

Where do Tidal Tails and Bridges come from?

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What are tails and bridges?



Credit: IPAC

Toomre Paper

- The structures can be made purely through tidal interactions

Credit: Toomre & Toomre 1972

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GALACTIC BRIDGES AND TAILS

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ABSTRACT

This paper argues that the bridges and tails seen in some multiple galaxies are just tidal relics of close encounters. These consequences of the brief but violent tidal forces are here studied in a deliberately simple-minded fashion: Each encounter is considered to involve only two galaxies and to be roughly parabolic; each galaxy is idealized as just a disk of noninteracting test particles which initially orbit a central mass point.

As shown here, the two-sided distortions provoked by gravity alone in such circumstances can indeed evolve kinematically into some remarkably narrow and elongated features: (i) After a relatively direct passage of a *small* companion, the outer portions of the primary disk often deform both into a near-side spiral arm or "bridge" extending toward this satellite, and into a far-side "counterarm." (ii) A similar encounter with an *equal* or more massive partner results typically in a long and curving "tail" of escaping debris from the far side of the victim disk, and in an avalanche of near-side particles, most of which are captured by the satellite.

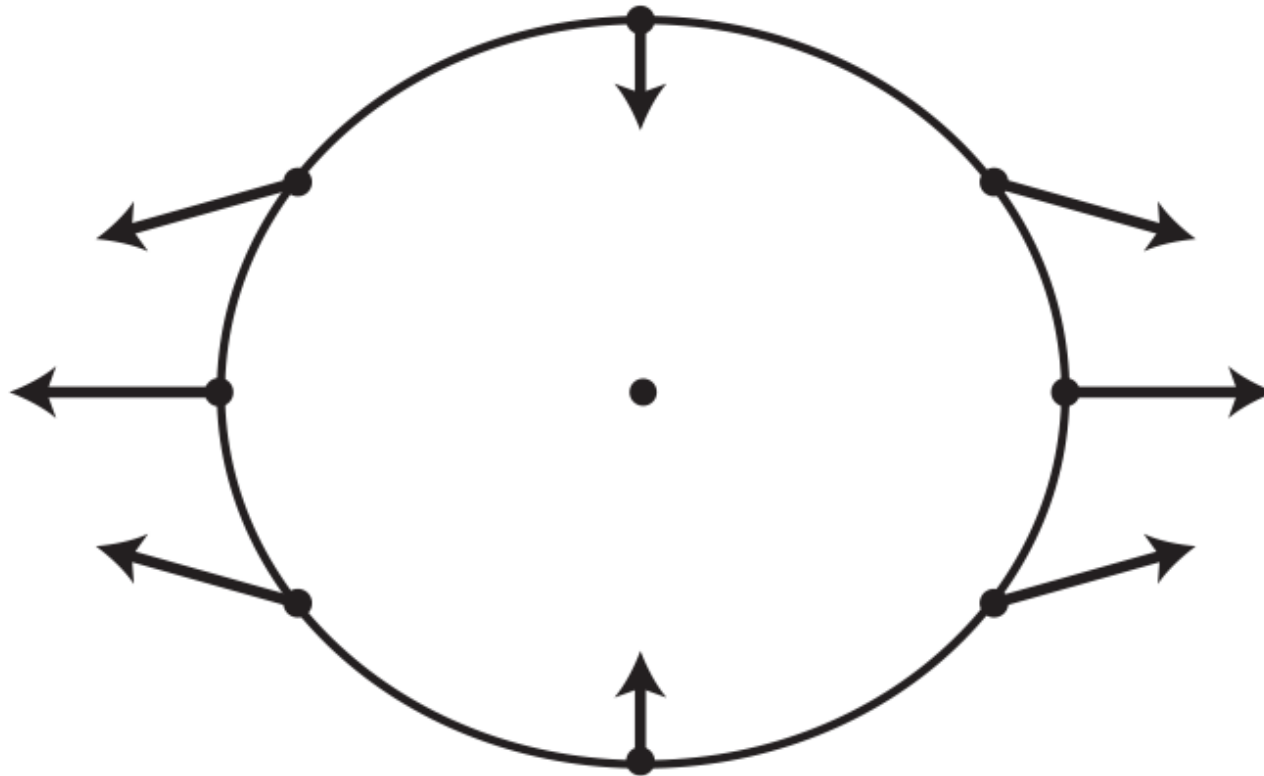
Besides extensive pictorial surveys of such tidal damage, this paper offers reconstructions of the orbits and *outer* shapes of four specific interacting pairs: Arp 295, M51 + NGC 5195, NGC 4676, and NGC 4038/9. Those models can be found in the fairly self-explanatory figures 19, 21, 22, and 23.

