

Creation of Stellar Streams:

The Ghost of Sagittarius and Its Siblings

Peixian Wang

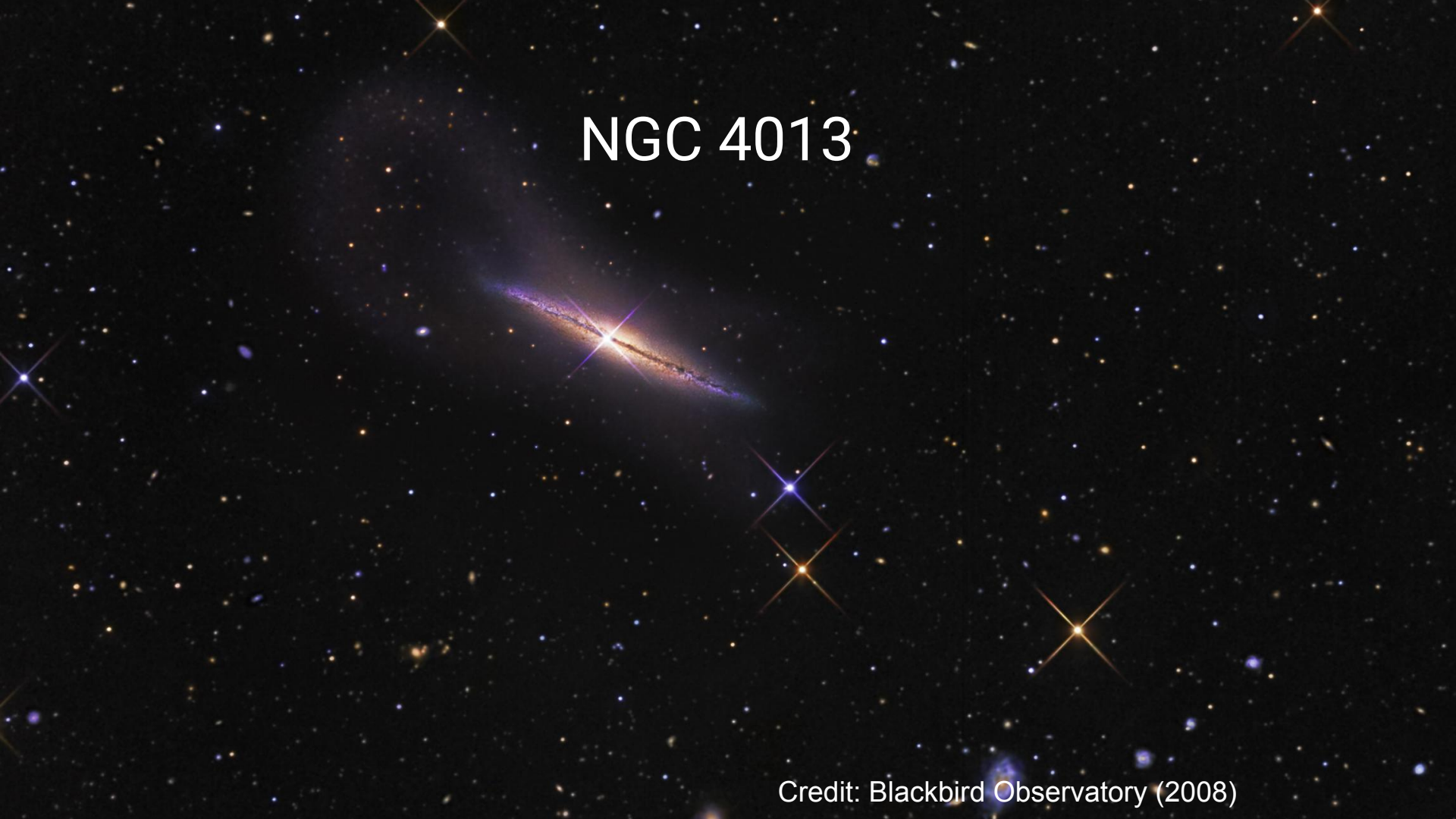


Creation of Stellar Streams:

