

ASTR400B

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Beginning of
Semester Survey



Class GitHub Repository

https://github.com/gurtina/ASTR400B_2025



Syllabus

- Office Hours
 - Prof Besla: 12:30 – 1:30 Thursdays N312
 - TA Himansh: Wednesdays 3-5 PM in 3rd floor Parker library of Steward Observatory

What is a Galaxy?

- Gravitationally bound conglomeration of stars → BUT a cluster of stars?
- Above some mass limit to be a galaxy → soo... Ultra Faint Galaxies.
- Supermassive black holes! → some don't
- Dark Matter ... ?????
- Dust !
- Rotation ! → BUT elliptical galaxies → kinematics
- Classic Structure → BUT ultrafaints

What is a Galaxy

- Willman & Strader 2012 “Galaxy”, Defined

A galaxy is a gravitationally bound set of stars whose properties cannot be explained by a combination of baryons (gas, dust and stars) and Newton's laws of gravity.

What are the components of a Galaxy?

- Stars, blackholes, dust , gas , dark matter
- Base definition → stars and dark matter

What is the Local Group?

- Collection of galaxies in our vicinity.
- Gravitationally bound system of galaxies that includes our Milky Way + its satellites and M31 (Andromeda) + its satellites

How do galaxies evolve over time?

- Secular Evolution: stars are moving (migrate), gas supply will decrease over time as stars form , stars will age
- External Influences : satellites being consumed, galactic COLLISIONS!!!! (mass growth).
- Color (age of stars)
- Brightness – luminosity
- Physical size
- Density Profiles
- ISM structure – spectral signatures
- Changes in structure – appearance: not symmetric – tidal bridges and tails

What is a Galaxy Merger?

- 2 or more galaxies collide and the central black holes have merged
- Defined as merged when the central nuclei have coalesced – no longer the case that two distinct centers of mass can be defined.

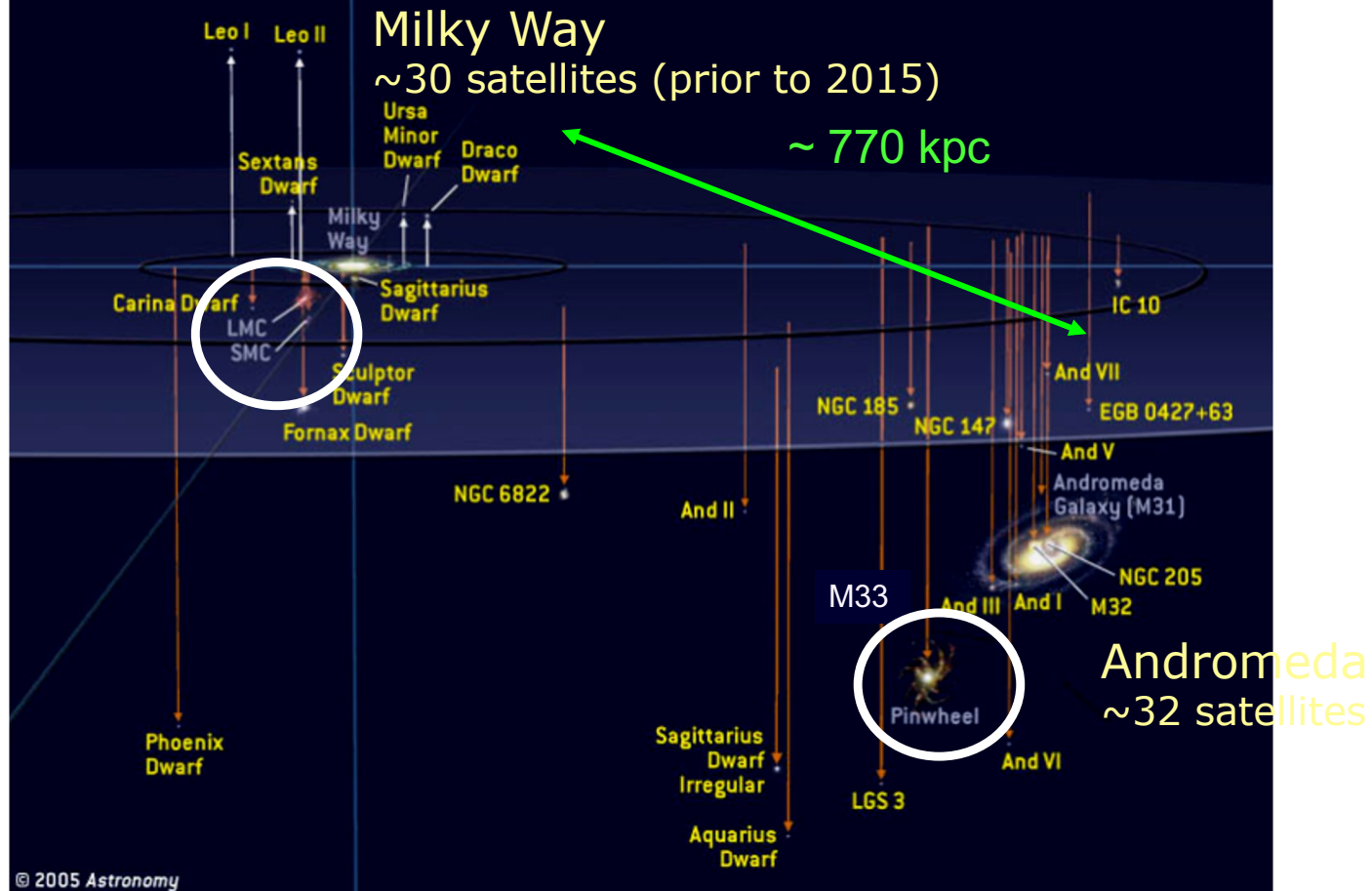
Why do Galaxies Merge?