Also discussed are some closely related issues of eccentric bound orbits, orbital decay, accretion, and forced spiral waves.

I. INTRODUCTION

When galaxies appear to be neighbors and at least one looks peculiar, *tidal* interactions are often suspected and sometimes even blamed. Yet occasionally these temptations have been resisted with considerable vigor. Such exceptions have included (i) various bridgelike situations where a pronounced spiral arm of a large galaxy extends to the vicinity of a lesser companion, and (ii) the long, usually curving, faintly luminous "tails" which accompany certain of the multiple galaxies. To be sure, even those features, first studied extensively by Zwicky (1953, 1956, 1959), have often been described as belonging to systems "in obvious interaction." But judging from the reservations admitted even by Zwicky (1963, 1967) despite his former use of words like "countertide" and "tidal extensions"—and especially from the vehement doubts

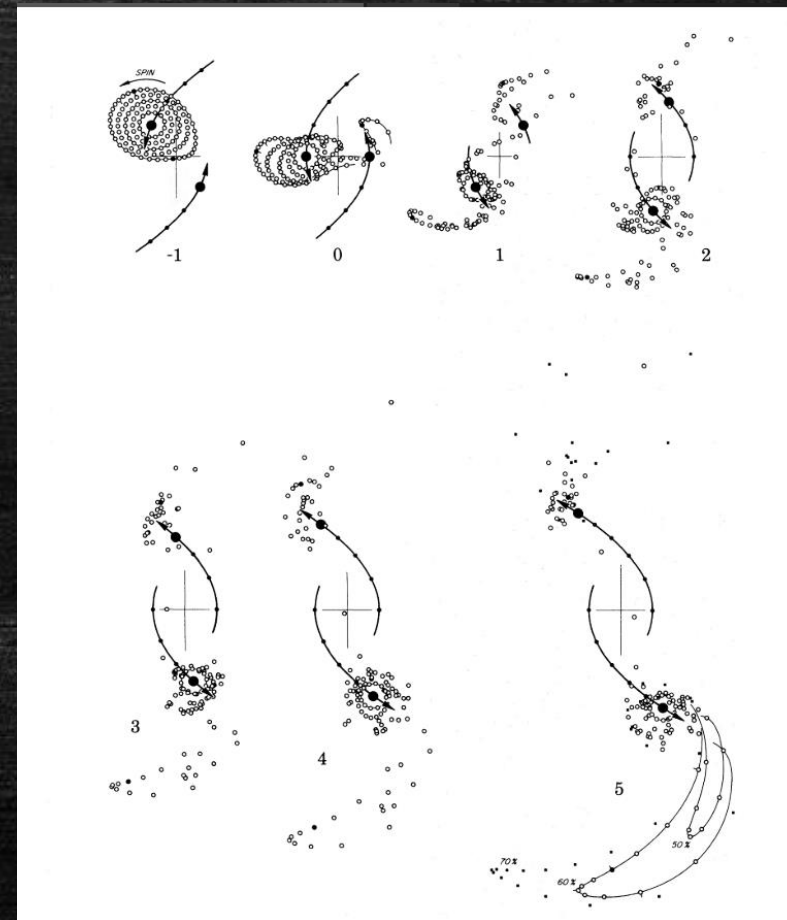
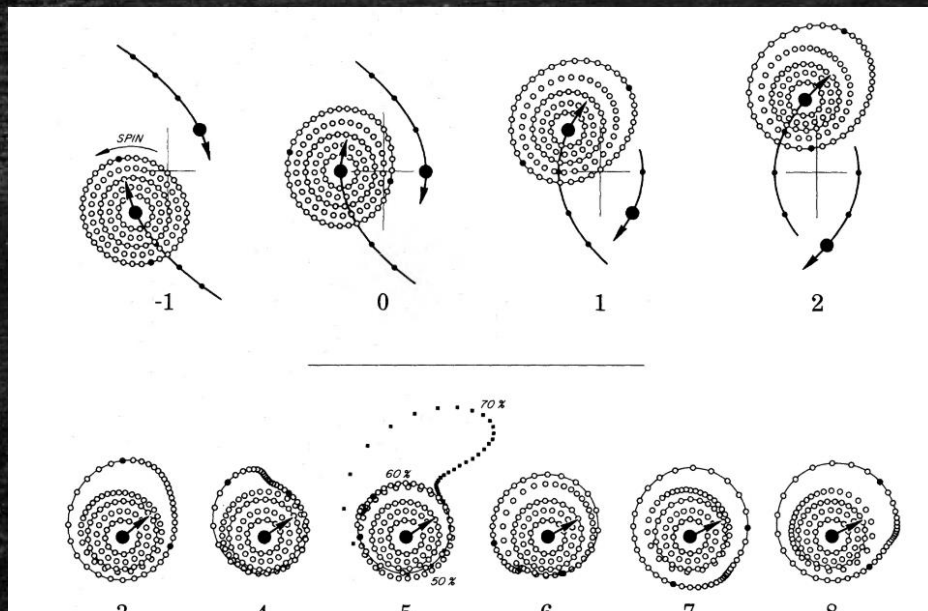
Tidal Force