The Ghost of Sagittarius and Its Siblings

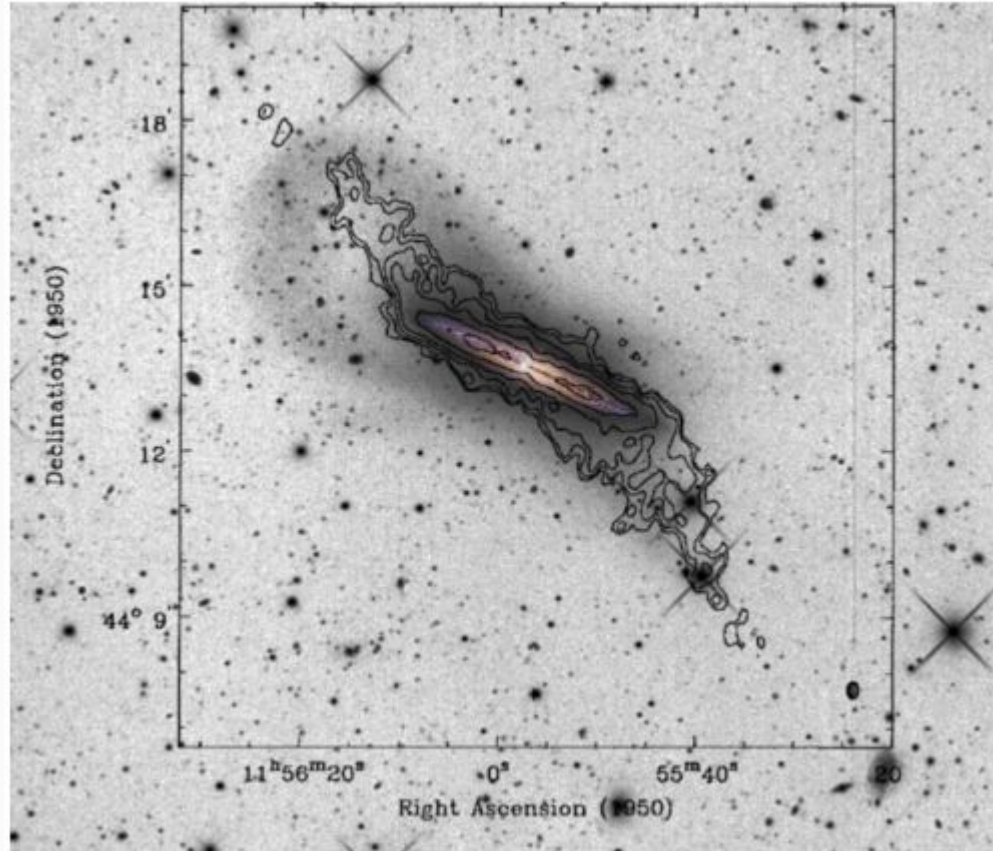
Stellar streams are:

1. Trail of stars orbiting the host galaxy
2. Former globular clusters or dwarf galaxies
3. Created through tidal stripping
4. Have halo substructures associated with the stellar streams
5. Two major structures - leading and trailing stream



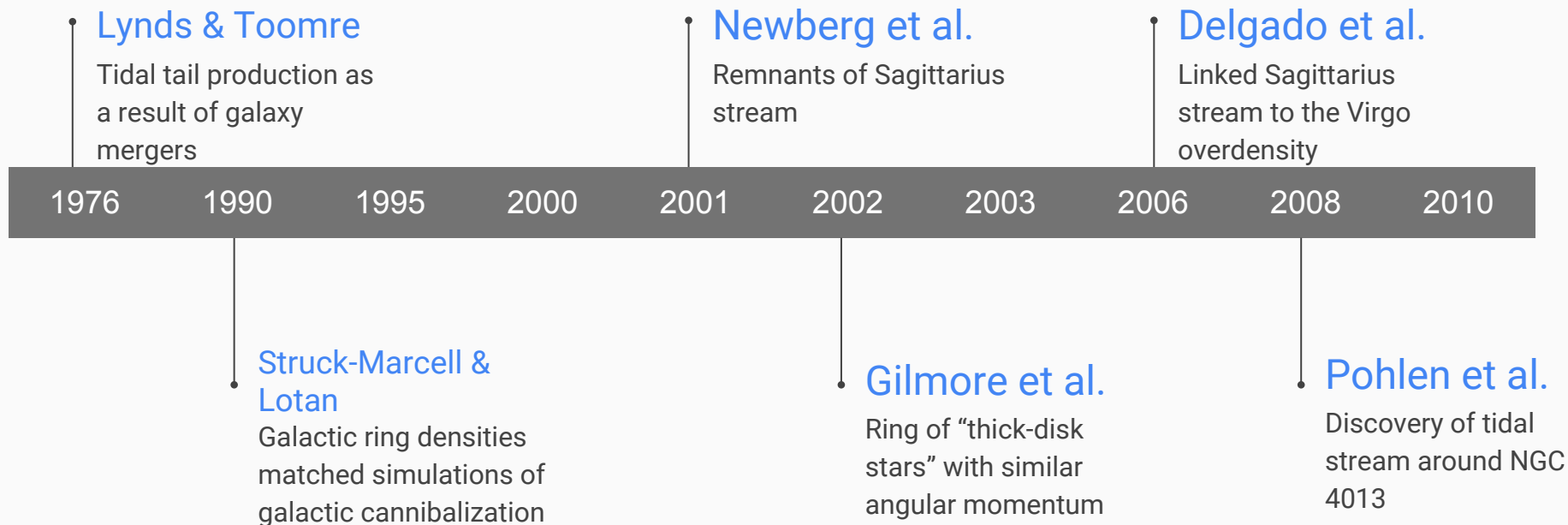
NGC 4013

Credit: Blackbird Observatory (2008)

