# The Universe

An Overview





## e Universe is everything

- … everything there is in space.
- … everything there is in time.

_____ *of light-years of space.*

_____ *of years of time.*





## The Light-Year

**Light-year**: *the distance light travels in a year.*

Speed of light = 300,000 km/s

Light-second = _____ km

Year = 31 million seconds

Light-year = _____

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## Space and Time

*As we look out into space, we look back in time.*

- We see the Moon as it was 1 sec ago.
- The Sun…8 _____ ago.
- Sirius…8 years ago.
- Deneb…1600 years ago.
- Omega Centauri…17,000 years ago.
- Andromeda Galaxy…2,000,000 years ago.
- Virgo Cluster…50,000,000 years ago.
- Most distant galaxy…12,000,000,000 years ago



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## Space

- The Universe consists of galaxies.
- Galaxies are grouped into galaxy _____.



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## Galaxy Clusters

- … are groups of galaxies.
  - Our cluster is the _____.
- … have dozens to thousands of galaxies.
- … are grouped into Superclusters.
  - Our supercluster is the _____ **Supercluster**

1,000,000 light-years

## Galaxies

- Galaxies consist of stars and solar systems.
- They contain *millions* to _____ of stars.

100,000 light-years





## The Milky Way

- Our galaxy is the **Milky Way.**
- …contains about 200 _____ stars.
- …has nebulae and star clusters.





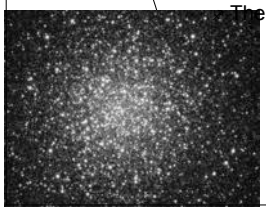
## Nebulae

- A **nebula** is a cloud of _____ gas.
- Plural: nebulae.
- Star clusters form out of nebulae.

*M42 in Orion*

## Globular Star Clusters

- Large--thousands of stars
  - ≈100 LY across
- Old-- _____ of years old
  - The first stars in the Galaxy.



*M3 in Canes Venatici*





## Open Star Clusters

- Small--dozens to hundreds of stars.
  - about a light-year across.
- Young--millions of years old.
  - The youngest stars in the Galaxy.
- After a while, the stars in a cluster disperse.

*M39 in Cygnus*



## Solar Systems

- Stars are often found in solar systems consisting of:
  - one or more stars
  - several planets
  - A lot of junk
- Solar systems are a few light-hours across.

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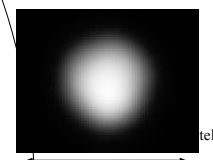
## Stars

- Stars: hot, shining objects
- more than ____x the mass of Jupiter



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5 light-seconds



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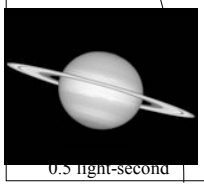
## Planets

- Planets: cold, dark objects
- <_____x the mass of Jupiter
- Different kinds:
  - Gas giants
  - Ice giants
  - Terrestrial planets
  - Icy moons



0.5 light-second



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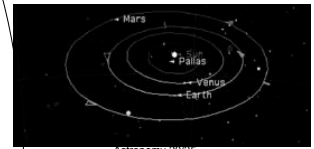
## The Solar System

- Our solar system is *The* Solar System
- 1 Star: the Sun
- About 17 planet-sized worlds
- Many small worlds: moons, asteroids, and _____



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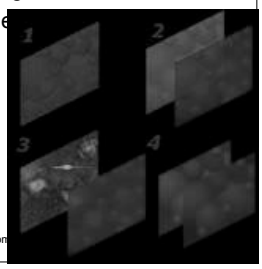
## Time

- The Universe had a beginning.
- It's changing as it grows olde
- It will end someday.



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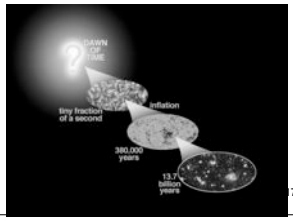
## The Big Bang

- … when Matter, Energy, Space, and Time were all created.
- … happened 14 _____ years ago.



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## The Expanding Universe

- The Universe is expanding.
- The galaxy _____ are getting farther apart.
  - But galaxy clusters and galaxies themselves hold together.
- Eventually, we will lose sight of the other galaxy clusters.

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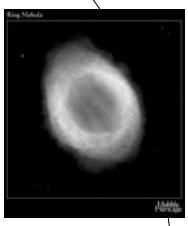
## The Aging Universe



- The Universe is changing.
- In the beginning ... only hydrogen and _____ gas.
- Gas turns into stars.
- Stars turn hydrogen into _____ elements.
- Stars return the elements to space when they die.



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## Birth of the Solar System

- Planets & people are made of heavy elements.
- The Solar System formed 4.5 _____ years ago.



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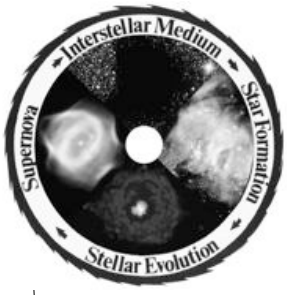
## The Star Cycle



## The Future Universe

- Stars die when their Hydrogen is used up.
  - The Sun will die 5 billion years from now.
- The Universe will eventually become cold and dark.
- Alternative: *Big* _____.