Credit: SciJinks.gov

Retrograde vs Prograde

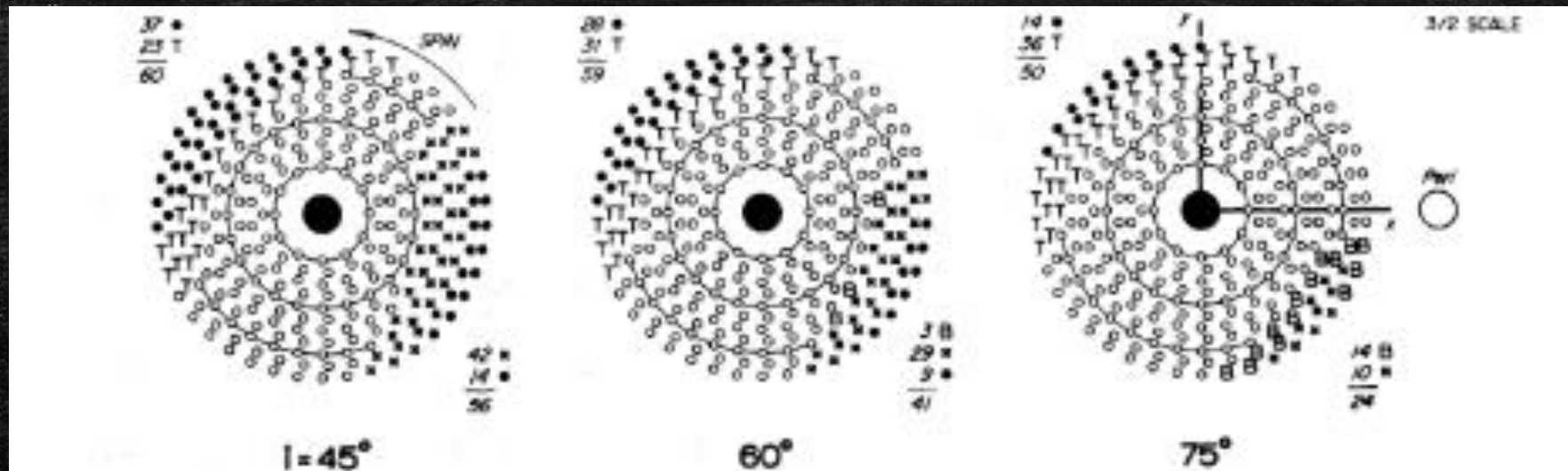
Retrograde



Prograde

Toomre Paper

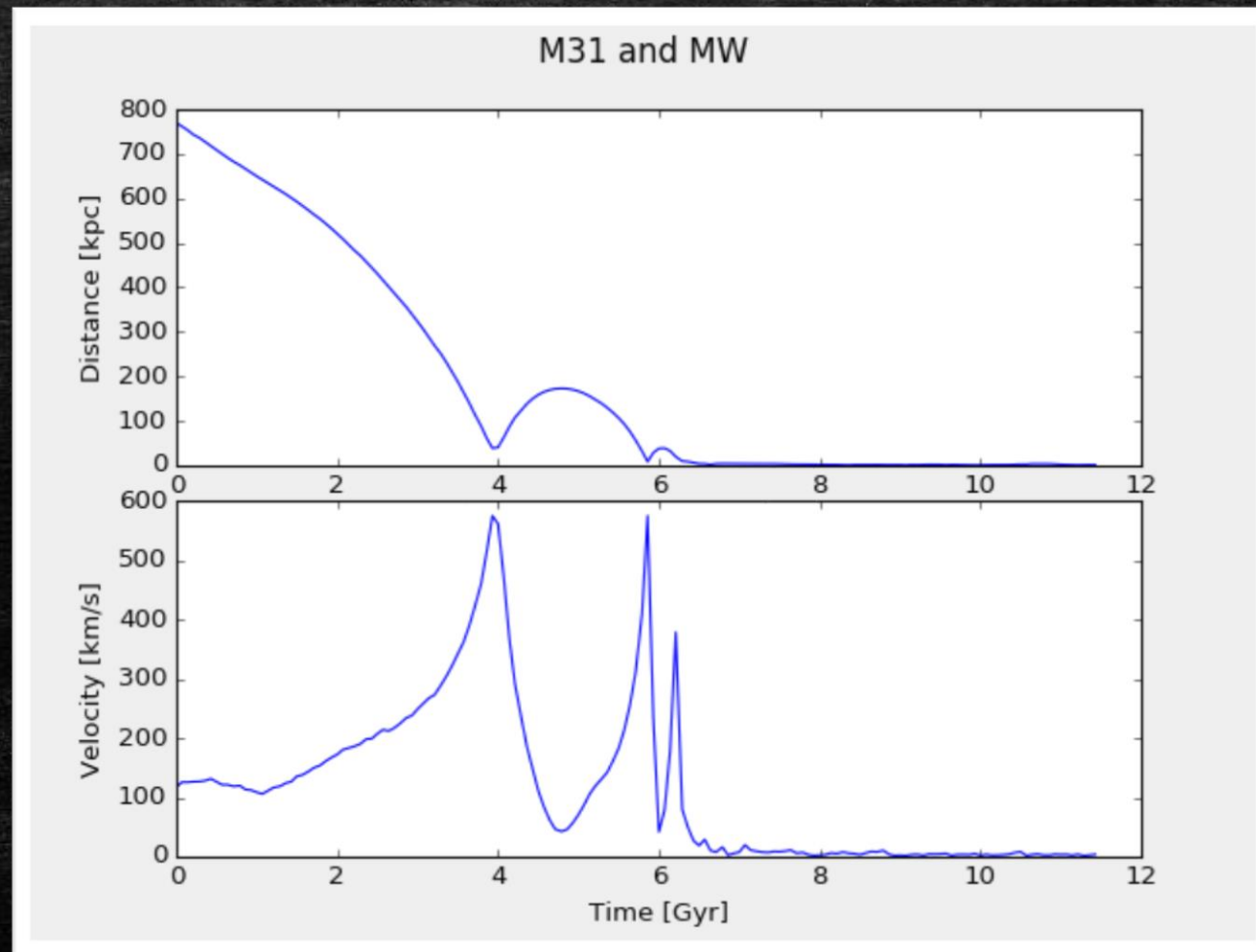
- Tracked where the tails and bridges came from