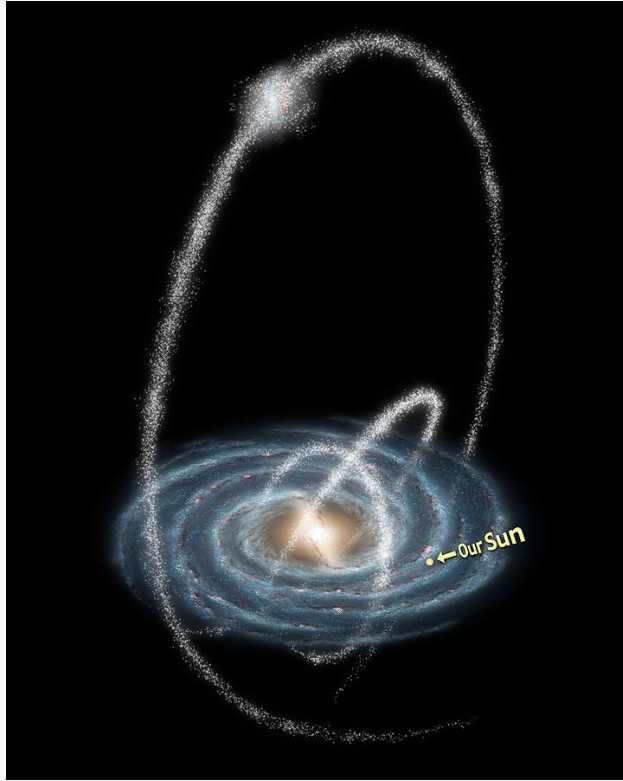


Overlay of the H I contours onto Bottema (1996) (Delgado et al. 2008)

