

Astronomy Notes

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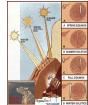
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1 Lecture 1

Thats the first class.

2 Lecture 2 - History of Astronomy

Sun Dagger Petroglyph:



Every human civilizations discover the astronomy.

2.1 Positions on the sky:

Constellations patterns of the apparent positions on the sky. All cultures are able to define the patterns cuz they won't change in a long period of time.

There are movements of stars can be capture using long exposure. The point that doesn't move is called **Polaris** → caused by the rotation of the Earth.

2.2 Movement and Patterns of the Moon

The changing phases of the moon Every 27.3 ays or so, the Moon makes a complete revolution.

Half of the moon is always illuminate by the Sun - but our view of its illuminated side changes → And the moon rotates at the same rates that rotates around the sun. Though we see the moon at the same side, its dark side always changes.

Because of the relative positions of moon with respect to Sun, the different phases can only be visible for certain period.

Not all times the moon rise at the same place (due east but a bit north when coming to winter.)

2.3 Other patterns

The Sun moves with respect to background stars, so that at different times of the year you will see different constellations.

This is due to the changing positions of the Earth in its orbit around the Sun.

2.3.1 Eclipse

Will be discussed during Thursday.

3 Lecture 3-The Retrograde Motion

Venus and Jupiter also changes its positions.

They sometimes move back and forth, this motion is called retrograde motion.



When the Earth moves past Mars, there is a short period seems like the Mars moves in an opposite way.

Add sun and moon and there are 7 such things moving in the sky; Those match the 7 days of a week.

Aristotelian notions of physics includes four elements: Earth, water, air, and fire.

The motions are mostly caused by the combined mass of a whole milky way.

4 Lecture 4

Around 150 AD, Greek people developed a simple geocentric model.

The parallactic motion should be seen if the Earth were orbiting around the sun. (back-and-forth motion)

In 1592, Galileo Galilei accepted a position at the University of Padua where he would become well known for his work refuting basic tenets of Aristotle theory. He invented the telescope and proved that the Earth is not the center

of all motions. Also the phases of Venus and showed that Venus clearly had to be orbiting the sun.

4.1 Kepler's Laws

- Kepler was also refuting the traditional model. He paid attention to the planetary observations of Tycho Brahe to develop a series of laws of planetary motion.
- Kepler's 2nd law. Planet moves faster when they are closer to the sun, and slower when they are far.
- Kepler's 3rd law. The nearest moves faster and far moves slower (more on relationships).

4.2 Newton's Laws

Between 1665 and 1690, Newton discovered his theory about Speed, Velocity, and Acceleration.

5 Lecture 5 - Terrestrial and Jovian Planets

Today's lecture will be about the patterns of different planets.

The first pattern is one we've already seen, and was visible to even ancient astronomers - the planets all appear to orbit in the same general plane.

This highly ordered arrangement makes it clear that the planets must have formed at roughly same time and in a way that had some preferred plane and axis of rotation.

The explanation about this phenomenon.

We can see so much rotating disks of material. Many of them are clearly surrounded by disks of gas and dust. These flattened disks appear to be an inherent part of the formation of stars. The spinning shapes the cloud into a

disk as it collapses because material in the equatorial plane has a harder time falling in to the center due to centrifugal accelerations.

As the solar nebula collapsed into a flatter, denser disk, the small material began to clump together or accrete, preserving the angular momentum just like the orbiting patterns as they formed from. This brings us the different planets in our solar system.

By the late 1800's it had become clear that the worlds of the outer Solar System were far different from those of the inner Solar System. Not only were these planets much farther apart from each other.

The **Terrestrial Planets** are all Earthlike in that they share a similar internal structure. Their solid surfaces are all covered by a very thin layer of gases and sometimes fluids. The composition, temperature and pressure are distinct. Those forces erase old craters and create new features on planetary surfaces. For moon and mercury have far less extensive atmospheres, this results in little geographic change on surface since its formation.

The **Jovian Planets** have much thicker atmosphere compared to terrestrial planets. They don't have a solid surface at all underneath those bulky atmospheres. Their deep interiors are believed to be composed of increasingly dense layers of hydrogen and hydrogen compounds, such as water, ammonia...

Why are the Jovian planets so big?

The accretion process steadily built up all of the planets from solid, grain-sized particles (Similar to the meteorites we still see falling on the Earth.)

