Extragalactic Astronomy
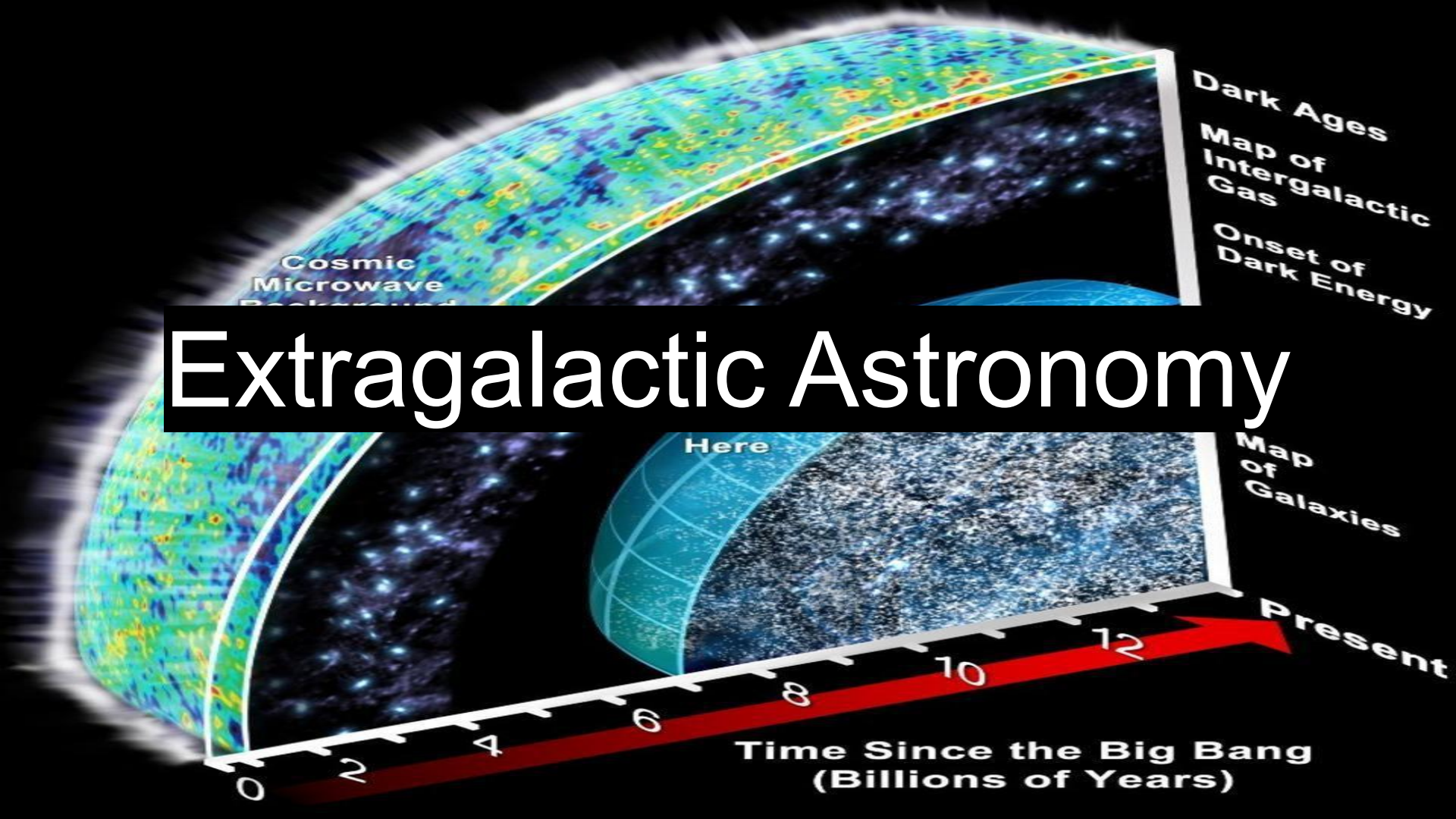
Poll everywhere

When poll is active respond at **PollEv.com/nikhilpatten355**

Send **nikhilpatten355** to **22333**

Poll Everywhere

results

Dark Matter

- Normal (baryonic) matter is less than 5% of our universe
- Dark matter is spherically distributed around galaxies in halos
- What is this matter that emits no light?
- MACHOs: Massive compact halo object
  - Neutrinos? Black holes? Brown or red dwarf stars? Cool white dwarfs?
- WIMPs: Weakly Interacting Massive Particles
  - Something exotic, undiscovered particles?
- We don't know what it is (yet), but we are certain it is there

Bullet Cluster

- Two colliding clusters of galaxies
- Strong gravitational lensing
- In 1933 Fritz Zwicky observed galaxies are moving too fast to be bound by gravity
- Lensing offset from the hot gas from the galaxies
- Dark matter is responsible for lensing
- 90% of the mass of the entire cluster

Bullet cluster from
JWST NIRCAM

Bullet Cluster

- Bullet cluster video (2 mins)

Milky Way

- Formation video (2 mins)

Milky Way

- Hydrodynamic model
- Volumetric model
- Density waves, pulsars lagging spiral arms

Milky Way

- VLT orbits around Sgr A* (4×10^6 M$_\odot$)

Milky Way

- Journey to the Center of the Milky Way video (4–8 mins)

Milky Way

- Great Debate—location of globular clusters

Magellanic Clouds

- Two satellite galaxies to the Milky Way
- Larger one (Large Magellanic Cloud, LMC)
- Smaller one (Small Magellanic Cloud, SMC)
- Extremely metal-poor (anything other than hydrogen and helium is deficient)
- Useful to study stars in other environments