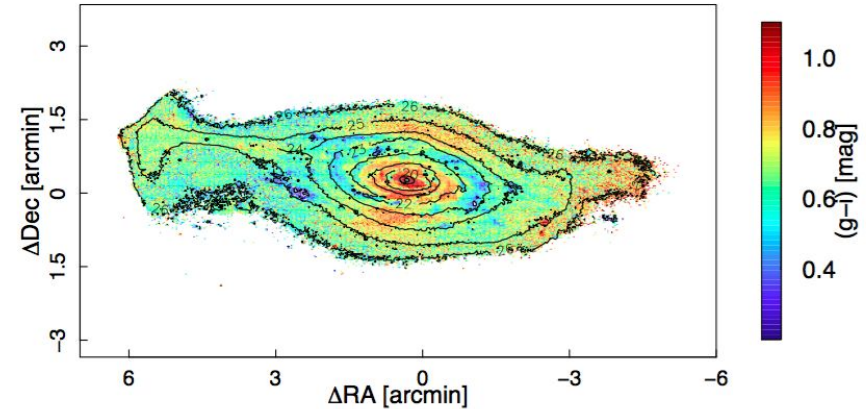
Previous Works

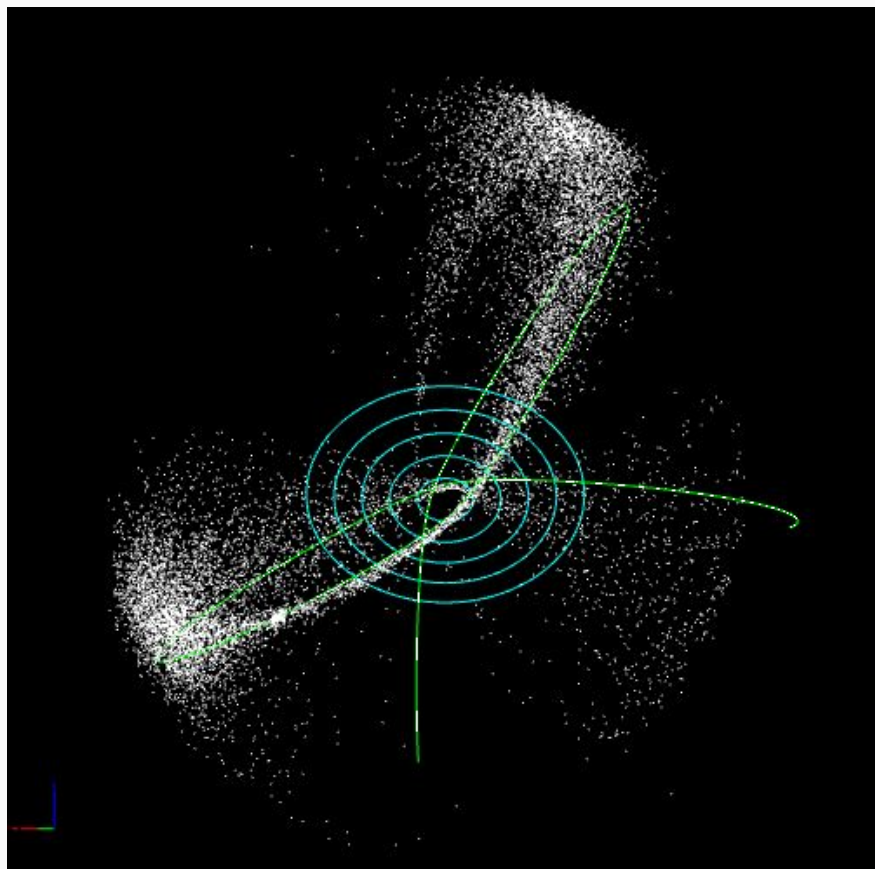


The Use of Stellar Streams

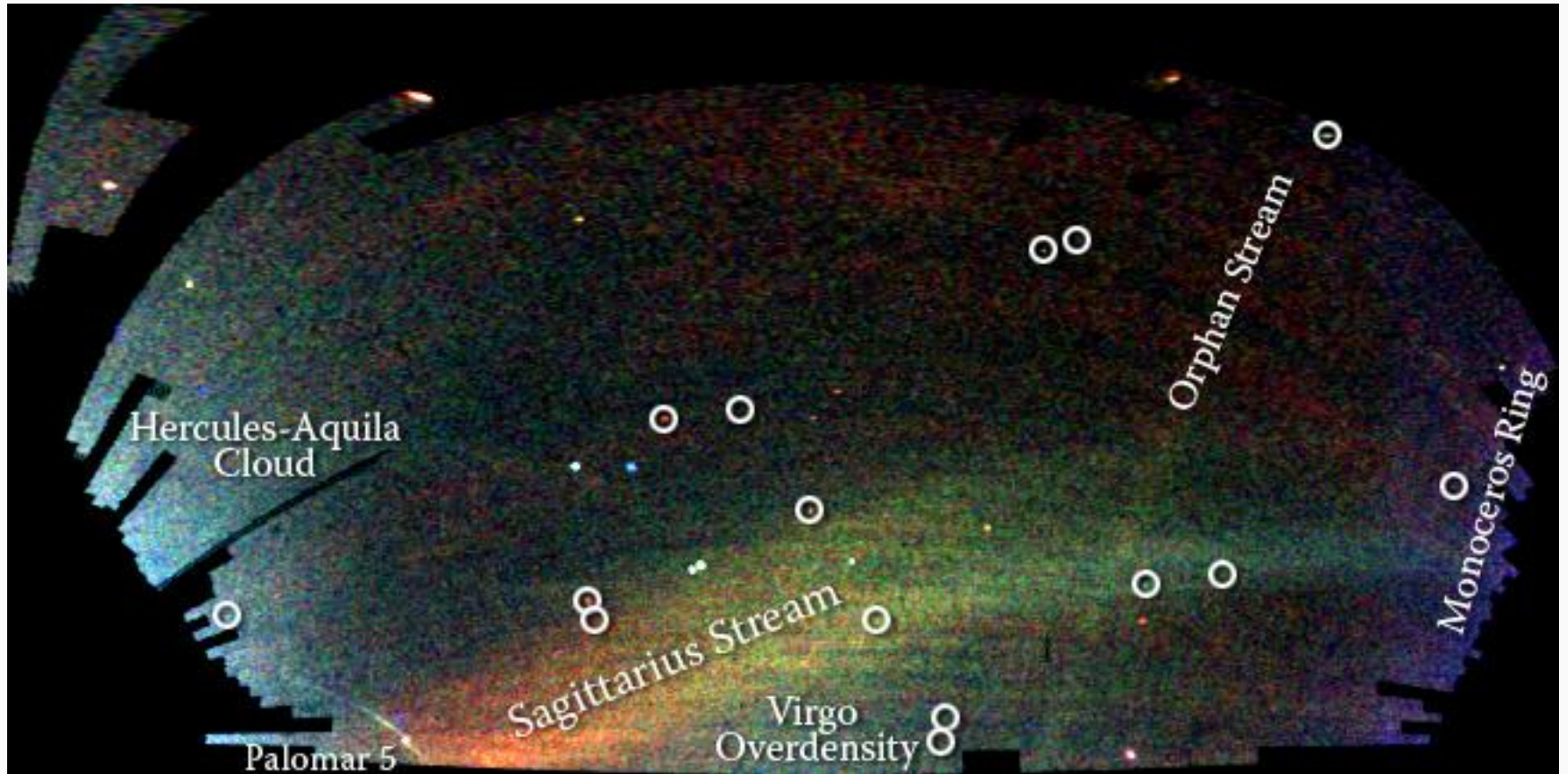


- Dynamical measurement for the distribution of mass in the Milky Way
- Reconstruct and investigate the Milky Way's past, along with other galaxies