- Gravity --> cause galaxies to collide or move towards one another
- Dynamical Friction : gravitational wake that develops in the dark matter medium through which a galaxy moves . This acts as a frictional term, decaying the orbit of the galaxy.

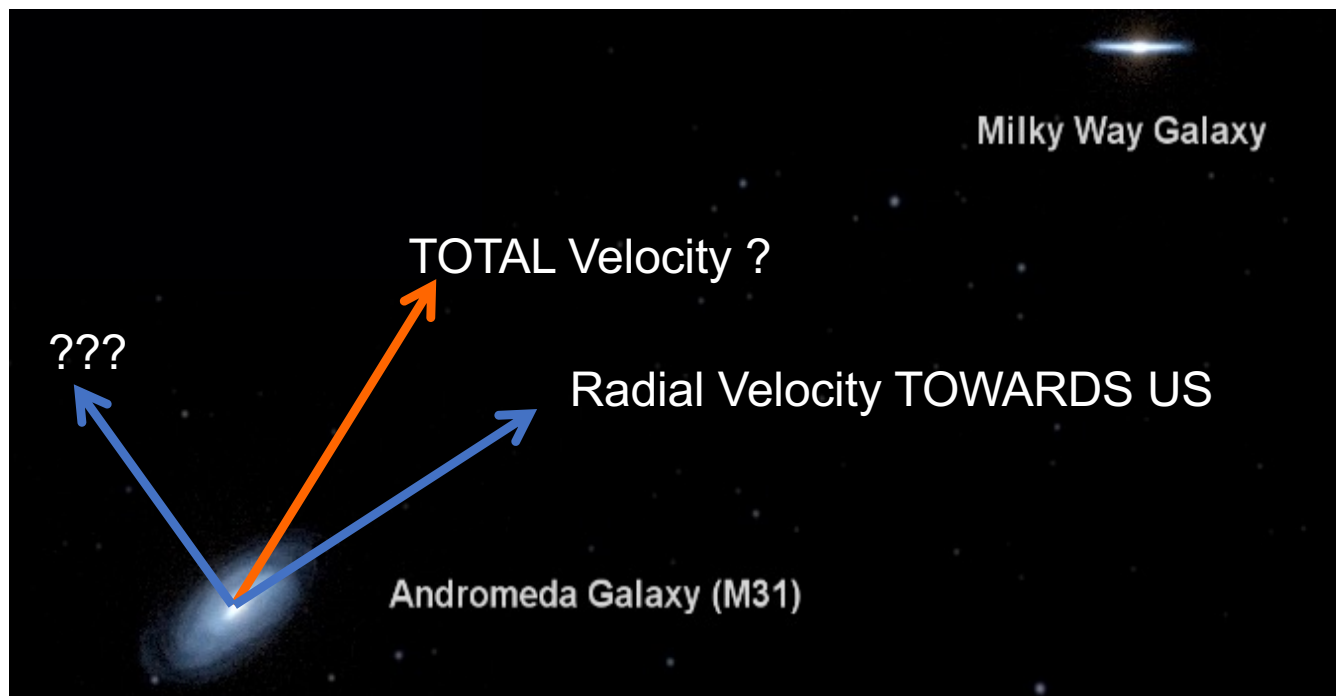
What does “Cosmology” mean in astronomy?