My questions

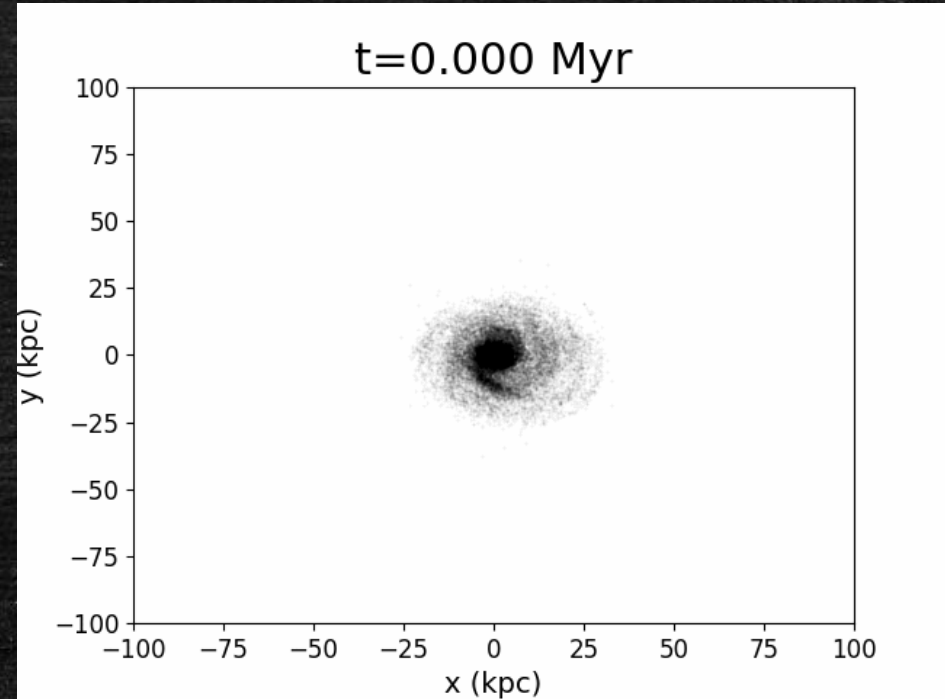
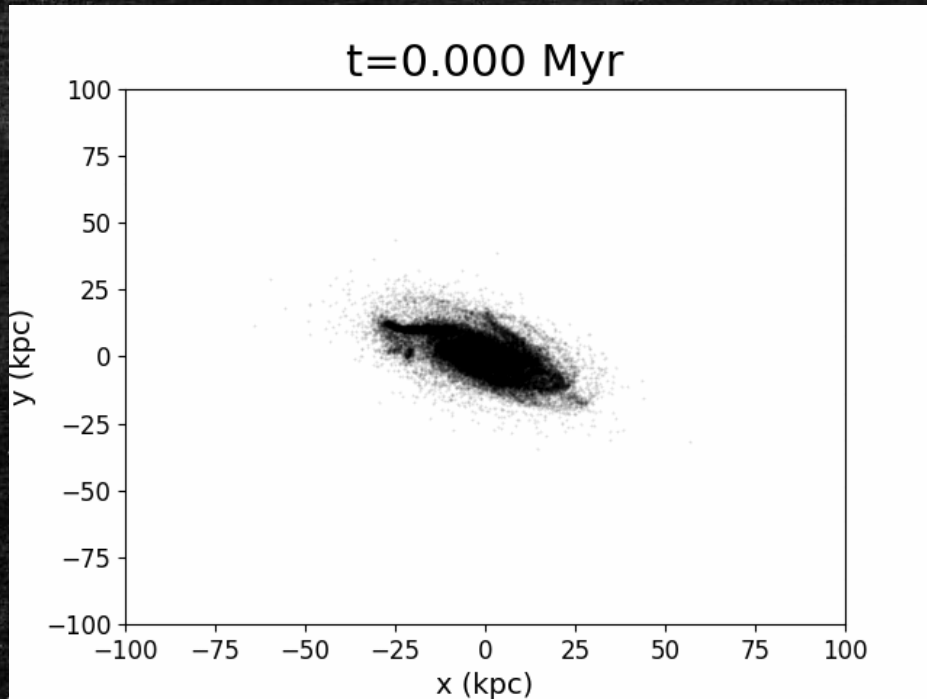
- Internal mixing from the tidal interactions
 - Where does the mixing occur
- Where do the tails and bridges come from?
 - Leading and trailing edges
 - How close to the center do the stars come from
 - Does one galaxy give more than the others
- How smooth/clumpy are the tails/bridges

Time Frame:



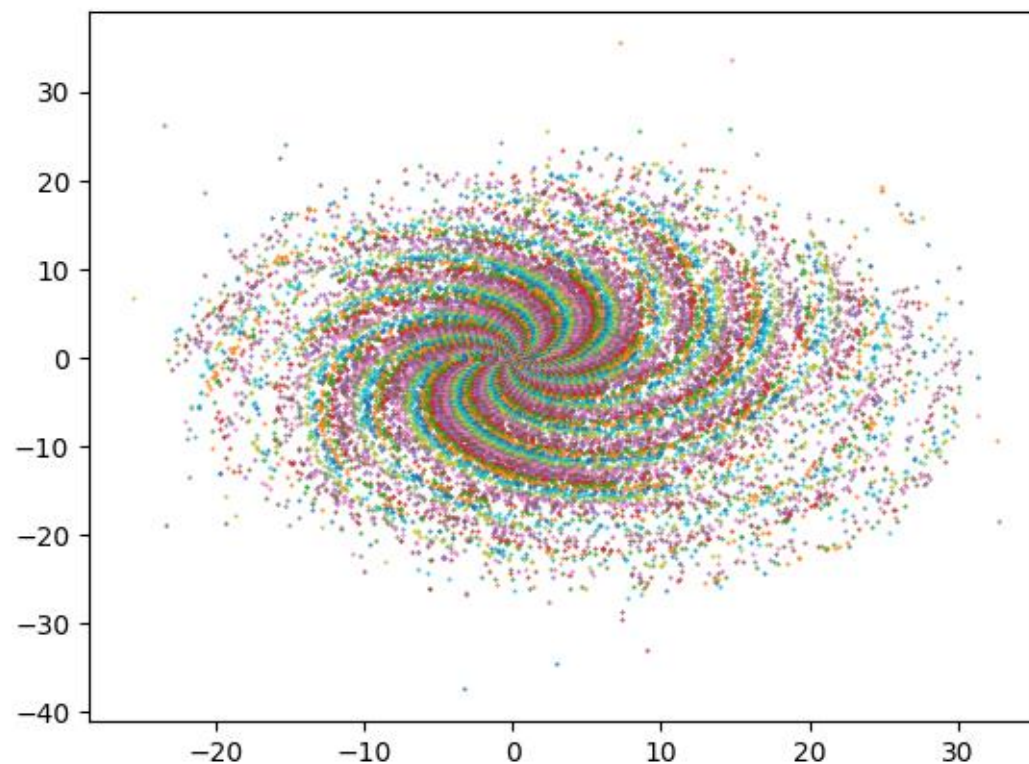
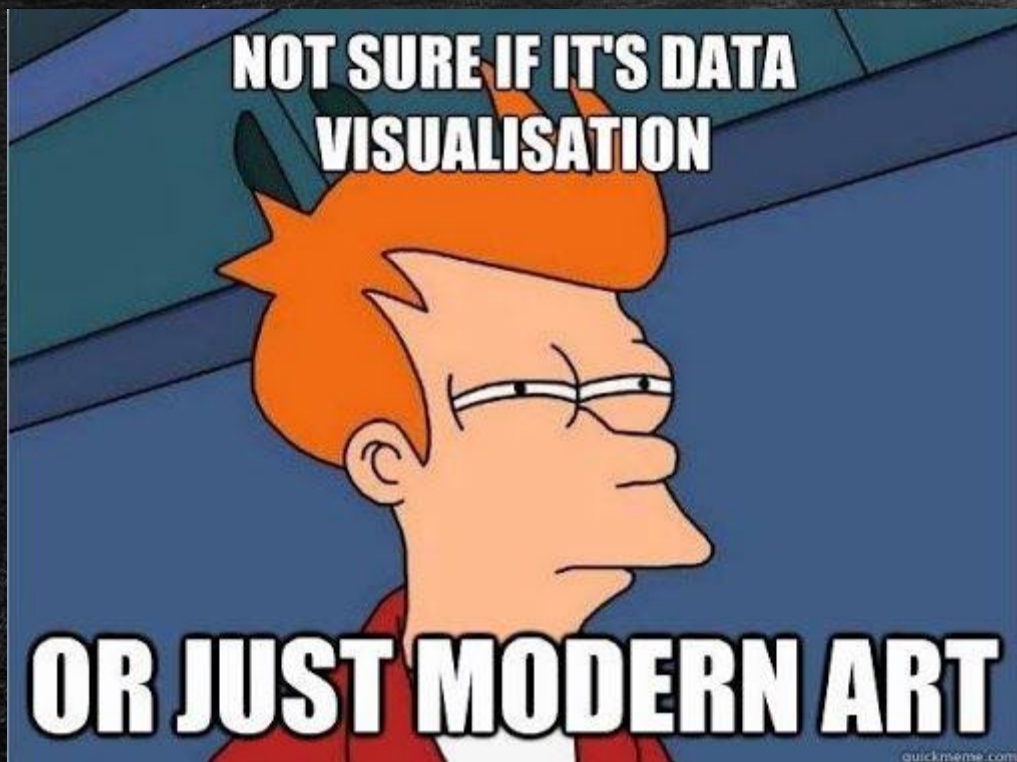
Time Frame:

- Use times right before