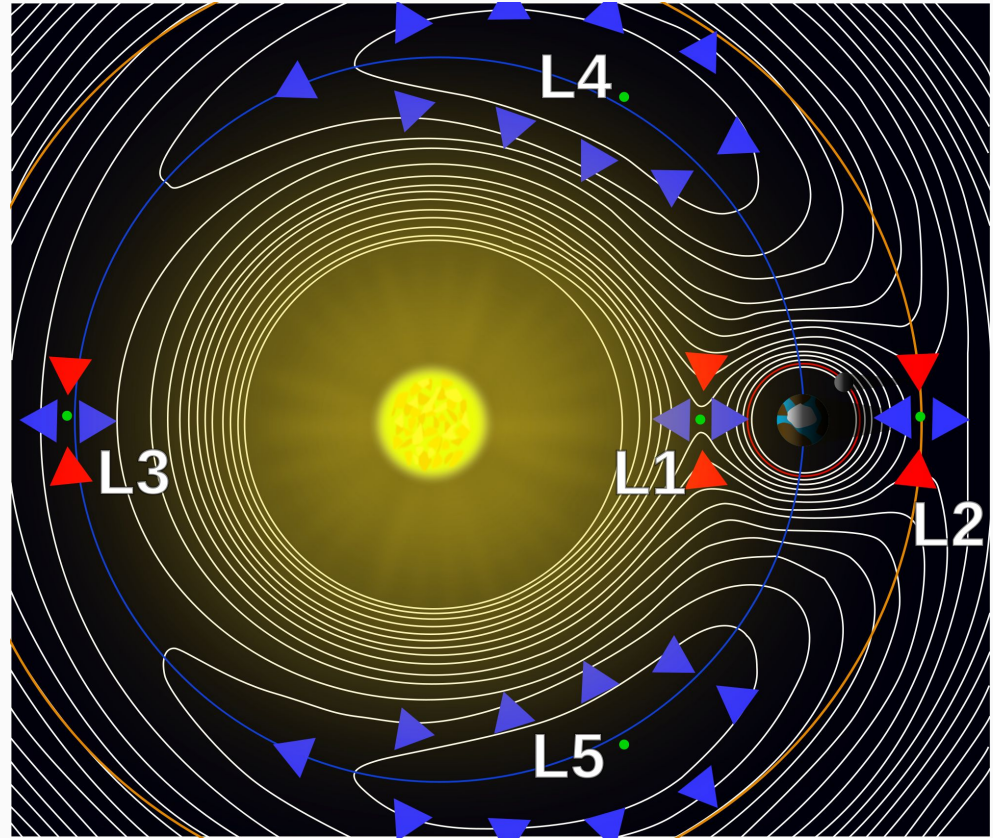
Stellar stream model of the Umbrella Galaxy/NGC 4651 (Foster et al. 2014)



Vasily's "Field of Streams" from SDSS data; color corresponds to distance (SDSS)

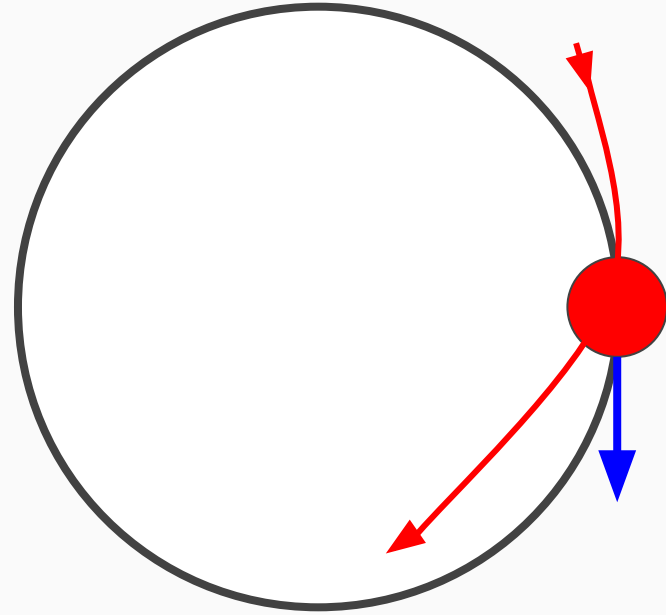
Formation

- Host galaxy and satellite are within a rotating 2-body system
- Stars escape through the two Lagrange points
- Lagrange points define the tidal radius of the system



Leading and Trailing Streams

- Outer orbit stars have higher energy orbits as they move, leading to them falling behind the satellite
- Stars stripped through the inner Lagrange point are moved forward and fall inwards
- Leads to two distinct portions of the stream



Simulation



Problems:

- Strong perturbations affect satellites
- Satellite infall is anisotropic

Goals:

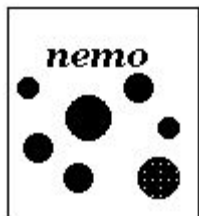
- How does mass affect stellar stream production?
- How are the satellites disrupted?