- Study of the genesis, evolution and fate of the universe

Our Local Group of Galaxies



What is the 3D velocity of M31?

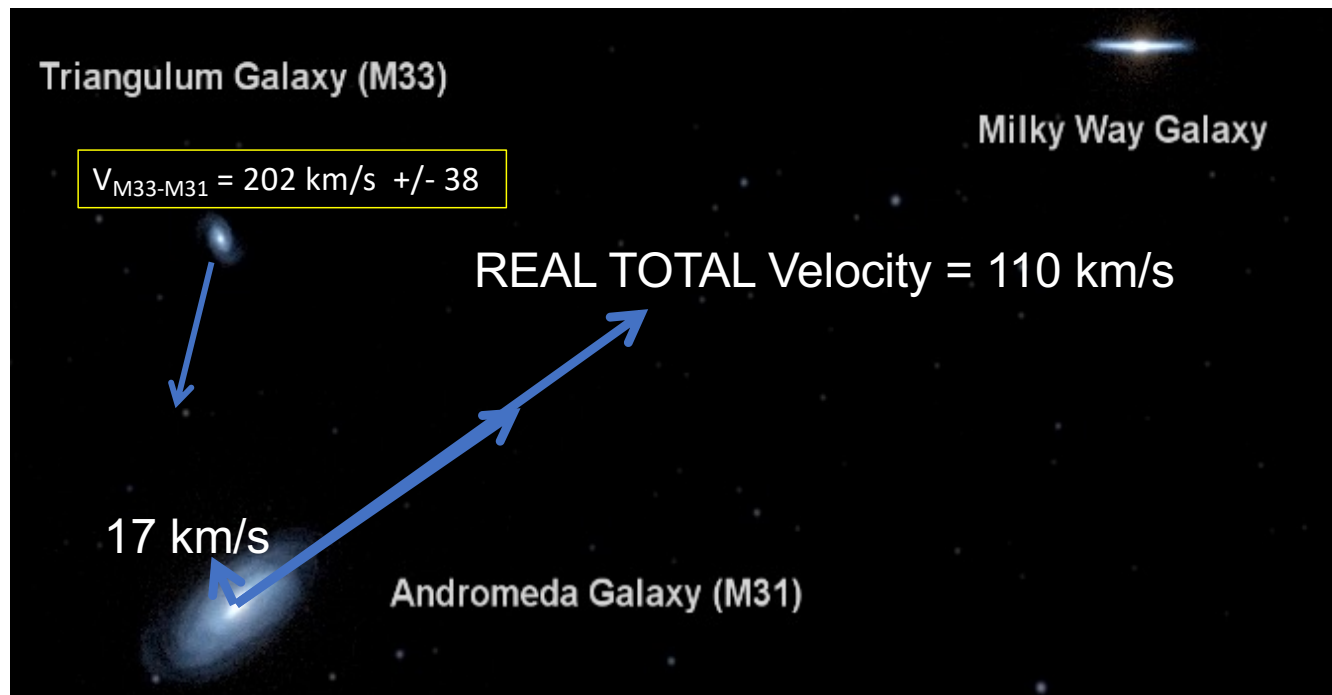


HSTPROMO: The First Direct Proper Motion Measurement of M31



Sohn + 2012 (12 μ as accuracy) - M31 is coming straight at us!

