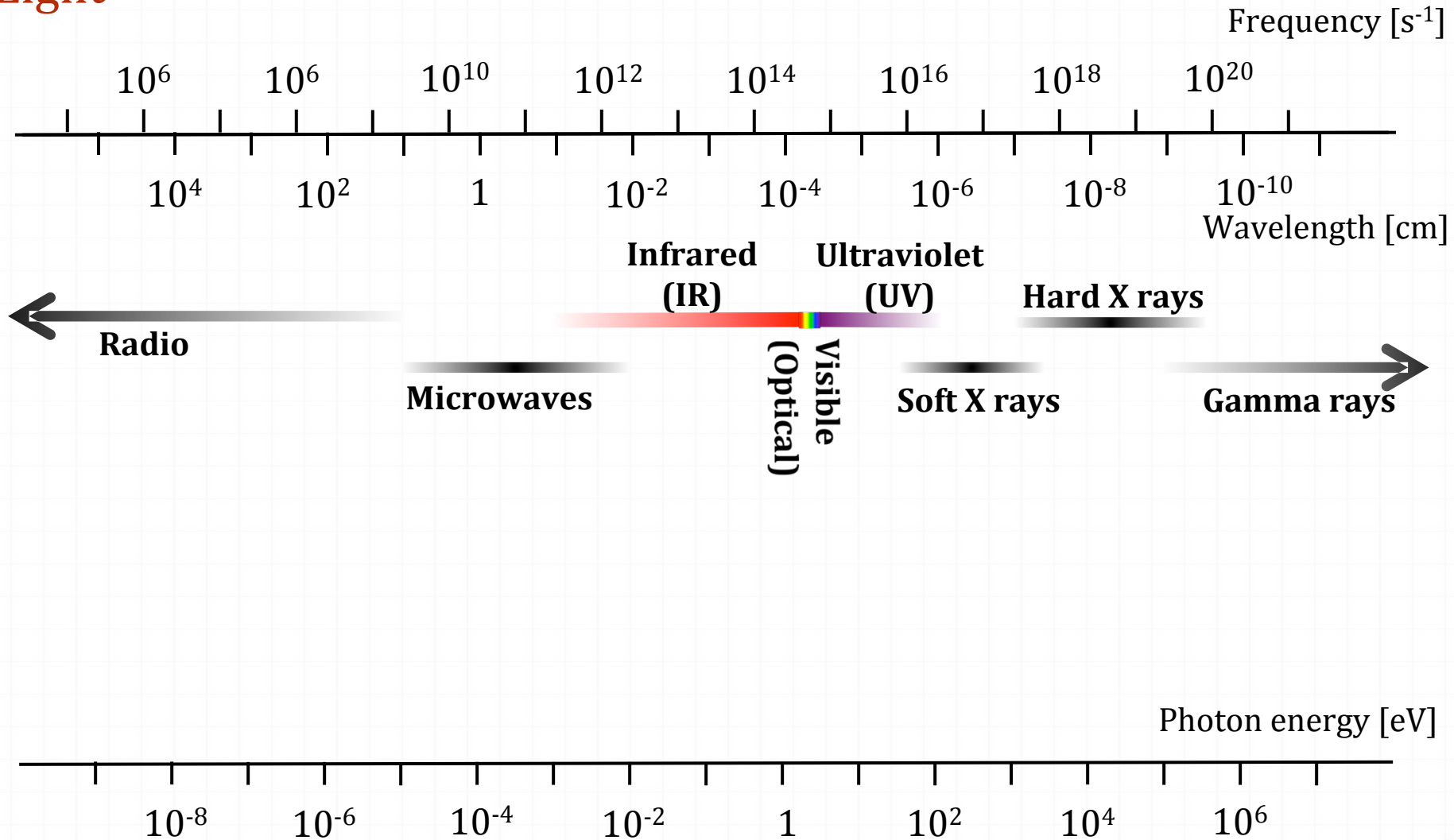
- 0 What is your major?
- 0 Are you a freshman, sophomore, junior, or senior?
- 0 Why are you interested in this class?
- 0 What astronomy classes have you taken?
- 0 What is your programming experience?

What is astrophysics?

- 0 Exploring mysteries in the universe
 - 0 How the universe works?
 - 0 How the universe begins and evolves?
 - 0 Is there life elsewhere in the universe?

