


Today's Class: Perspective on Space Astronomy & Exploration

- Final Paper is due TODAY at 5 pm.



Astronomy 2020 – Space Astronomy & Exploration

1

Space in the News: An Extreme Simulation of the Universe's First Stars

presented by Jackson Curry

- Our current observatories can only see so far meaning we must rely on simulations to try to understand what happened during the "Dark Ages" of the universe
- Team harnessed the power of supercomputers to simulate a supernova for the first iron-deficient stars in the universe which revealed how elements such as carbon, oxygen, and calcium were formed
- Question:** How far back in time would you trust the results and conclusions that simulations of this nature come to? Do you think that we will ever be able to create a simulation that is accurate going all the way back to the Big Bang or will there be a limiting point somewhere in the Dark Ages?

2

Thematic Questions for Astronomy 2020

1. Why do we explore?
2. How do we explore? Theoretical tools.
3. How have we explored so far? History.
4. What are the tools of exploration?
5. What are the obstacles facing space exploration?
6. Where can we explore?

Astronomy 2020 – Space Astronomy & Exploration

3

Why do we explore? Class Perspective from August

- A unifying goal for humanity.
- Using the Moon as a stepping stone to Mars & further explorations.
- Pursuit of knowledge & understanding the unknown.
- The ultimate human challenge.
- Dealing with overpopulation on Earth.
- Spur technological innovation.
- Promote international cooperation.
- It is human nature to explore.
- Reduce the chance for human extinction & ensure survival of humanity.
- Mine natural resources on the Moon, asteroids, etc.
- Helps us to better understand the Earth, the environment, & surroundings for human survival.

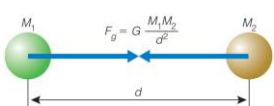


Astronomy 2020 – Space Astronomy & Exploration

4

How do we explore?

- Newton's Laws of Motion
 - Law of Inertia: objects stay at rest or move with constant velocity unless acted upon by a force.
 - $F = ma = F = \frac{\Delta p}{\Delta t}$
 - Action/Reaction (Conservation of Momentum)
- Conservation Laws
- Law of Gravitation:



Astronomy 2020 – Space Astronomy & Exploration

5

Class Exercise

Compared to its angular momentum when it is nearest the Sun, Earth's angular momentum when it is furthest the Sun is

- a. Greater
- b. Less
- c. The same

Astronomy 2020 – Space Astronomy & Exploration

6

Clicker Question

Compared to its angular momentum when it is nearest the Sun, Earth's angular momentum when it is nearest the Sun is

- Greater
- Less
- The same

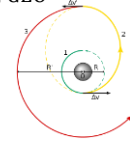
Astronomy 2020 – Space Astronomy & Exploration

7

How do we explore?

- The Physics of Orbits
 - Orbital velocity: $v = \sqrt{GM_E/R}$
 - Different orbits (circle, elliptical, parabolic)
 - Escape Velocity
 - Kinds of orbits: LEO, HEO, GEO

- Hohmann Transfer Orbit



- Gravitational Slingshot

Astronomy 2020 – Space Astronomy & Exploration

8

How have we explored so far?

- NASA's Early Years:

- Explorer 1
- Mercury, Gemini
- Apollo
- The Space Shuttle & the ISS



- The Current Human Program: Orion + SLS + Gateway + Human Lander System

- Commercial Space Transportation

Astronomy 2020 – Space Astronomy & Exploration

10

What are the tools of exploration?

- Space Telescopes

- Optics
- Imagers & spectrographs
- Hubble Space Telescope
- JWST
- Chandra X-ray Observatory
- NuSTAR, Fermi, SOFIA
- Kepler & TESS for exoplanets
- Low radio frequency array on lunar farside



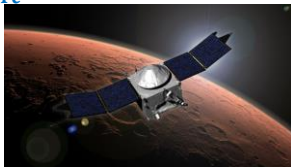
Astronomy 2020 – Space Astronomy & Exploration

11

What are the tools of exploration?

- Robotic Spacecraft

- Flybys
- Orbiters
- Landers
- Sample Return

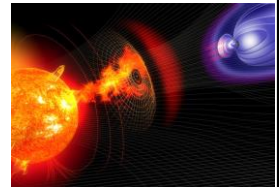


Astronomy 2020 – Space Astronomy & Exploration

12

What are the obstacles facing space exploration?

- The Sun & Space Weather
- Galactic Cosmic Rays
 - Impact on electronics
 - Impact on humans
- Long duration zero-g

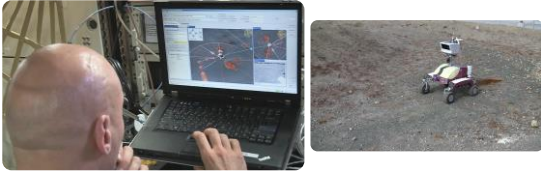


Astronomy 2020 – Space Astronomy & Exploration

13

Class Exercise

Are humans equipped to explore space or should we confine space exploration to robots?



Astronomy 2020 – Space Astronomy & Exploration

14

Where can we explore?



- **The Moon**
 - Witness plate of Earth's history & evolution
 - New places to explore: the poles & farside
 - Low frequency radio telescopes for the lunar farside

Astronomy 2020 – Space Astronomy & Exploration

15

Where can we explore?

- **Mars**
 - Follow the water!
 - Results from *Curiosity*
 - Geology
 - Atmosphere
- **Planning for a human mission to Mars**



Astronomy 2020 – Space Astronomy & Exploration

16

Where can we explore?

- **Mercury** – differences & similarities to the Moon
- **Venus**
 - “Evil” twin of Earth
 - Runaway Greenhouse Effect



Astronomy 2020 – Space Astronomy & Exploration

17

Where can we explore?

- **The Gas Giants & their moons:**
 - Jupiter & Europa
 - Saturn & Titan & Enceladus
- **The Ice Giants**
 - Uranus
 - Neptune & Triton

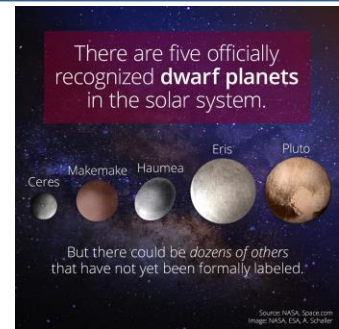


Astronomy 2020 – Space Astronomy & Exploration

18

Where can we explore?

- **Asteroids & planetary protection.**
- **Pluto & New Horizons**
- **The Kuiper Belt**



Astronomy 2020 – Space Astronomy & Exploration

19

Where can we explore?

- Exoplanets: future destinations?
- Interstellar travel & Einstein's Relativity



Astronomy 2020 – Space Astronomy & Exploration