significant tidal interactions (~ 3.75 Gyr or 265)



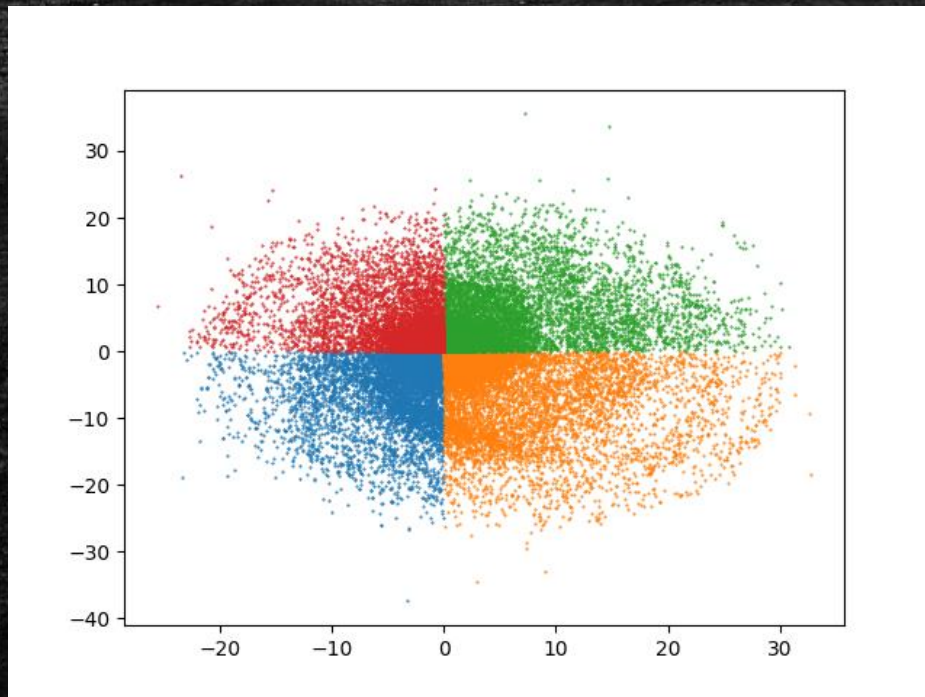
How will I do it?