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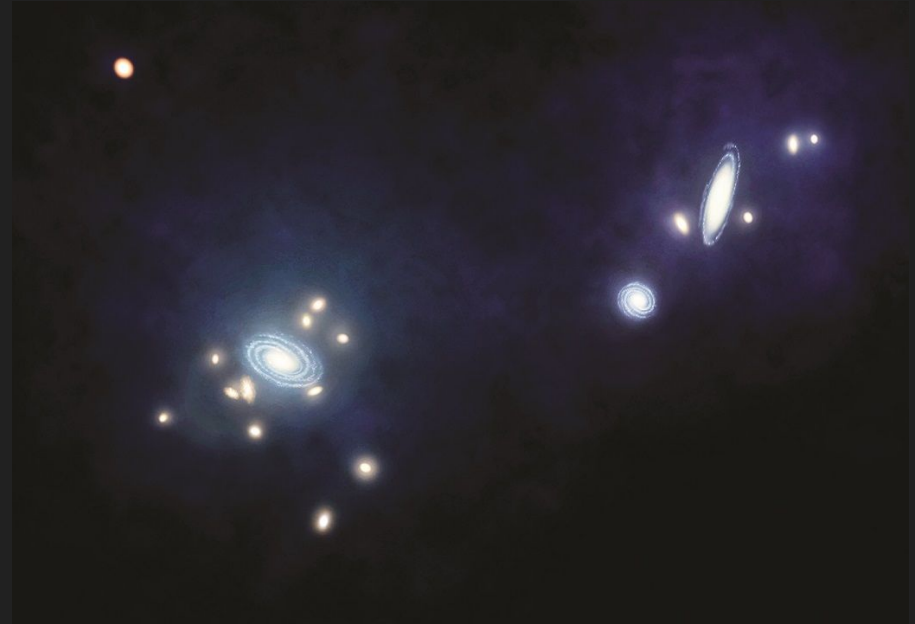- Useful to study stars in other environments

Magellanic Clouds

- Magellanic Clouds from Earth

Local Group

- Collection of ~100 galaxies within 10 Mpc
- Two largest members are Andromeda and the Milky Way galaxies
- Both have their own system of galactic satellites
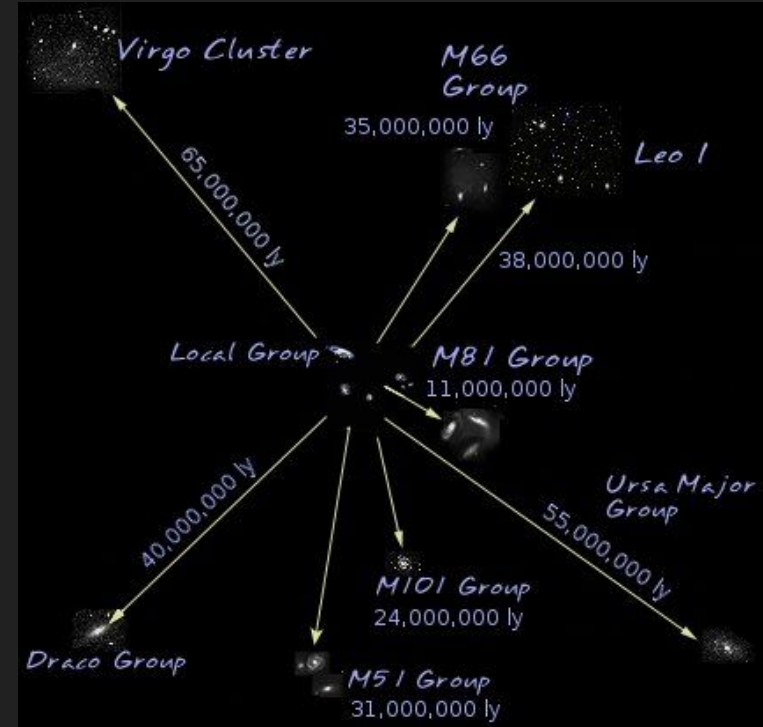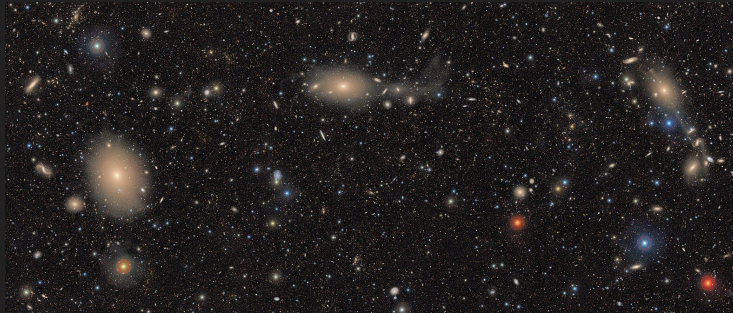
Andromeda Group

- Andromeda group model

Local Supercluster

- 100 galaxy groups within 45 Megaparsecs
- Prominent groups are:
  - Local group—Andromeda and the Milky Way
  - Virgo cluster—M87
  - M81 group—M81 and M82

M87 group

- M87 simulation

Local Supercluster

- Laniakea data

Spiral galaxy collision

- Tuning fork
- Collision compared to real data

Andromeda-Milky Way Collision

- Simulated sky over billions of years

Deep Sky Surveys

- DESI expanding universe video (4 mins)
- Zone of Avoidance-galactocentric coordinates and in sky

Announcements

- Homework due tonight.

Next time

- Hubble-Lemaître Law