Andromeda is heading DIRECTLY towards us!



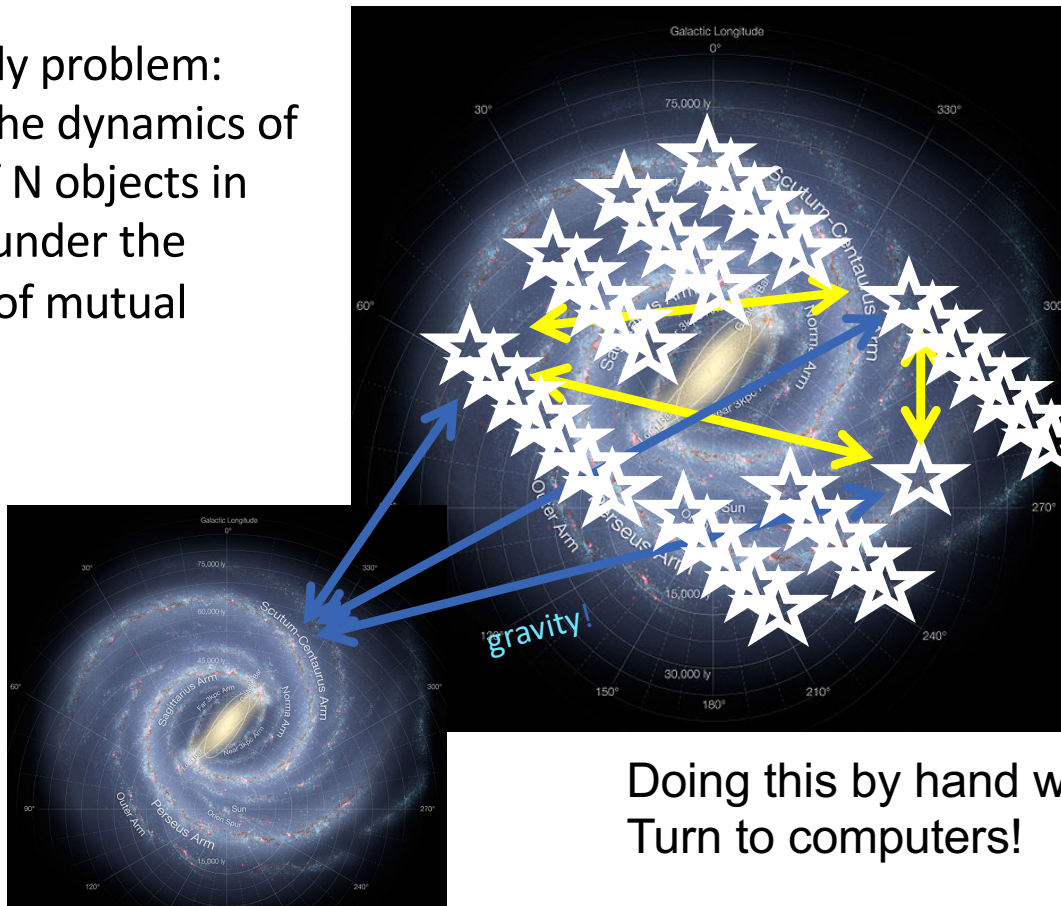
With the new M31 proper motion measurement we can predict the timing of the collision between the MW & M31: $3.87^{+0.42}_{-0.32}$ Gyr van der Marel, Besla+2012