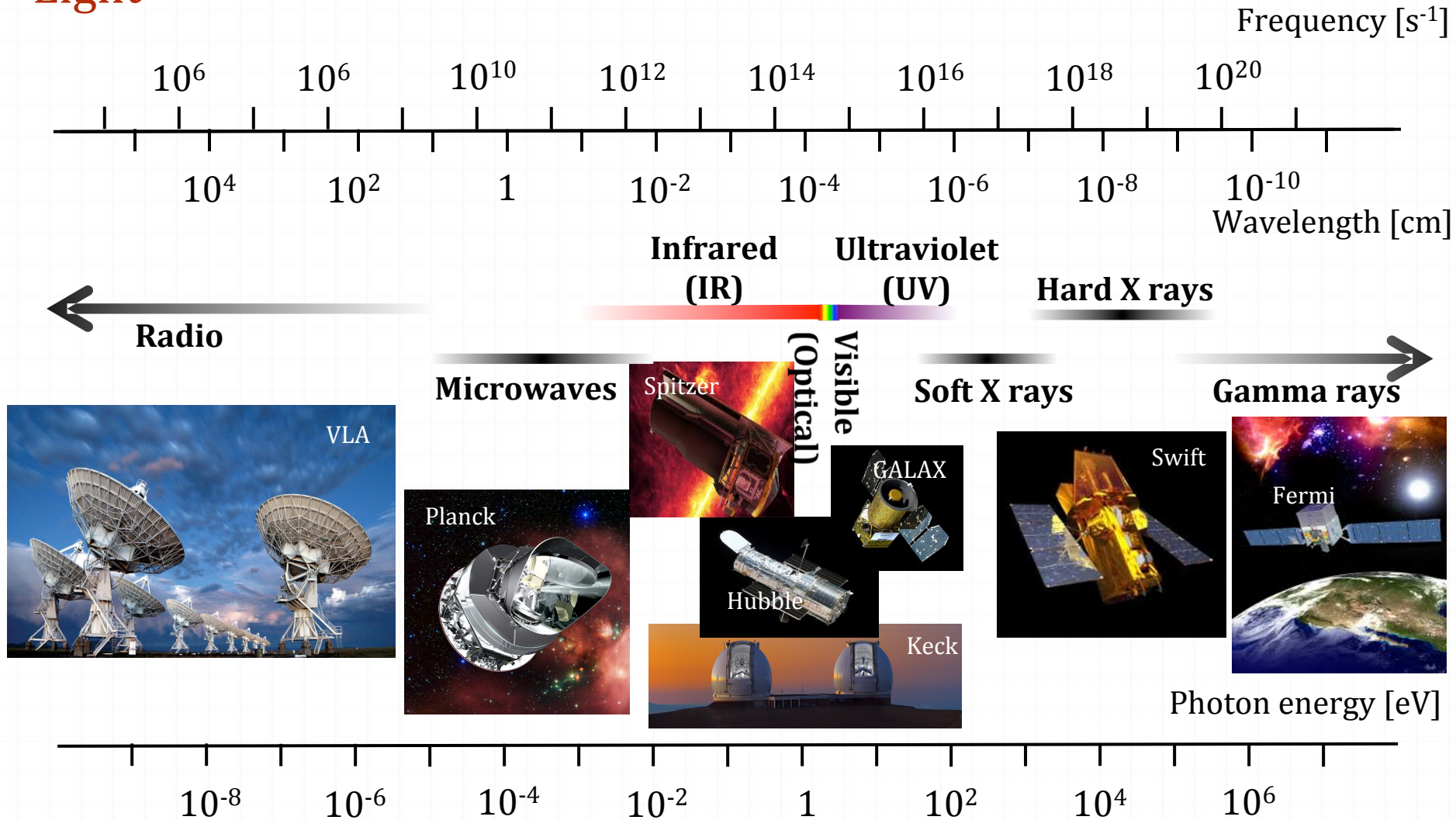
Tools to study the Universe

Light



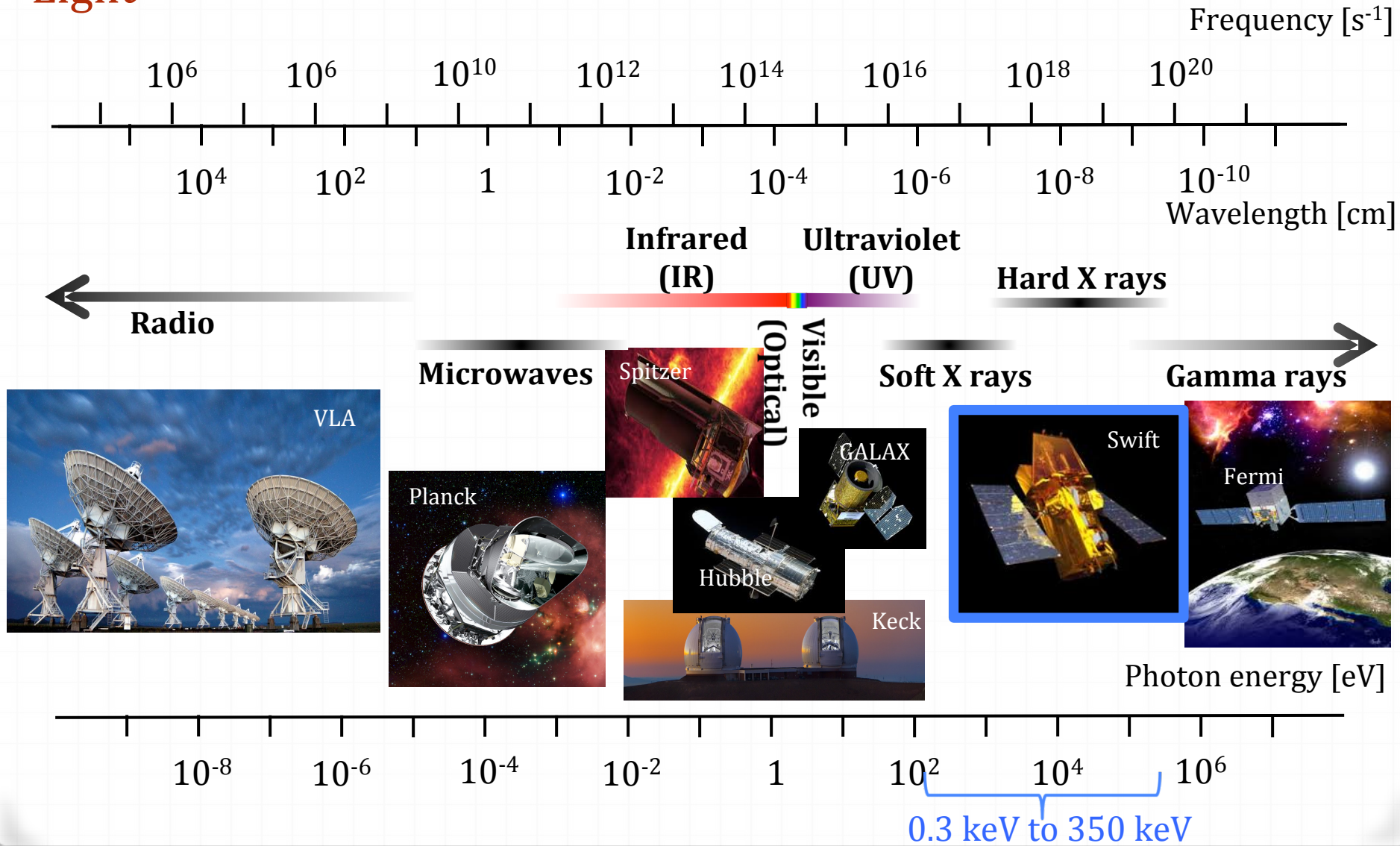
Tools to study the Universe

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Tools to study the Universe

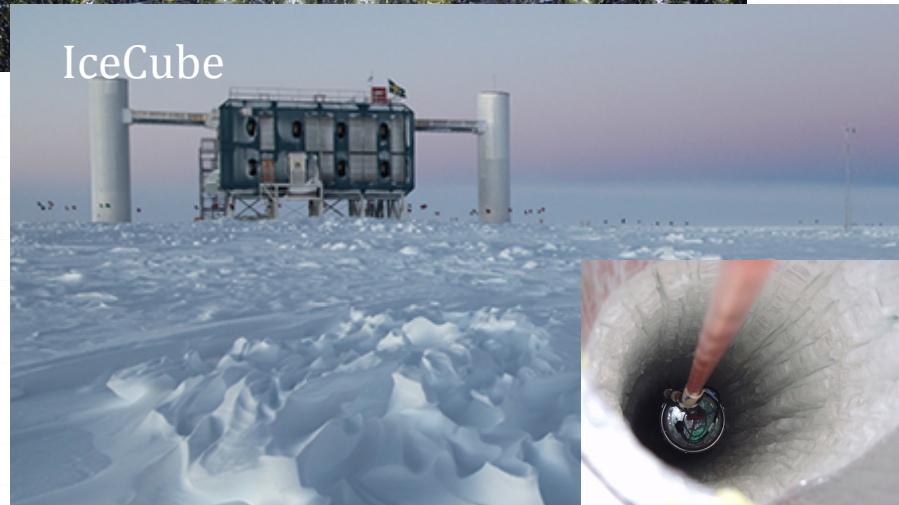
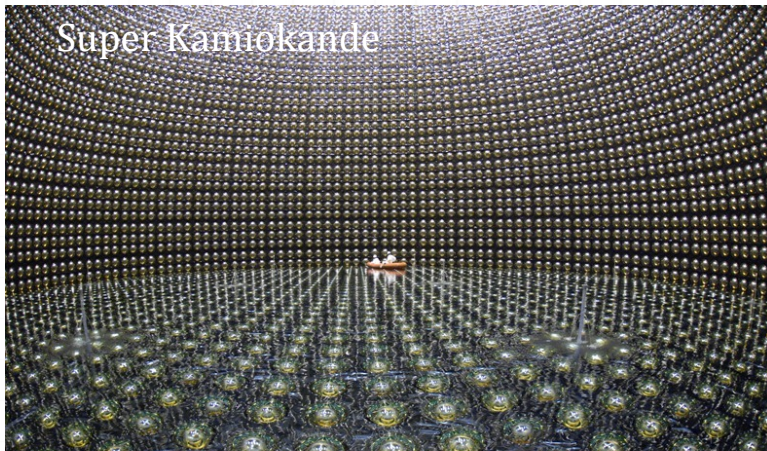
Light



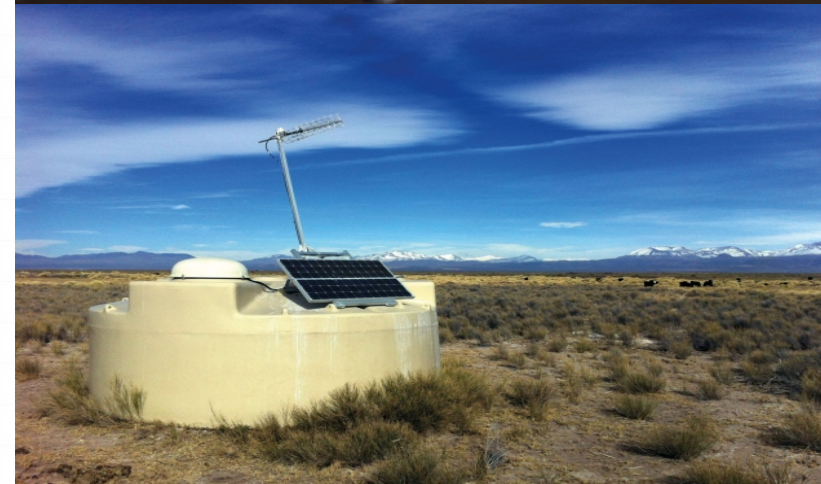
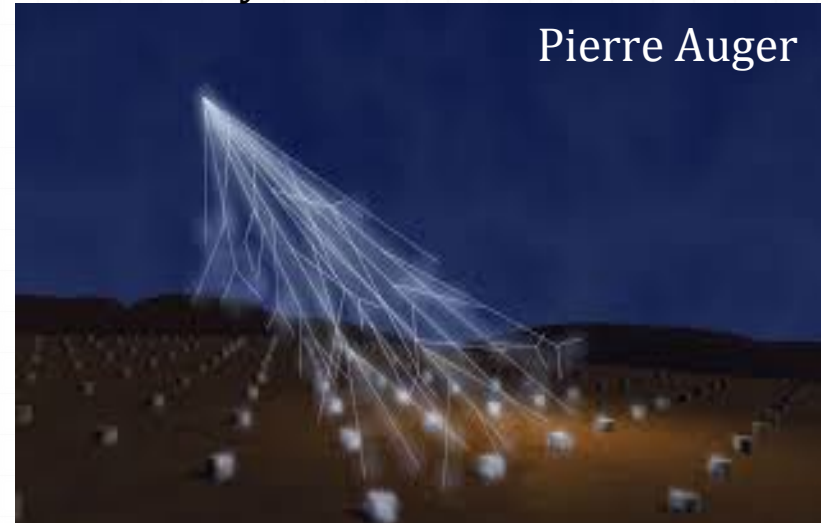
Tools to study the Universe

Particles

Neutrinos



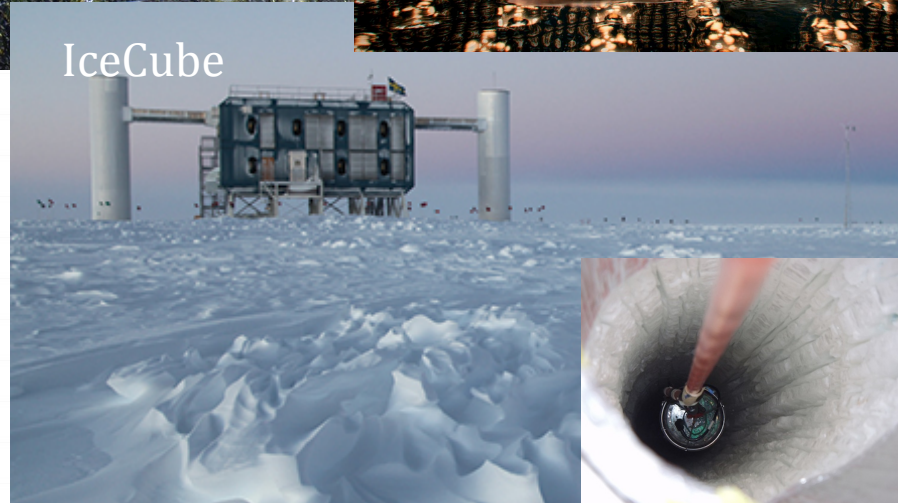
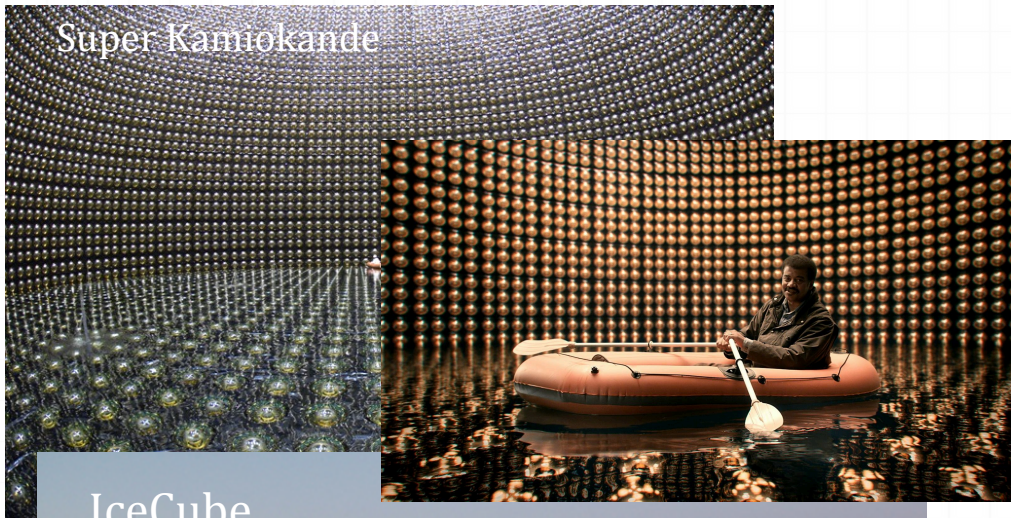
Cosmic Rays