Setup

Initial Conditions:

- Circular orbit
- $r = 0.4R_{\text{vir}}$
- $T_{\text{max}} = 2T_{\text{period}}$
- 10^6 particles

Satellite	$M/M_{\text{vir, host}}$	$R/R_{\text{vir, host}}$	$V_{\text{max}}/V_{\text{vir, host}}$
Massive	1.9×10^{-2}	9.02×10^{-2}	0.45
Sagittarius	9.0×10^{-4}	3.38×10^{-2}	0.16
Small	9.9×10^{-5}	1.66×10^{-2}	0.08

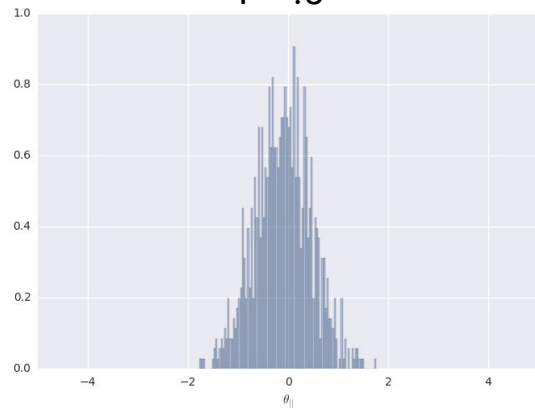


NEMO

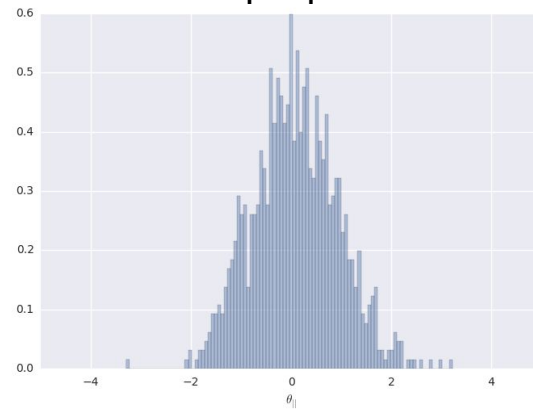
- Stellar Dynamics Toolbox
- Compiles into several tools
- Mostly C, some C++ & Fortran
- REPL-like pipeline