BINS!!!

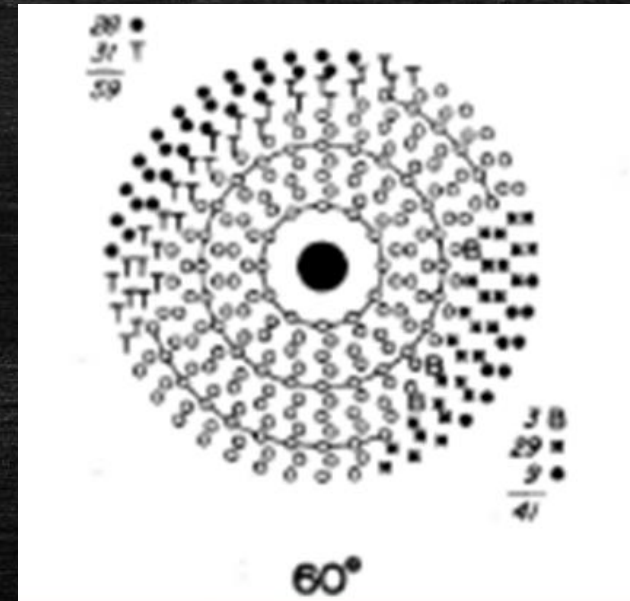


Leading/Trailing Edge

Break up into 4 regions



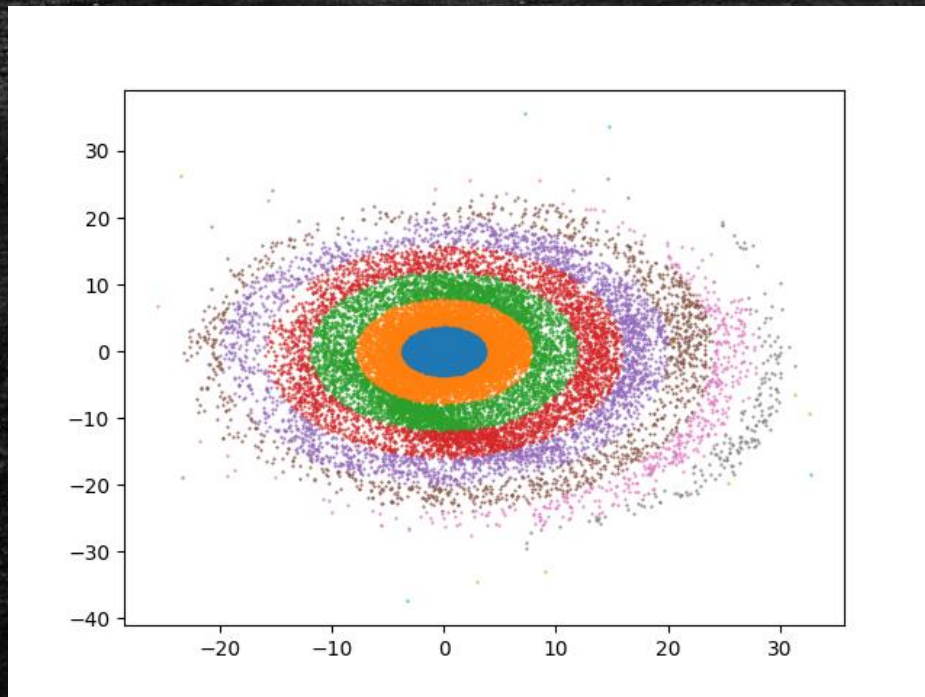
From Toomre Paper



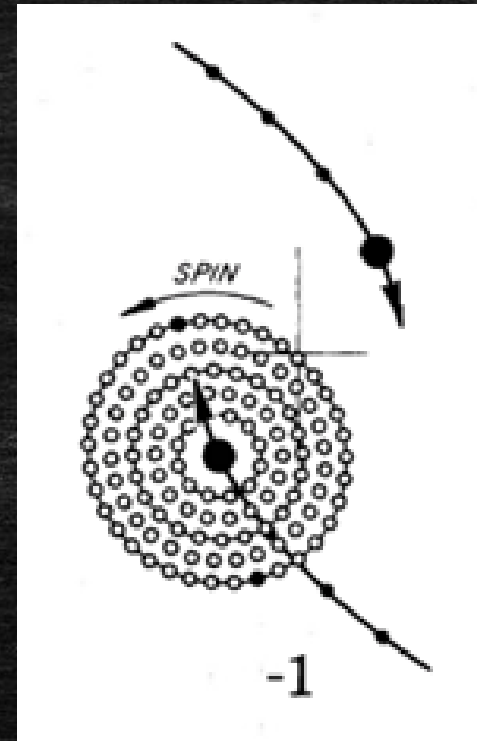
Credit: Toomre & Toomre 1972

How deep?

Break up into several regions



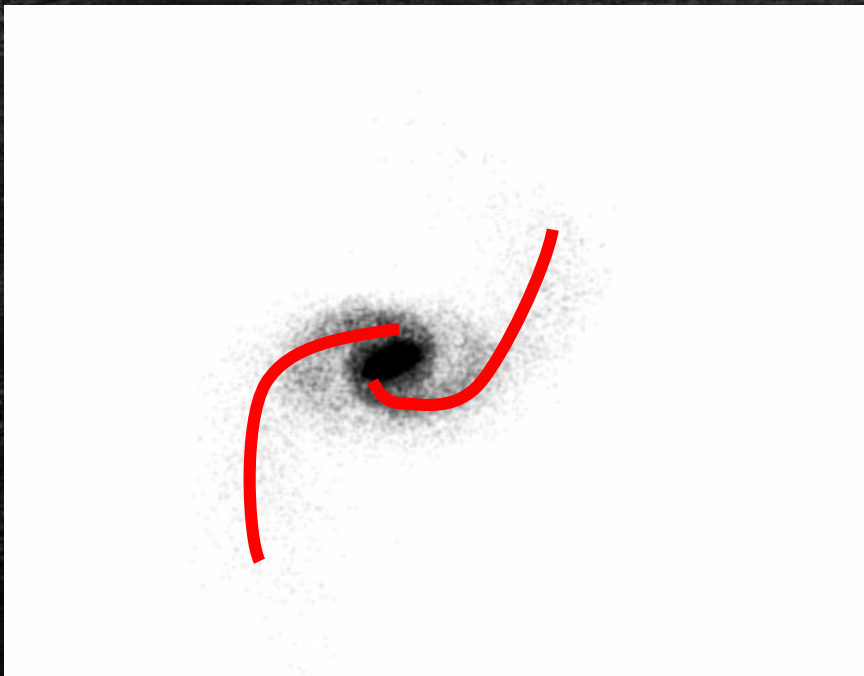
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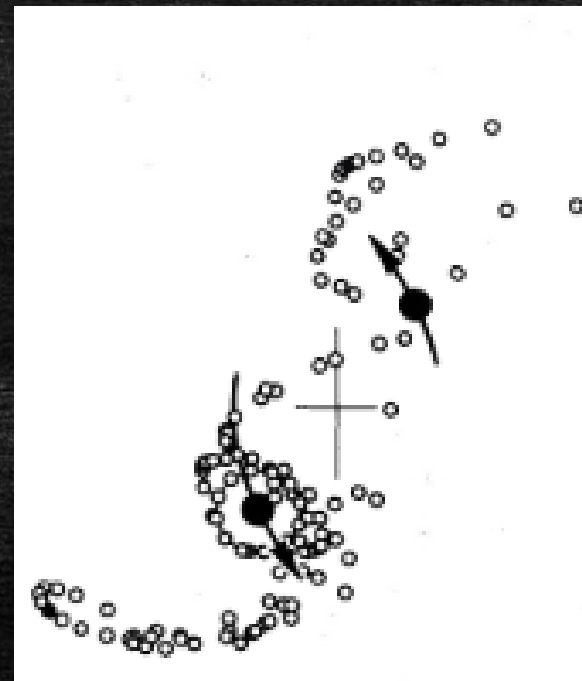
Credit: Toomre & Toomre 1972

How clumpy?

Fit curves to the tails and bridges



From Toomre Paper



Credit: Toomre & Toomre 1972

Summary of expectations

- The internal mixing of the galaxies for the first collision will occur in
- Andromeda will make up a larger percentage of the bridge
- The stratification shown in Toomre paper will not be as strong
- The tails will be mostly smooth

Questions