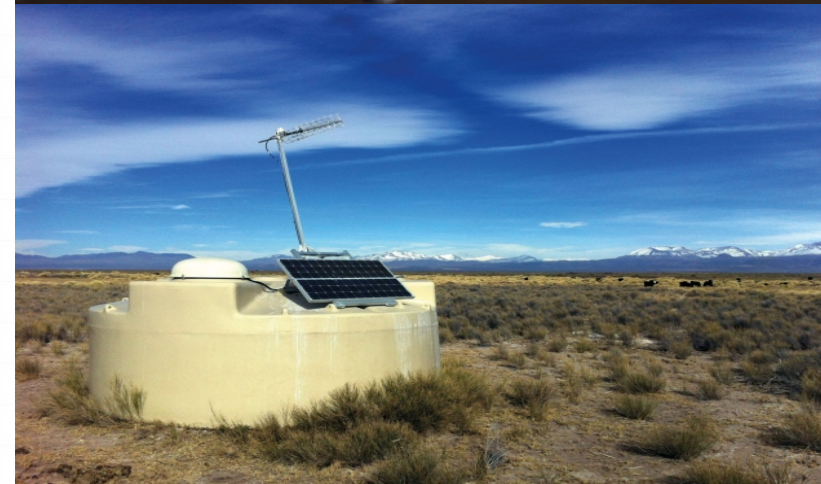
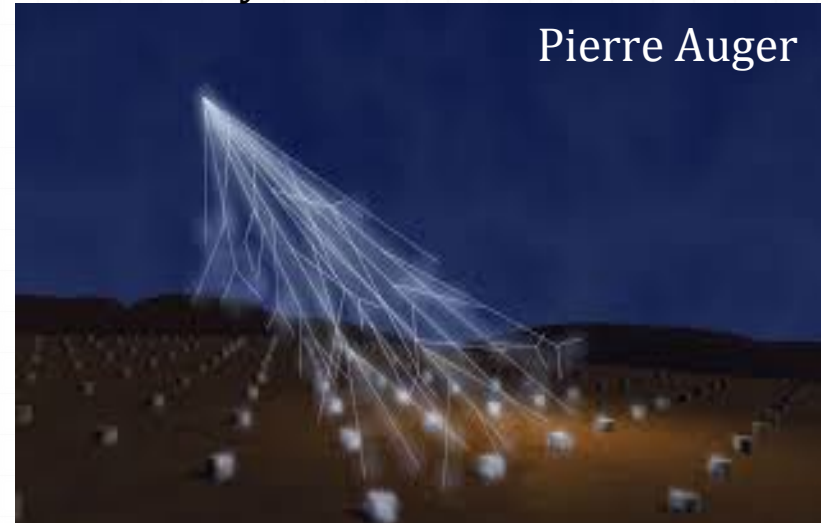
Tools to study the Universe

Particles

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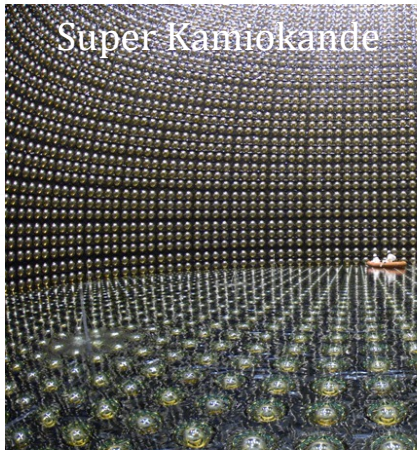
Cosmic Rays