Results

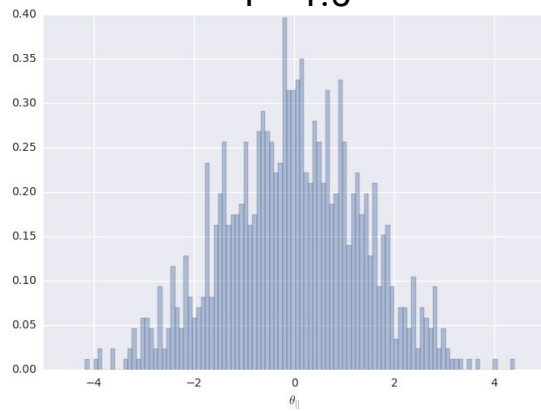
$T = .5$



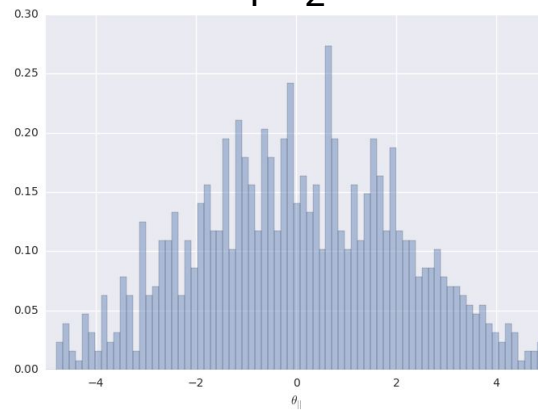
$T = 1$



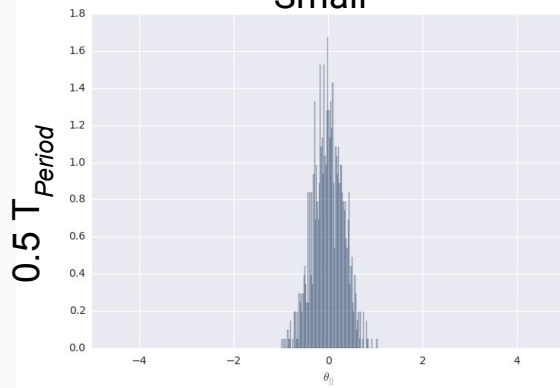
$T = 1.5$



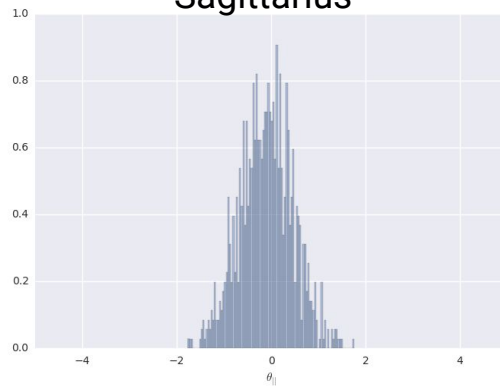
$T = 2$



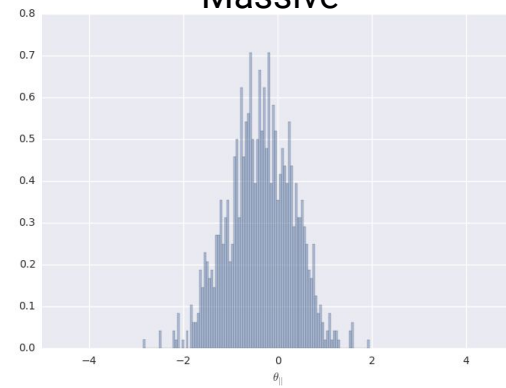
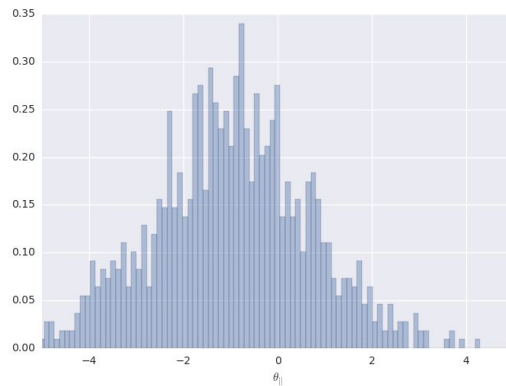
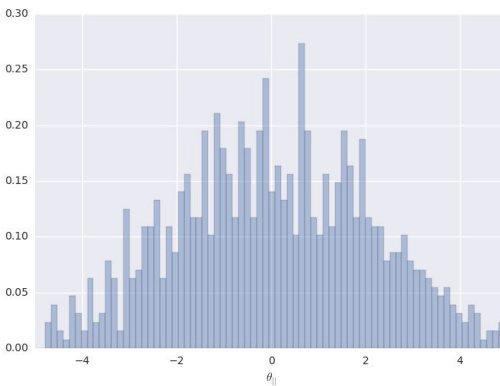
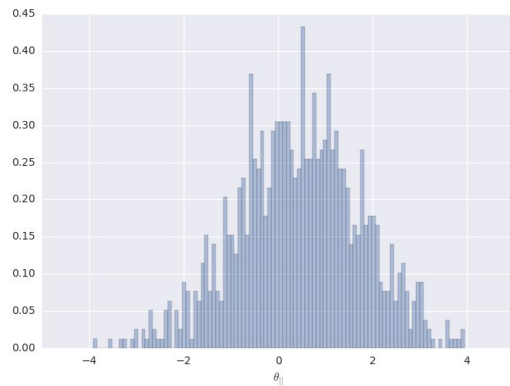
Small