Near the forming sun, only rare heavy elements such as metals and rock could form from such grains. Farther away from the forming stars, much more common hydrogen compounds like water vapor and methane were able to condense into ices.

This allowed protoplanets in the outer solar system to quickly grow larger - large enough for their gravity to begin attracting and holding onto hydrogen and helium gas, by far the most abundant materials in the Solar Nebula.

This **gas capture phase** helps explain much of this second pattern.

The gravitational attraction of that infalling gas also brought some solid materials (some ices some rocks).

Ganymede is the largest moon in the Solar System. Jupiter raises powerful tides in its moon, and the huge mass tides produce frictional force that makes many heat inside the moon. Europa tidal heating may be just right to keep it to hold the liquid water. Titan is the most remarkable moons of Jupiter, because of the enormous atmosphere.

Discussion

Copernican Revolution(1550-1650)

Gali Venus/Jupiter - Earth is not the center Kepler's second law: equal area / equal time - closer faster

Kepler's third law:

$$P^2 \propto a^3 \quad (1)$$

While the equation is $P^2 = (M_1 + M_2)a^3$

Newton's Universal Law of Gravitation:

$$F = G \frac{m_1 m_2}{r^2} \quad (2)$$

Remember the Kinds of planers.

6 Lecture 6-Astroids and Comets

The ring of Saturn was first discovered from Earth by Galileo.

All jovian planets have ring system.

The collision of their moons provide enough dust.

Too small to be a spherical shape.

Kuiper Belt is a band of leftover planet-making material. Oort Cloud used

7 Lecture 7

The rings are believed to be created and replenished over time by collisions of asteroids and comets - mostly the latter - with the large moons of the Jovian planets.

The majority of them have low inclinations

The speed stars move depends upon the mass of the planet - more massive planets exert more gravitational forces.

Another method for detecting planets around other stars is the so-called "transit method". → get the radius.

habitable zone is really all about the possibility of liquid water on a planet's surface.

Lecture 9-The stars

In order to see the small planets around the large stars, a big telescope is needed.

Man made light are reflected by the atmosphere. Light pollution is the major reason why

astronomers put large telescopes in remote locations.

Also, turbulence in the atmosphere also distort light, making stars appear to twinkle in color. The apparent jiggling of the stars. **This can be fixed by some adaptive optics.** The light wave can be restored.

However, the most severe problem caused by the atmosphere is the absorption of light. It absorb most of the light. Some details cannot be captured without infrared. **That's why we put our telescope in the space.** (not because they are closer to the stars)

William Herschel discovered Uranus and found the non-visible light.

The sun

We know how the sun really works is... These are what we can measure:

- how bright stars appear to be as seen from Earth.
- how much and in what directions they are moving.
- their color (or more precisely, their Spectral Energy Distribution - how much UV vs. Visible vs. Radio)
- Which absorption / emission lines are present in their spectra.

Luminosity - the total amount of power radiated by a star into space, as measured at some fixed distance from the star. Apparent Bright - How we see on the Earth.

The relationship is:

$$AppLight = \frac{L}{4\pi d^2}$$

If we could find either the luminosity and distance.

We can use parallax to measure the distance using the parallax angle.

To measure the luminosity directly. To measure the mass of stars, we can do it by directly observing the effect of the gravity from another star.

Binary system can be used to find the radius of a star in systems that actually eclipse each other.

The luminosity is using the equation

$$L = 4\pi R^2 \sigma T^4$$

How could we precisely measure the temperature of a star? We could observe the absorption patterns.

It turns out that "spectral type" is not determined by a star's chemical composition. All stars contain roughly 75% H, 23% He, and only 1-2% of all the elements.

Payne-Gaposechkin showed that the temperature of a star's atmosphere dictates the type of ions or molecules that can exist there, and the energy states of electrons and atoms.

Spectral Type	Color	Temperature (K)*	Spectral Features
O		28,000-50,000	Ionized helium, especially helium
B		10,000-28,000	Helium, some hydrogen
A		7,500-10,000	Strong hydrogen, some ionized metals**
F		6,000-7,500	Hydrogen and ionized metals such as calcium and iron
G		5,000-6,000	Both metals and ionized metals, especially ionized calcium
K		3,500-5,000	Metals
M		2,500-3,500	Strong titanium oxide and some calcium

* To convert approximately to Fahrenheit, multiply by 9/5.
 ** Astronomers regard elements heavier than helium as metals.

In specific, M-type stars dominate the univers.