Tools to study the Universe

Particles

Neutrinos



Cosmic Rays



IceCube



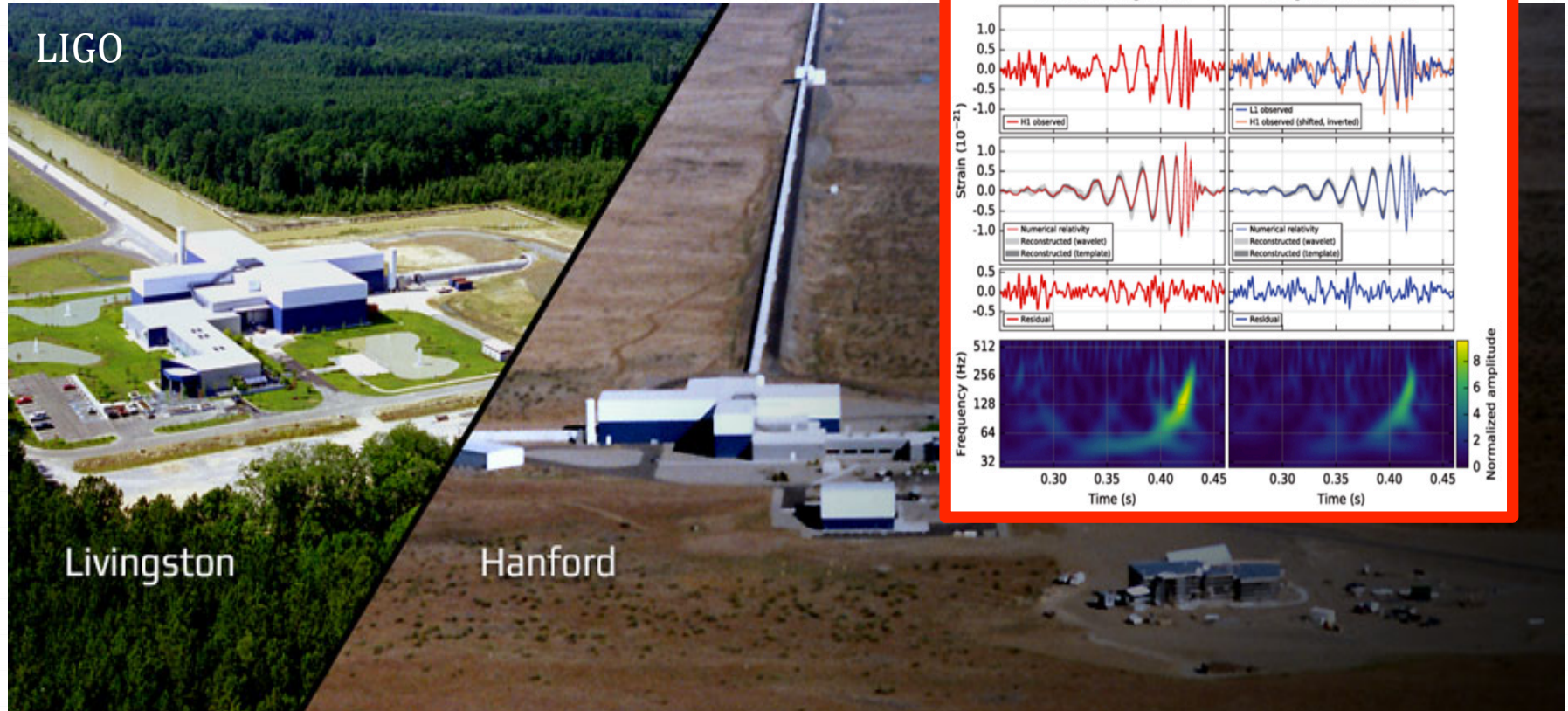
Tools to study the Universe

Gravitational Waves



Tools to study the Universe

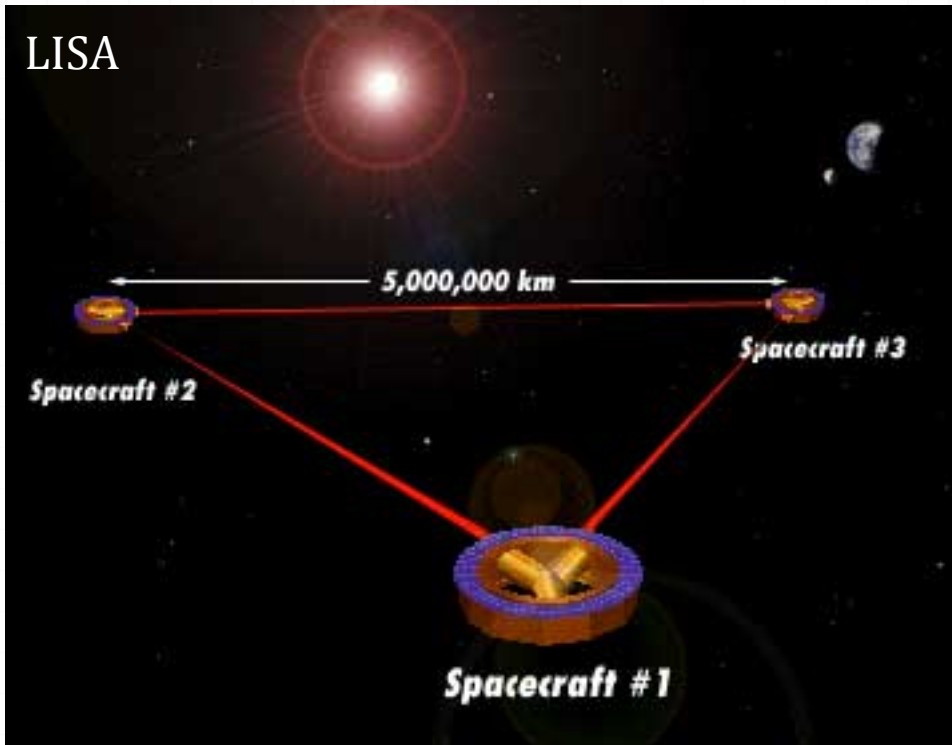
Gravitational Waves



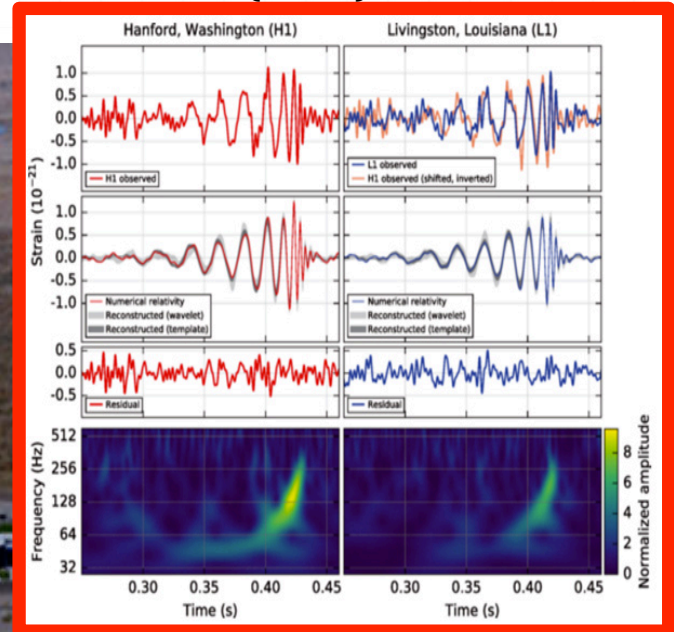
Tools to study the Universe

Gravitational Waves

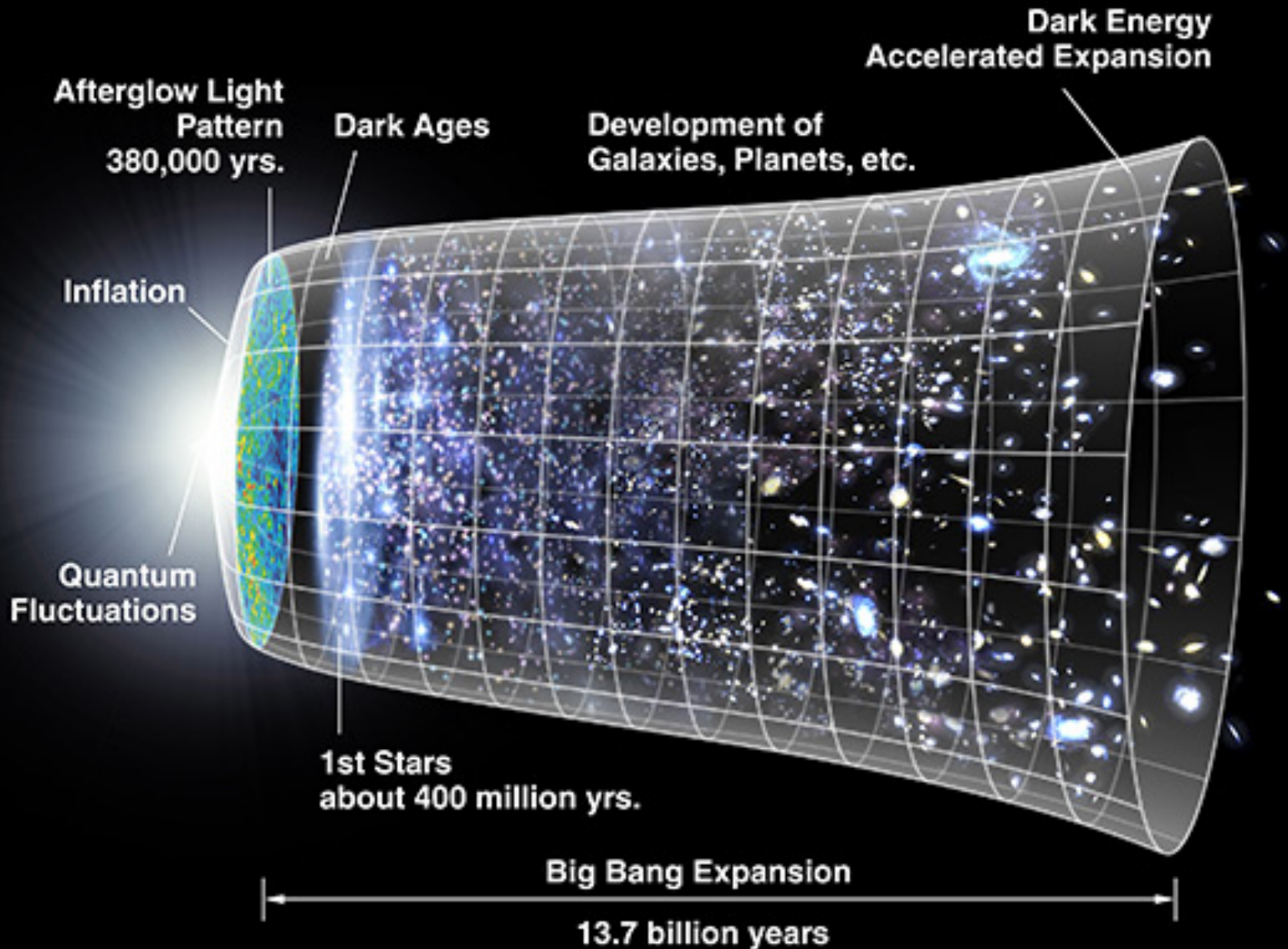
LISA



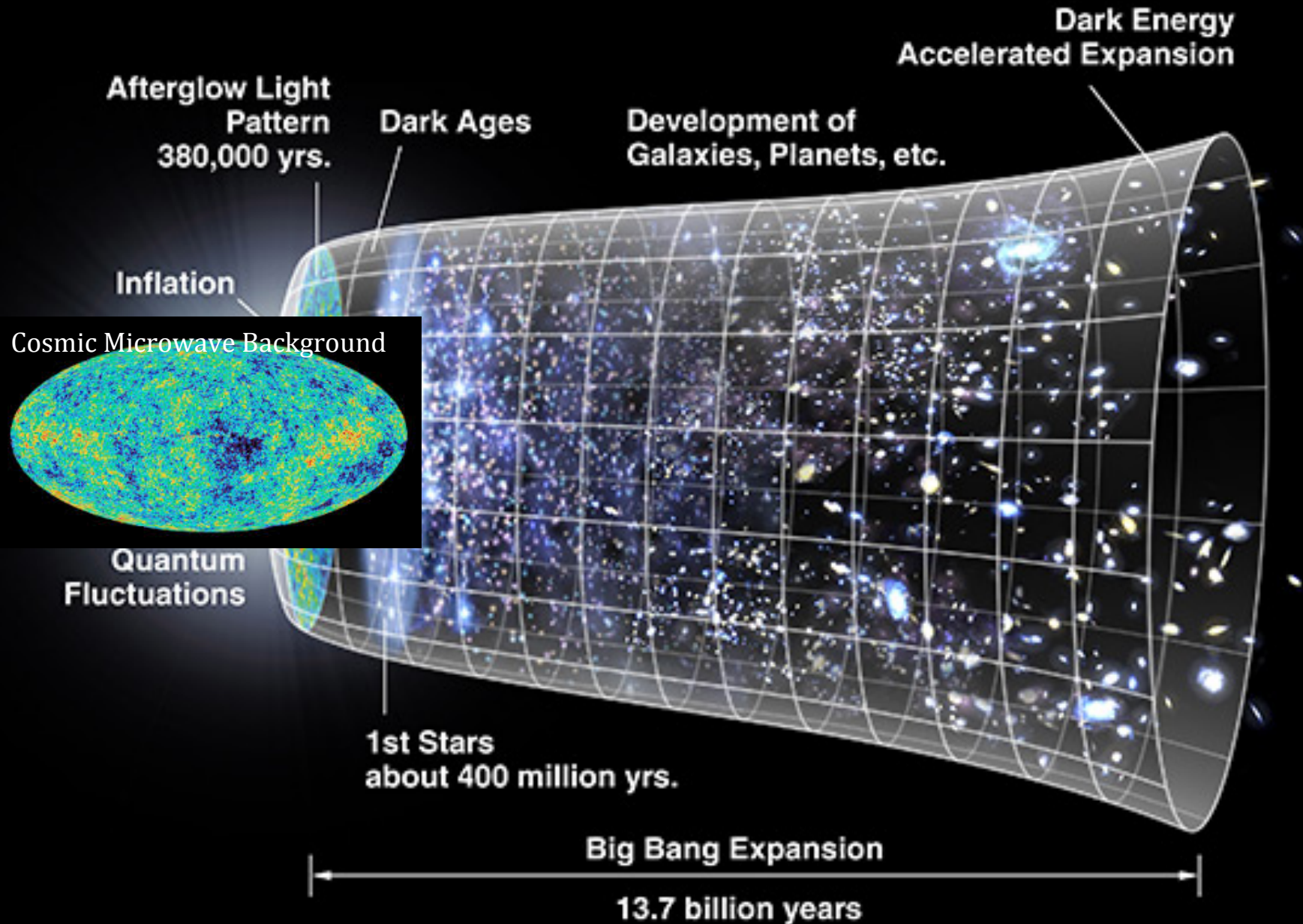
Abbott et al. (2016)



