

# Astronomy 350L (Spring 2005)



# The History and Philosophy of Astronomy

(Lecture 15: Perspective: The Baroque Universe)

Instructor: Volker Bromm TA: Amanda Bauer

The University of Texas at Austin

## **General Timeline**





Renaissance (1450-1600) Baroque (1600-1750)

Enlightenment (1750-1820)

#### time

# **General Timeline**

#### Copernicus



#### Newton



William Herschel



Renaissance (1450-1600)

Baroque (1600-1750)

Enlightenment (1750-1820)

#### time

# • Age of Contradictions!



#### (Rubens)



(Rembrandt)

• exuberant optimism

quiet reflection

#### Awareness of how precarious life is!





#### (Pieter Claesz)

(Georges de la Tour)

• "Memento Mori" (Remember that you will die) • "Carpe Diem" (Seize the day)

# • Age of Absolutism: All-powerful monarchs!





#### Versailles

#### Louis XIV (The Sun King)



- Geometric grandeur!
- Examples:Versailles

- Piazza of St. Peter (Lorenzo Bernini)



• Age of the Theater: "All the World's a Stage..."

#### **Baroque: The Scientific Revolution**



• Scientific Method: Test theories with experiments!

## **Baroque: Greatest Achievements in Astronomy**



 Philosophiae Naturalis
 Principia Mathematica
 (Mathematical Principles of Natural Philosophy)

# Challenges Descartes' *Principia Philosophiae* (1644)

- Descartes: qualitative
- Newton: quantitative, predictive
- *The* foundational text for modern physics and astronomy!

#### **Greatest Achievement: Architecture of Solar System**

 Newton's laws Kepler's Three Laws of Planetary Motion



#### **Greatest Achievement: What are Comets?**



comets move on highly eccentric orbits around Sun!

#### **Baroque Astronomy in Perspective**

- Status of knowledge on:
  - concept of space
  - concept of time
  - nature of stars
  - concept of motion à modern (Newton)
  - Architecture of Solar System
    à modern (Newton)

## **Baroque: Spatial Structure of Universe**



- infinite, 3-dimensional Euclidean space
- Cartesian coordinates (x,y,z)

# • Q: Is space full (no vacuum), or (partially) empty?

# **Baroque: Spatial Structure of Universe**

• Q: Is space full (no vacuum), or (partially) empty?



space=matter
 à no vacuum!

<u>Newton</u>



 matter is made of atoms à vacuum (void) exists!

## Newtons's Principia:

Scholium: Absolute Space

"Absolute space...without relation to anything external, remains always similar and immovable"

- Passive stage for all motion
- Exists independent of matter, and is thus eternal

# The Reality of Absolute Space:



- Newton's bucket experiment
- Rotation is motion with respect to absolute space!
- As opposed to linear motion, which is only relative to other bodies!

# **Baroque: Concept of Time**

# Q: What is time?



# • Saint Augustine (354-430AD):

"I know what time is until you ask me to define it"

## Newtons's Principia:

• Scholium: Absolute Time

"Absolute, true, and mathematical time, of itself,... flows equably without relation to anything external "

- Time exists without any matter
- Time had no beginning
- Q: What about the Universe then? Is it eternal?

## **Baroque: Creation of Universe**



- James Ussher (Archbishop of Armagh, 1581-1656)
- calculated (using the Bible) when God created the universe:

Oct. 23<sup>rd</sup>, 4004 BC (Sunday, 8pm)

#### **Newton: Creation of Universe**

#### • before creation: empty space and time, no matter!



## Newton: Creation of Universe

• after creation: empty space and time with matter everywhere!



#### **Newton: Creation of Universe**



#### Leibniz (1646-1716)

# • Leibniz asks:

"If God had infinite time before he created the universe, why did he wait so long???"

- He instead proposed that time was created by God together with Universe (timeless state before creation)
- Would take till 20<sup>th</sup> cent to sort this out!

#### **Newton: Formation of the Stars**

 $\bigcirc$ 

 $\bigcirc$ 

• infinitely many stars (Suns)!

 $\bigcirc$ 

 $\bigcirc$ 



• Stars are fixed; i.e.: they don't move!

• Q: Is such a Universe possible (is it stable)?



## • Can stellar system be stable under gravity?



• A: No! Analogue: Balance infinitely many needles exactly on their tips! An unstable situation!

• A: No, stars would begin to move around randomly!



# Great Task Ahead I: Elucidate Stellar System!



# Great Task Ahead II: What are the Stars?



# Great Task Ahead III: Origin of Universe and Time!



#### **Perspective: The Baroque Universe**

# • Successfully explained:

- Planetary motions, comets
- universal gravity (Newton)
- general architecture of the Solar System

# • New questions/problems:

- How and when was Universe created?
- Did time have a beginning?
- Architecture of stellar systems: Structure and motions?
- Physical nature of the stars (and planets)?

- - -