Artistic License: Z. Levay and R. van der Marel (STScI), T. Hallas, and A. Mellinger

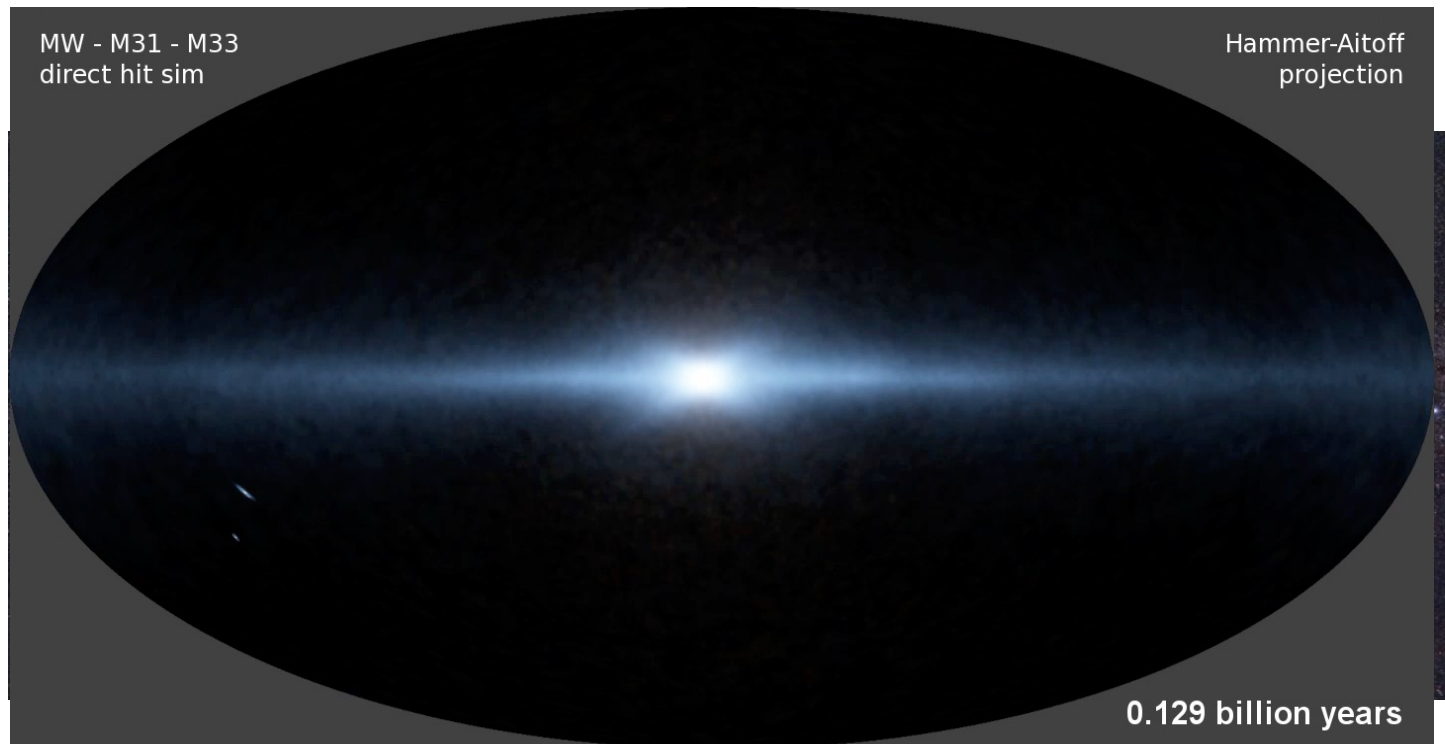
Simulating a Galaxy Collision

The N-body problem:
solve for the dynamics of
a group of N objects in
3D space under the
influence of mutual
gravity.



Doing this by hand would suck!
Turn to computers!

How might the night sky change?



Credit: Besla, Frank Summers

Q: What are the Future Prospects
for Astronomy in 6 Billion Years?