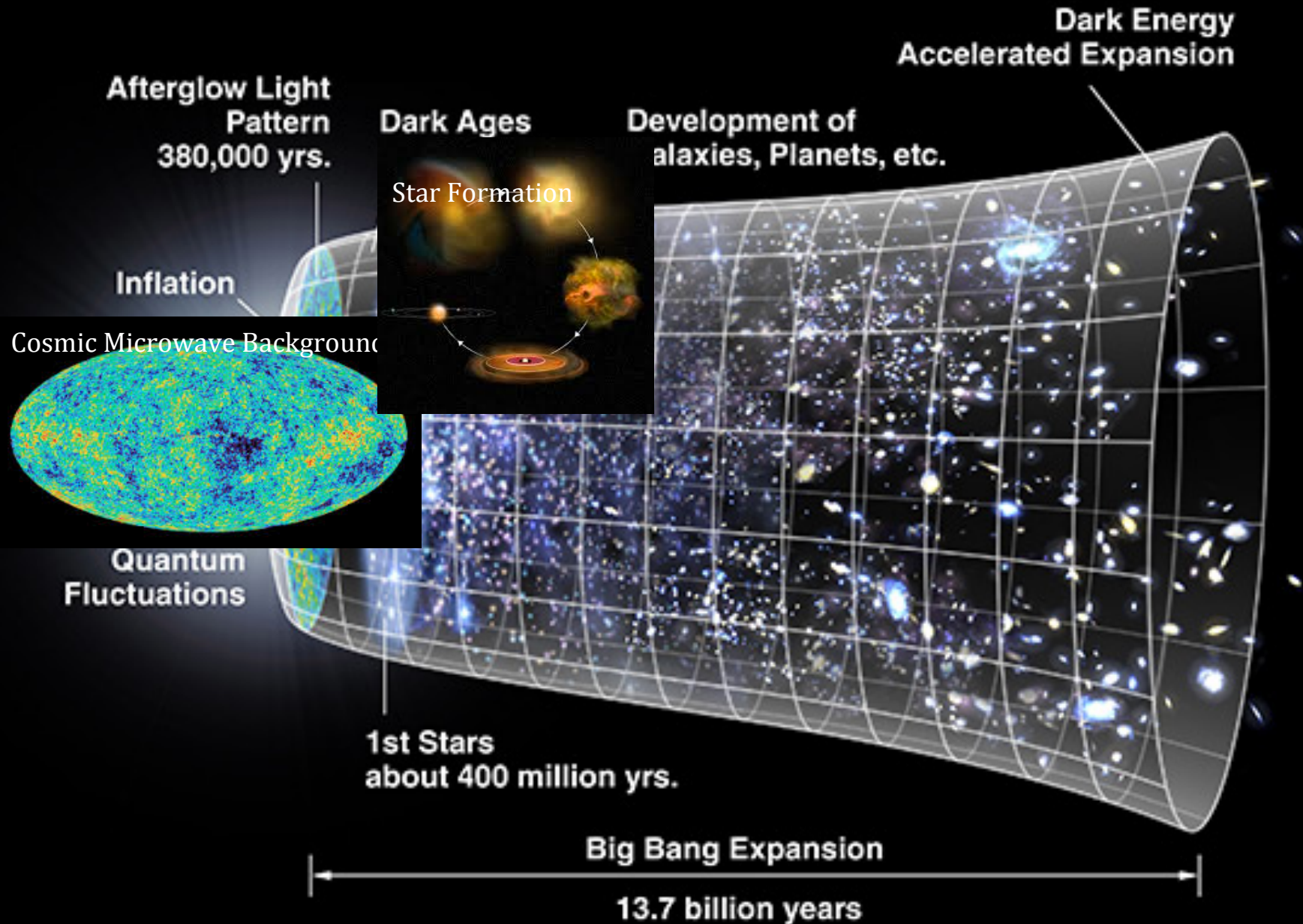
Topics in astrophysics



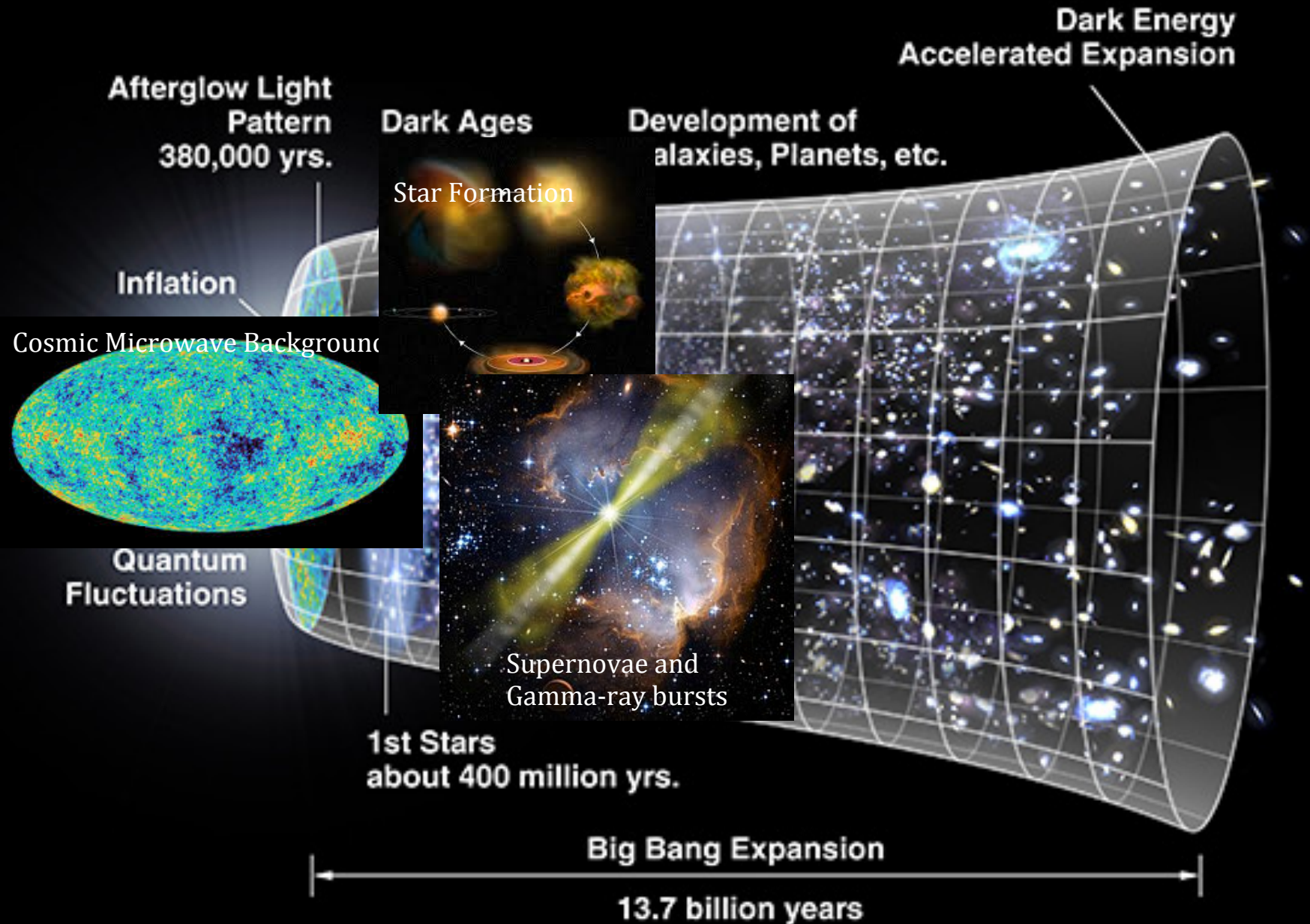
Topics in astrophysics



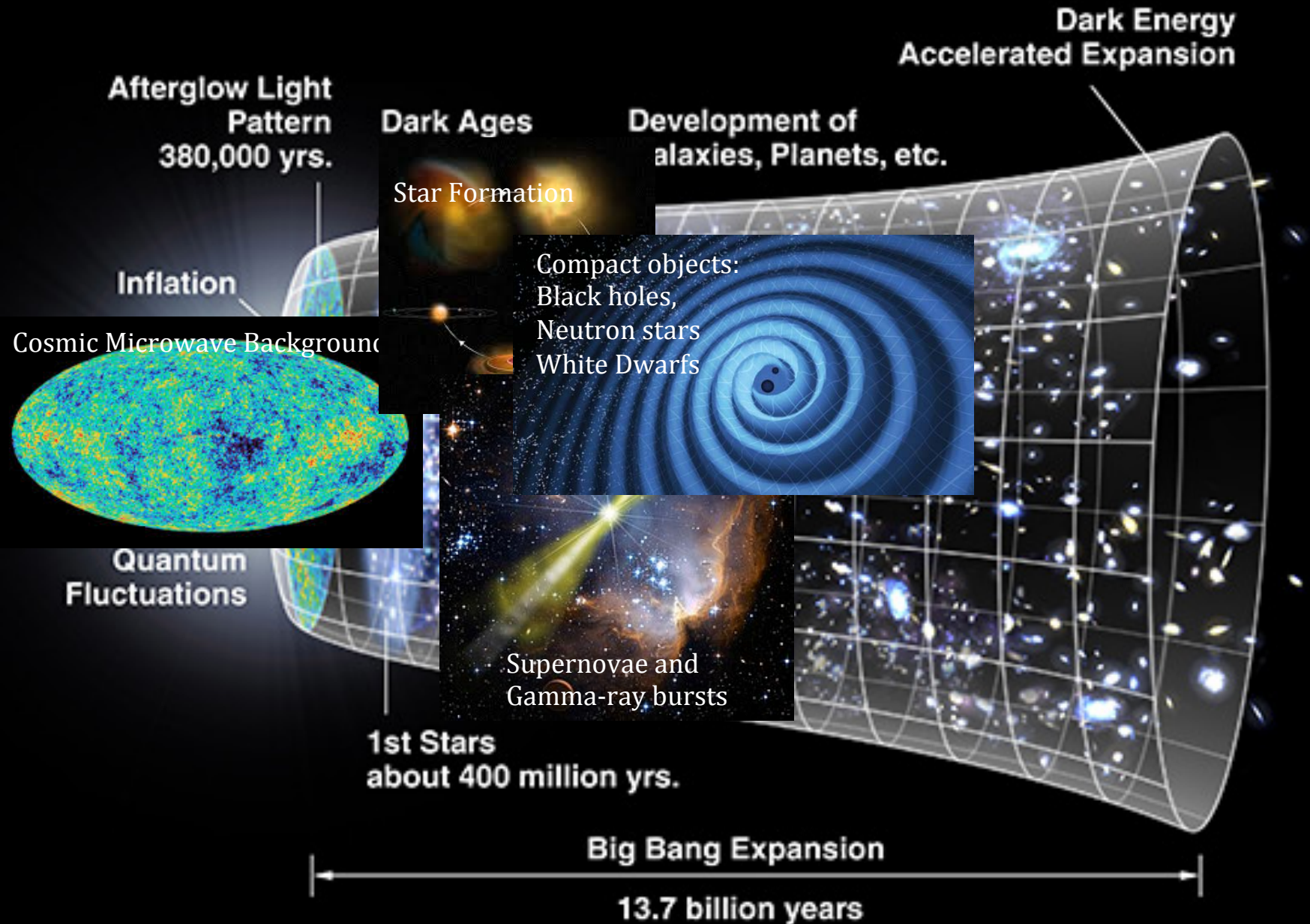