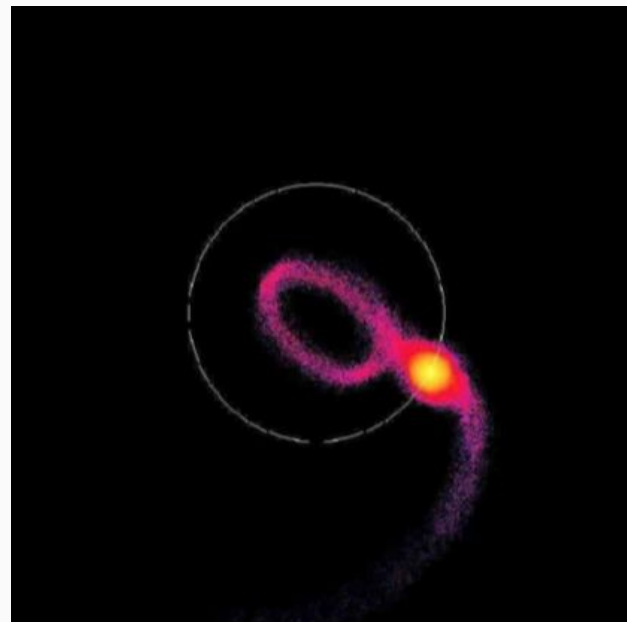
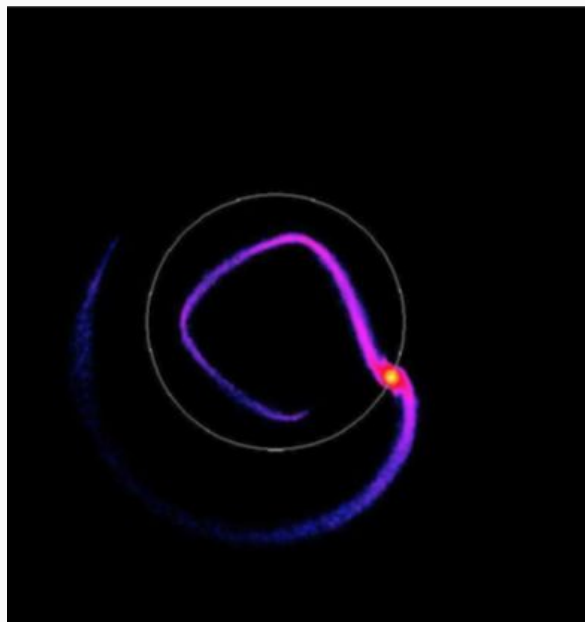
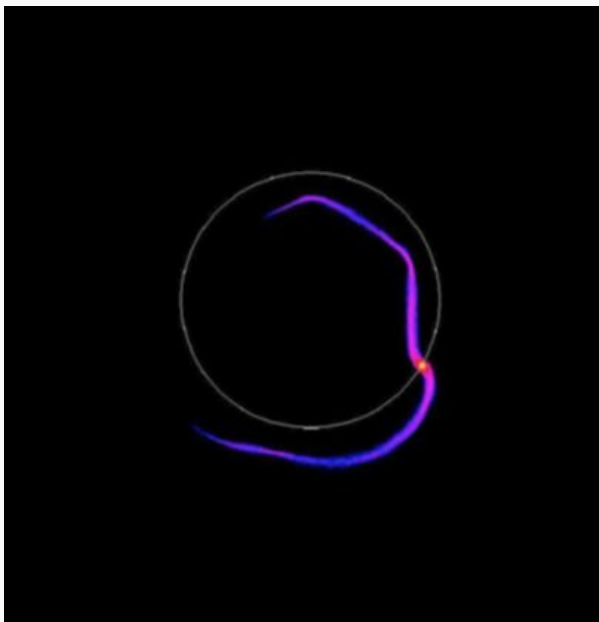


Sagittarius

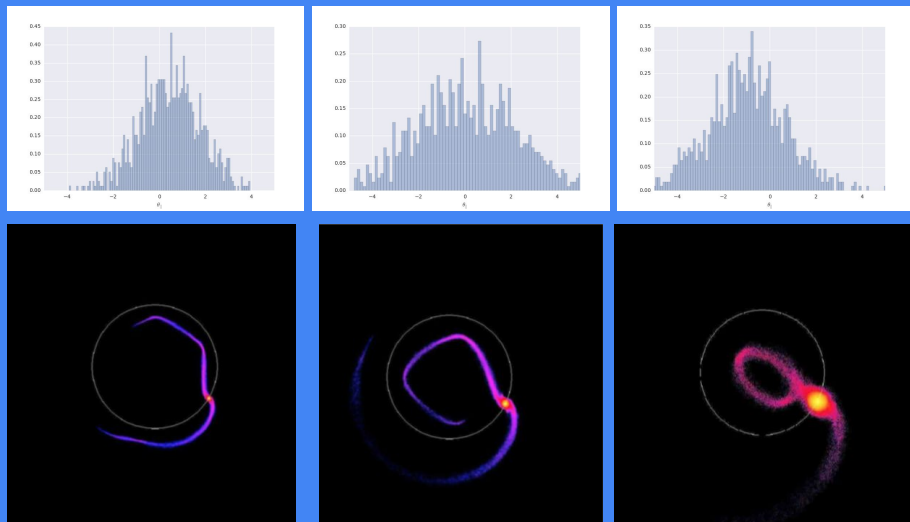


Massive

 $2 T_{\text{Period}}$ 



Conclusions



- *All satellites create streams displaced from orbital path*
- *Length and density of sharp bends suggest initial galaxy size*
- *Angle of displacement suggests initial galaxy size*

Questions?