Topics in astrophysics



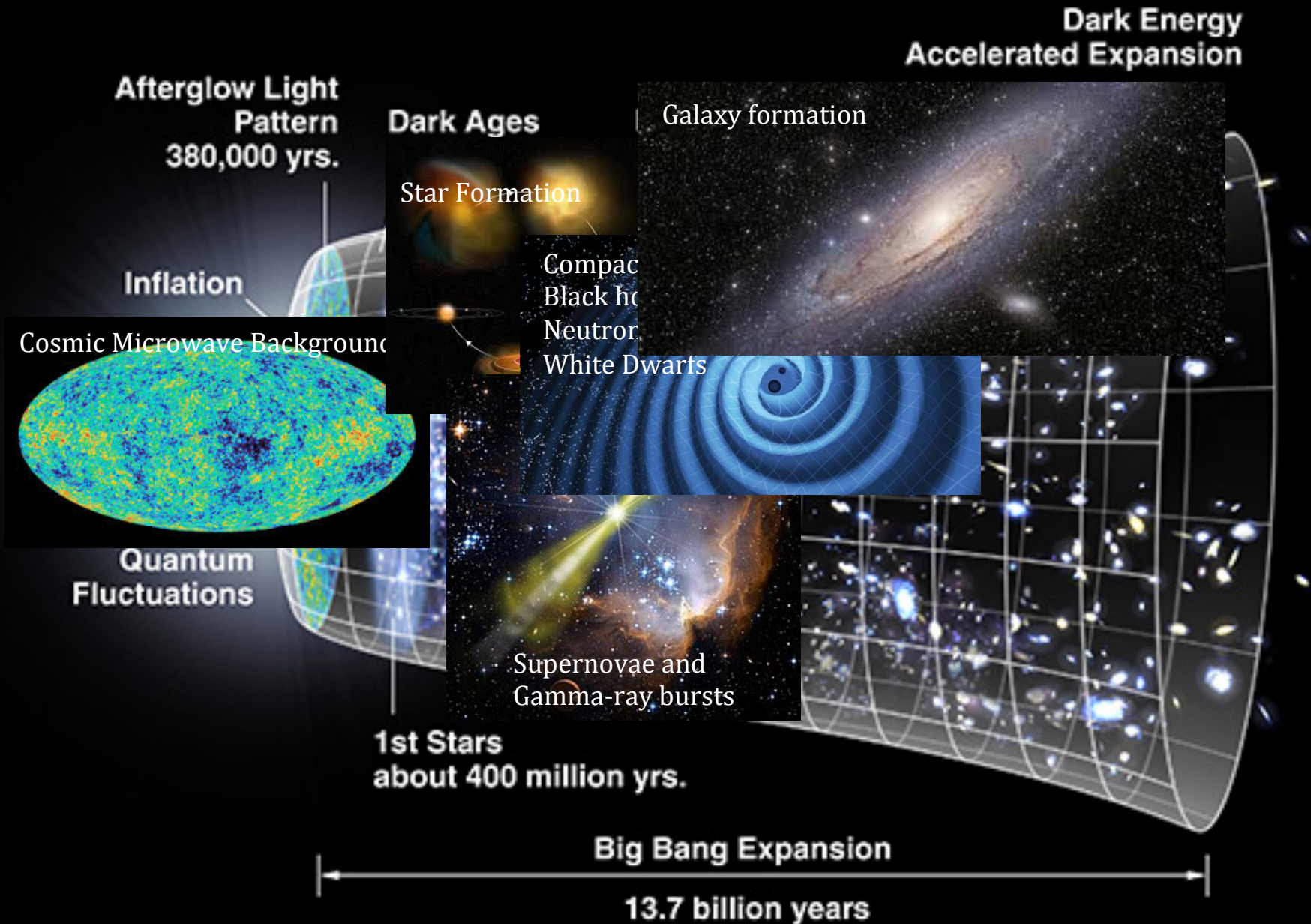
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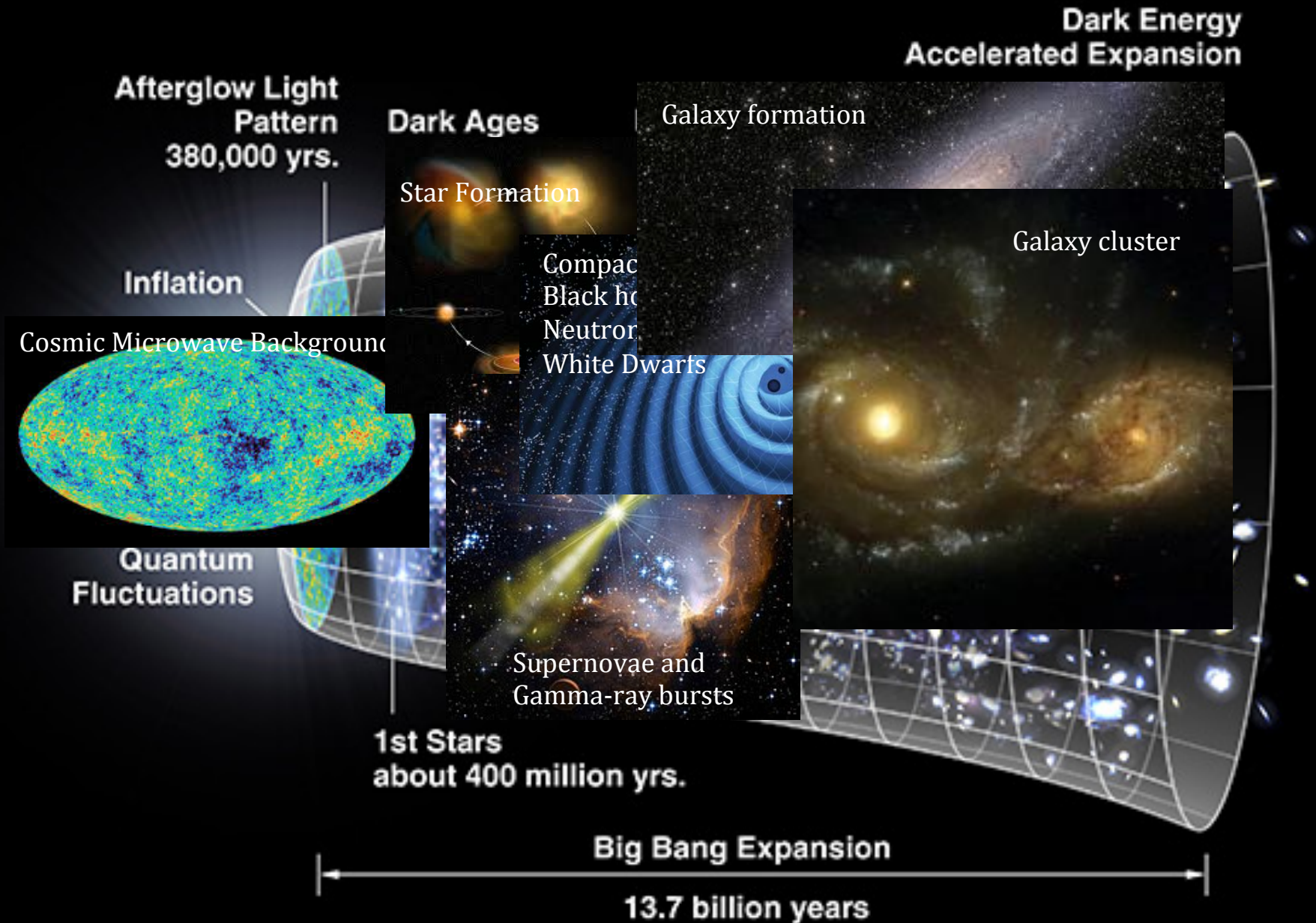
Topics in astrophysics



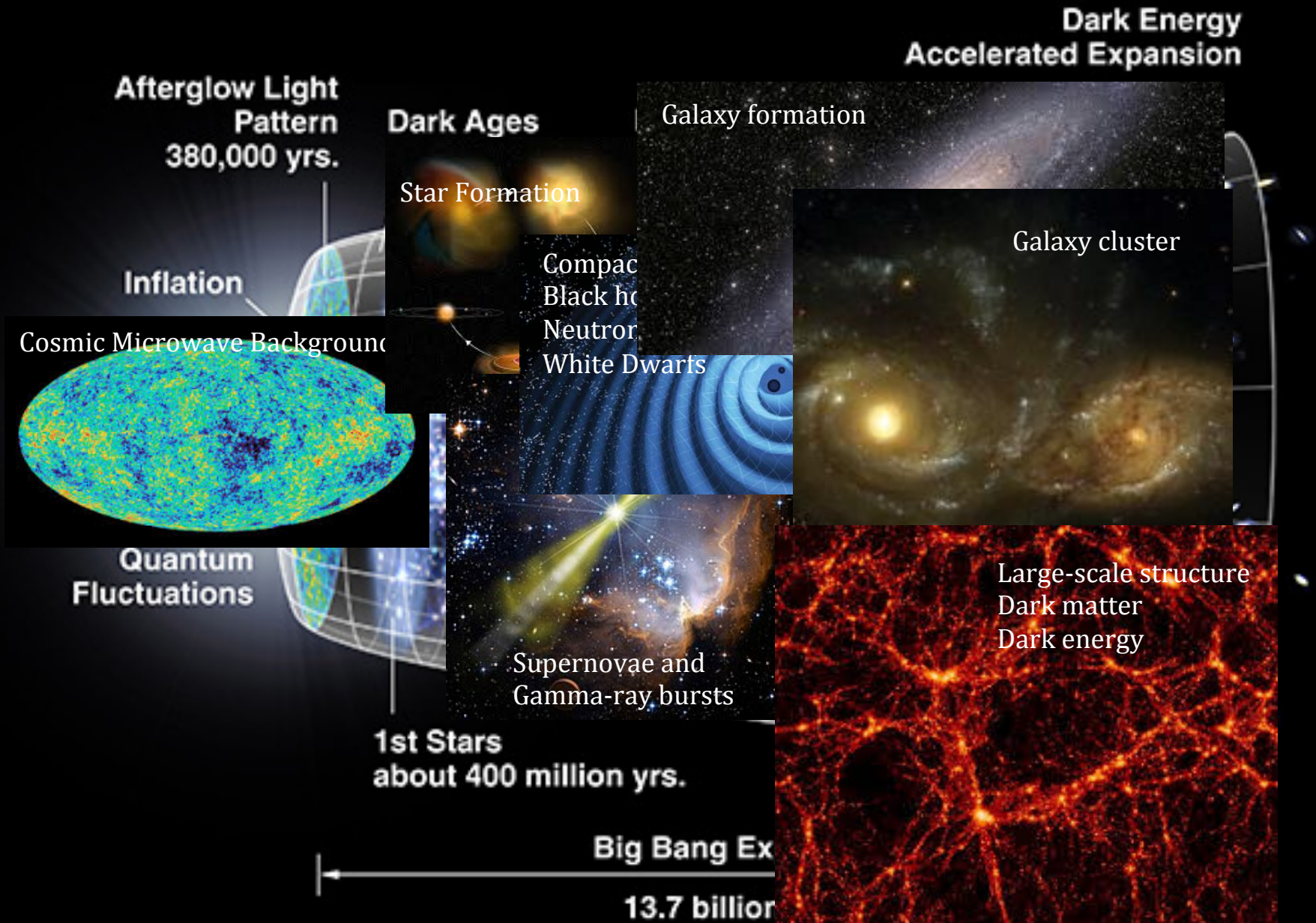
Topics in astrophysics



Topics in astrophysics



Topics in astrophysics



Topics in astrophysics

Solar system and solar physics

Dark Energy
Accelerated Expansion

Galaxy cluster

Cosmic Microwave Background

Neutron
White Dwarfs

Quantum
Fluctuations

Supernovae and
Gamma-ray bursts

Large-scale structure
Dark matter
Dark energy

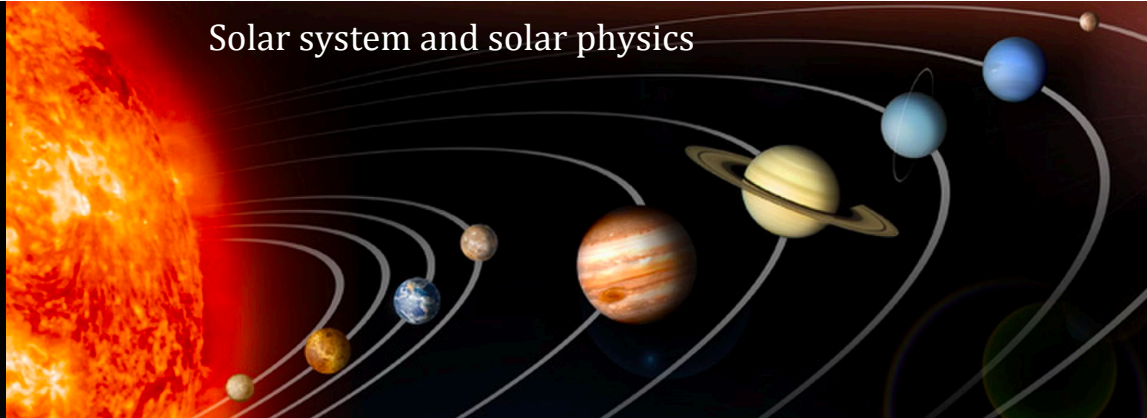
1st Stars
about 400 million yrs.

Big Bang Ex

13.7 billion

Topics in astrophysics

Solar system and solar physics

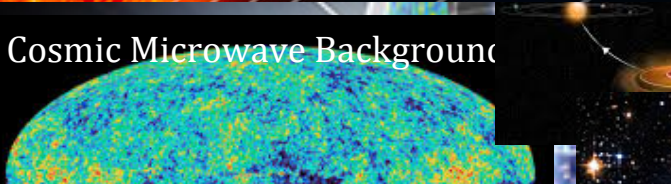


Dark Energy
Accelerated Expansion



Galaxy cluster

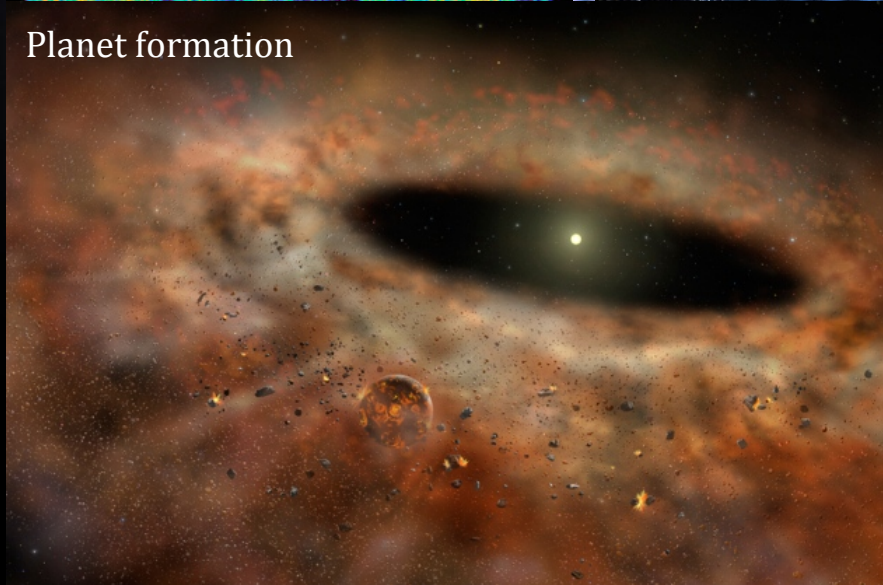
Cosmic Microwave Background



Neutron
White Dwarfs



Planet formation



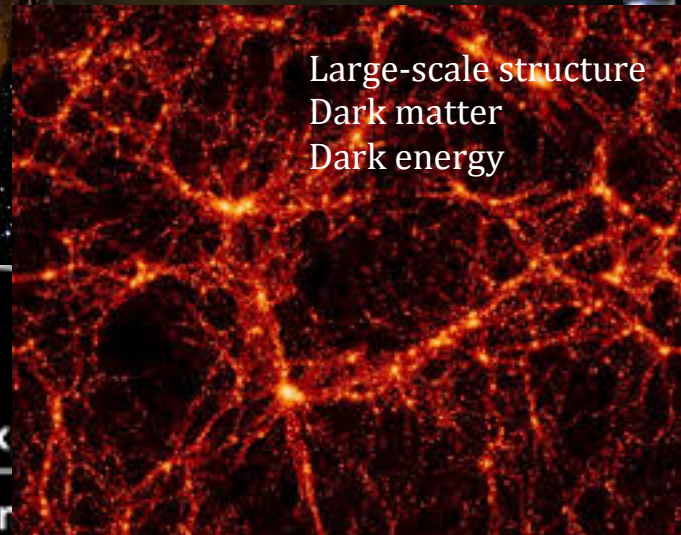
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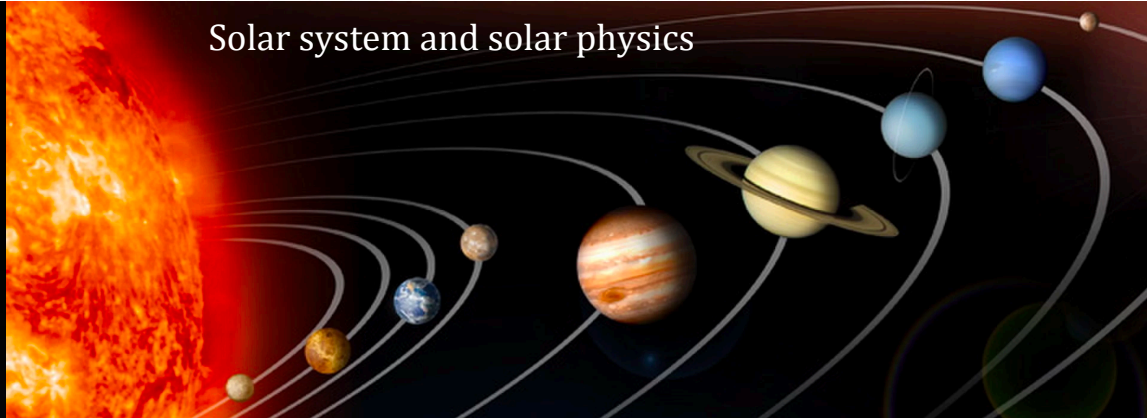
13.7 billion

Large-scale structure
Dark matter
Dark energy



Topics in astrophysics

Solar system and solar physics

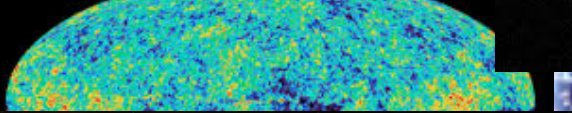


Dark Energy
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Galaxy cluster

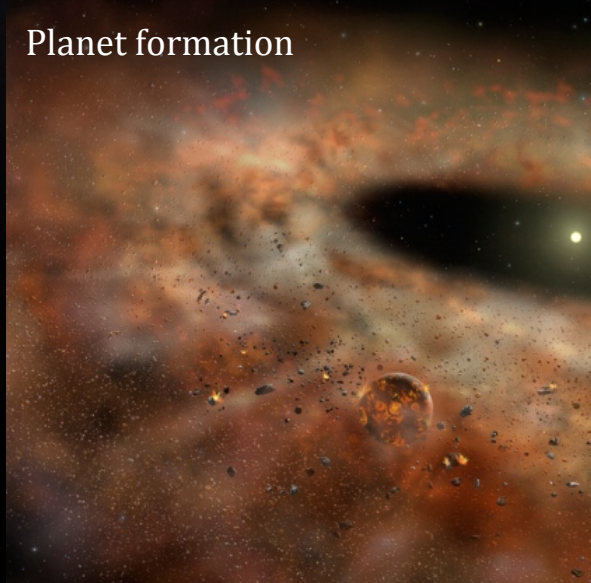
Cosmic Microwave Background



Neutron
White Dwarfs



Planet formation



POTENTIAL HABITABLE EXOPLANETS



Earth

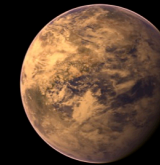


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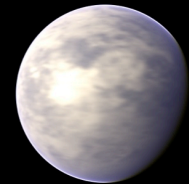
Kepler-62 e



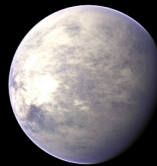
Gliese 581 g*



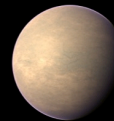
Gliese 667C c



Kepler-22 b

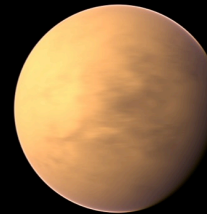


Tau Ceti e*

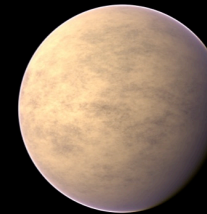


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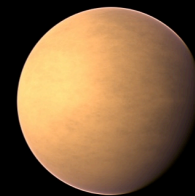
Kepler-62 f



Gliese 163 c



HD 40307 g*



Gliese 581 d

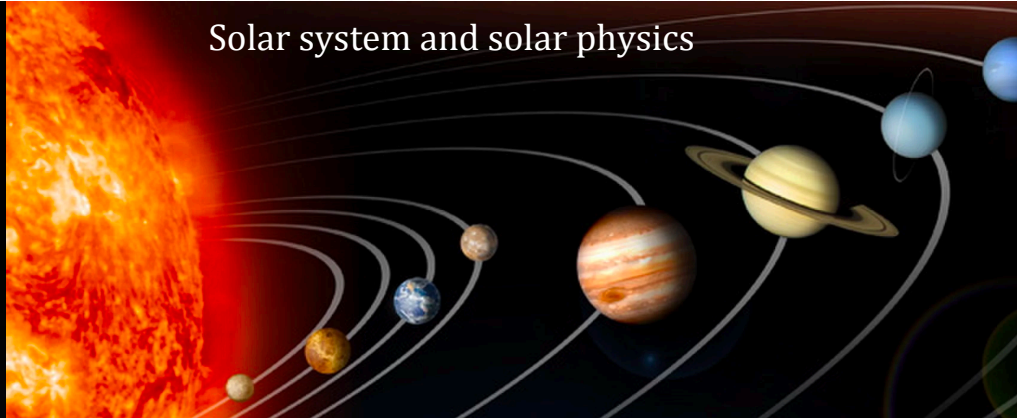
*planet candidates

CREDIT: PHL @ UPR Arecibo (phl.upr.edu) Jan 3rd, 2013

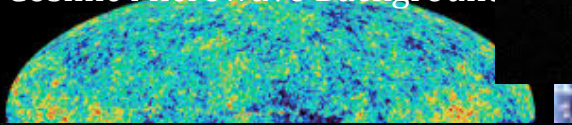
13.7 billion

Topics in astrophysics

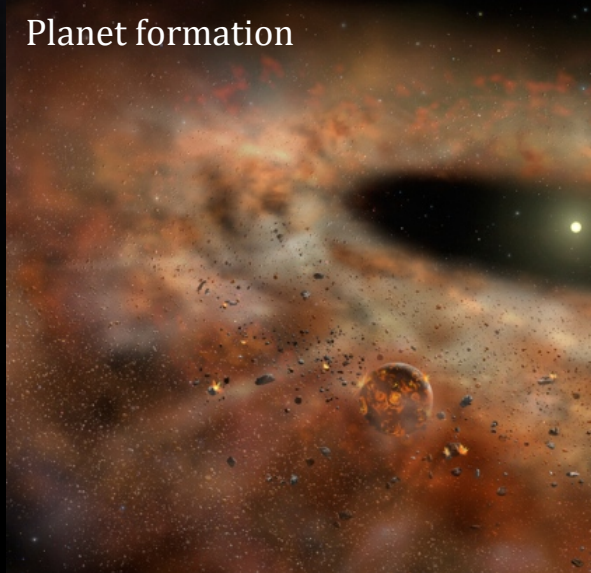
Solar system and solar physics



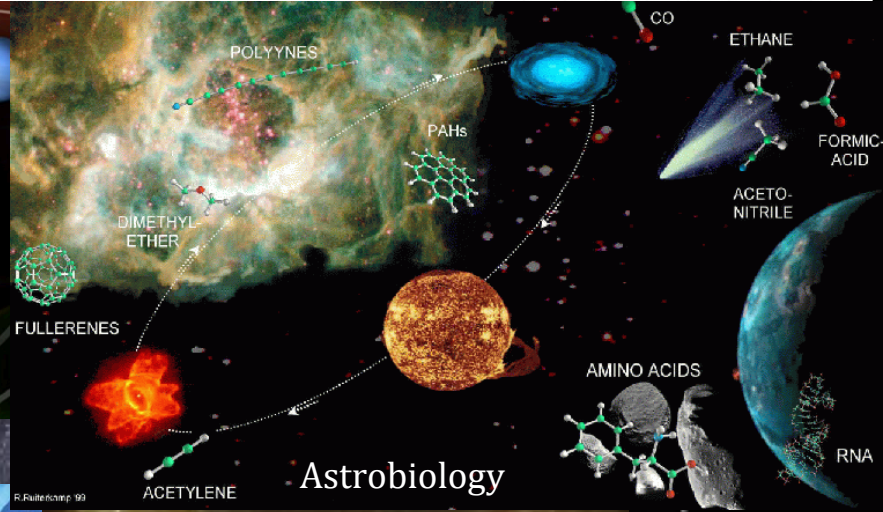
Cosmic Microwave Background



Planet formation



Neutron
White Dwarfs



Astrobiology

POTENTIAL HABITABLE EXOPLANETS



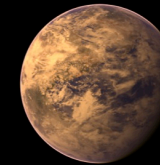
Earth



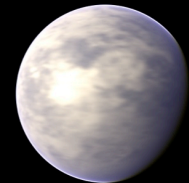
NEW
Kepler-62 e



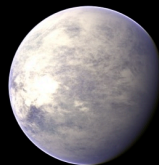
Gliese 581 g*



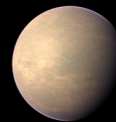
Gliese 667C c



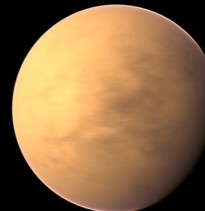
Kepler-22 b



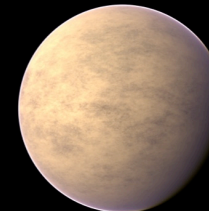
Tau Ceti e*



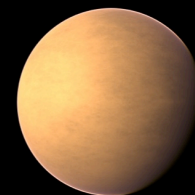
NEW
Kepler-62 f



Gliese 163 c



HD 40307 g*



Gliese 581 d

*planet candidates

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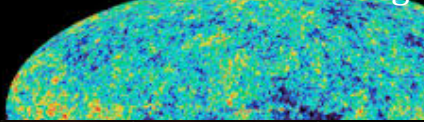
13.7 billion

Topics in astrophysics

Solar system and solar physics



Cosmic Microwave Background



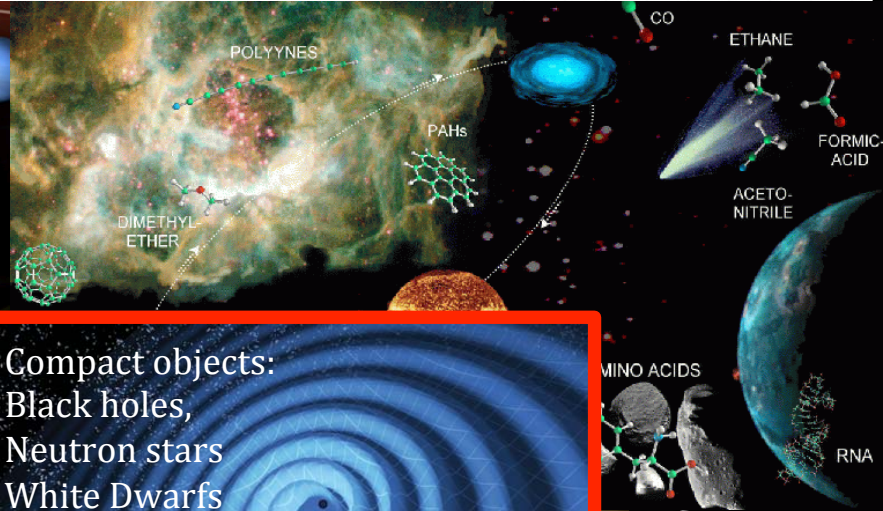
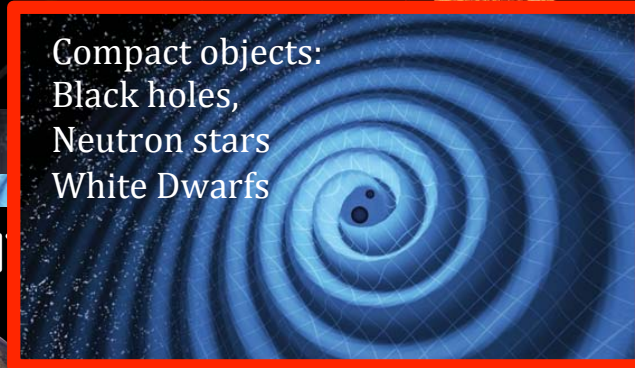
Planet formation



Supernovae and Gamma-ray bursts



Compact objects:
Black holes,
Neutron stars
White Dwarfs



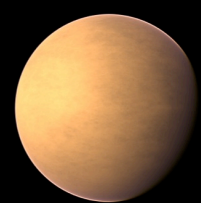
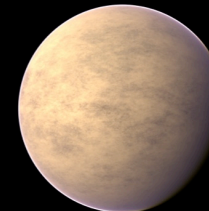
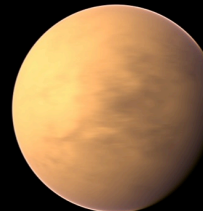
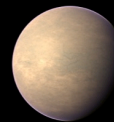
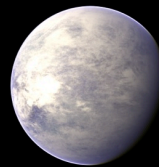
Earth

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Kepler-62 e

Gliese 581 g*

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Kepler-22 b



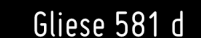
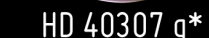
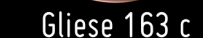
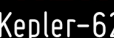
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Kepler-62 f

Gliese 163 c

HD 40307 g*

Gliese 581 d



*planet candidates

CREDIT: PHL @ UPR Arecibo (phl.upr.edu) Jan 3rd, 2013

13.7 billion