OPEN CLUSTER EVOLUTION AND THE SEARCH FOR THE SUN'S SIBLINGS

Carmen Adriana Martínez Barbosa
Anthony Brown
Simon Portegies Zwart

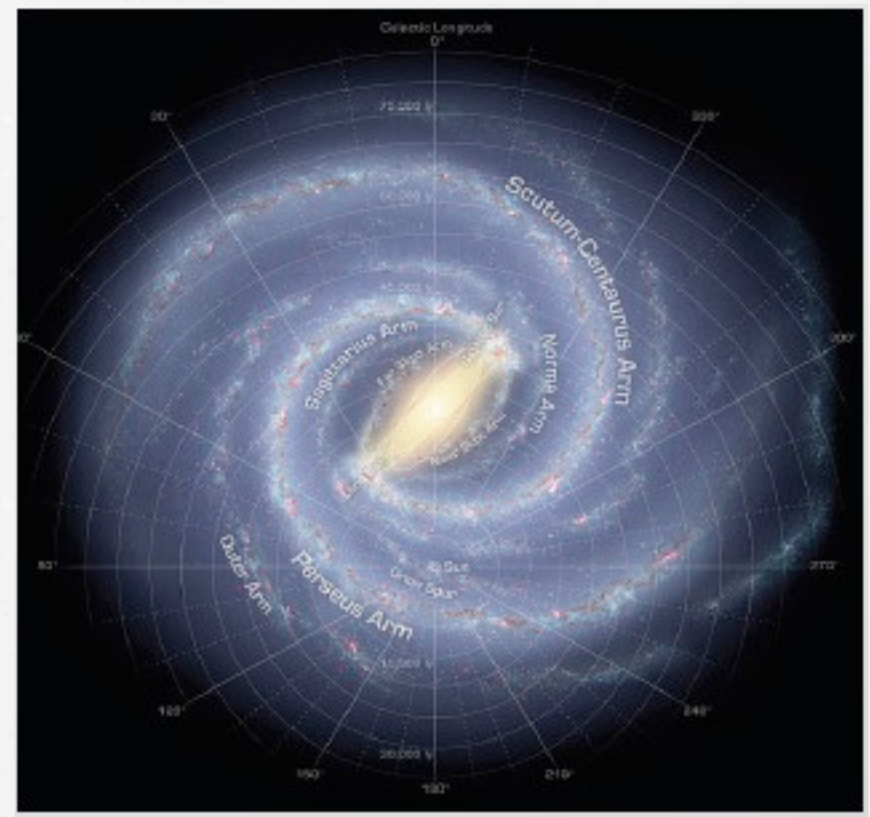
Leiden observatory

QUESTIONS TO BE TACKLED IN THIS RESEARCH

- Details of the parental cluster of the sun
- Understand how it was evolved in the galaxy
- Can we find the siblings of the sun?
- How is the evolution of open clusters in a realistic galactic potential?
- Effect of cluster migration on age and metallicity gradients?

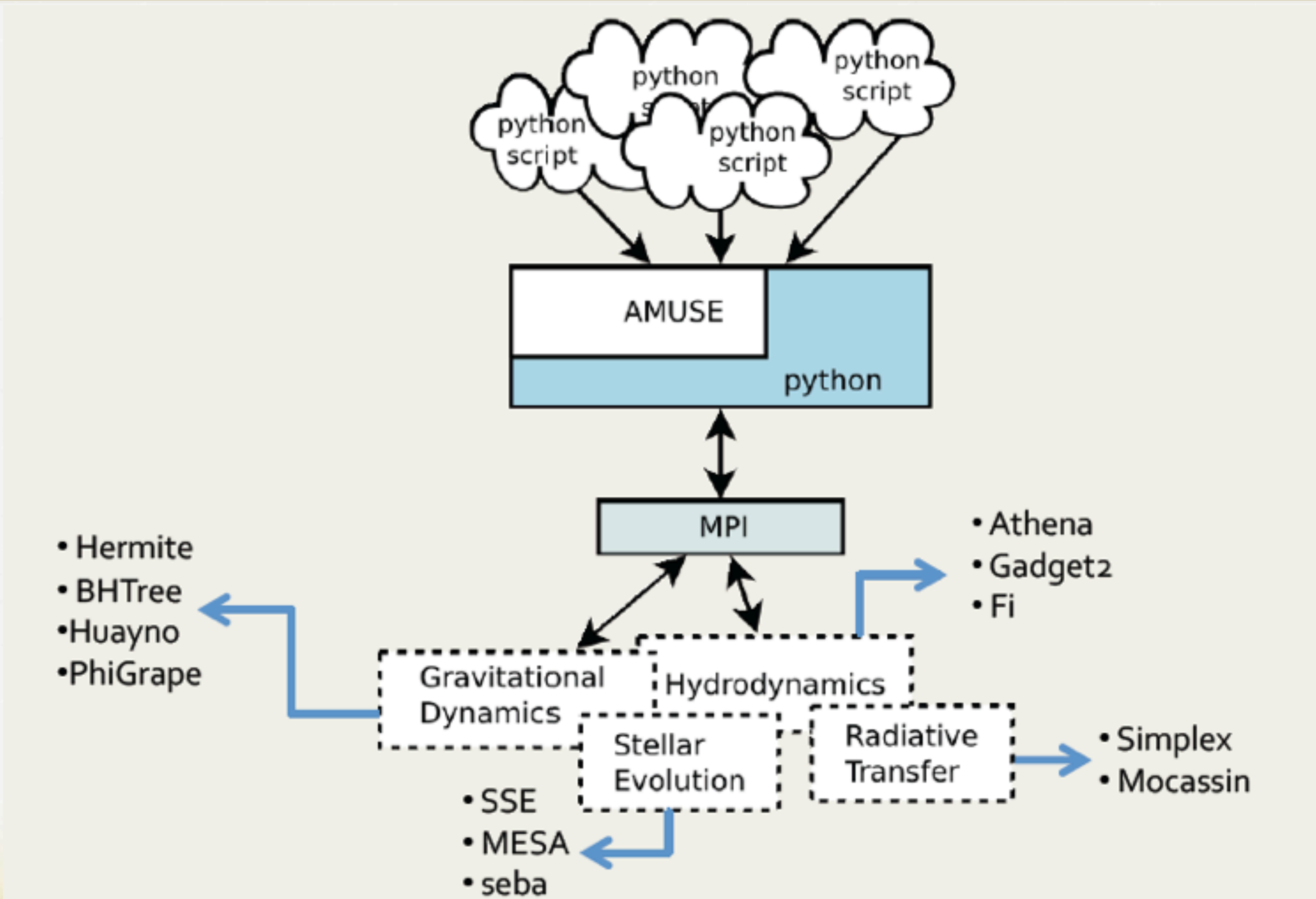
NEEDED

- Realistic simulations



- Combine simulations with chemical tagging

AMUSE


python
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python script
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AMUSE
python
MPI
• Hermite
• BHTree
•Huayno
•PhiGrape
• Athena
• Gadget2
• Fi
Gravitational Dynamics
Hydrodynamics
Stellar Evolution
Radiative Transfer
• Simplex
• Mocassin
• SSE
• MESA
• seba

VARIANCE IN THE INITIAL POSITION OF THE SUN'S BIRTH CLUSTER

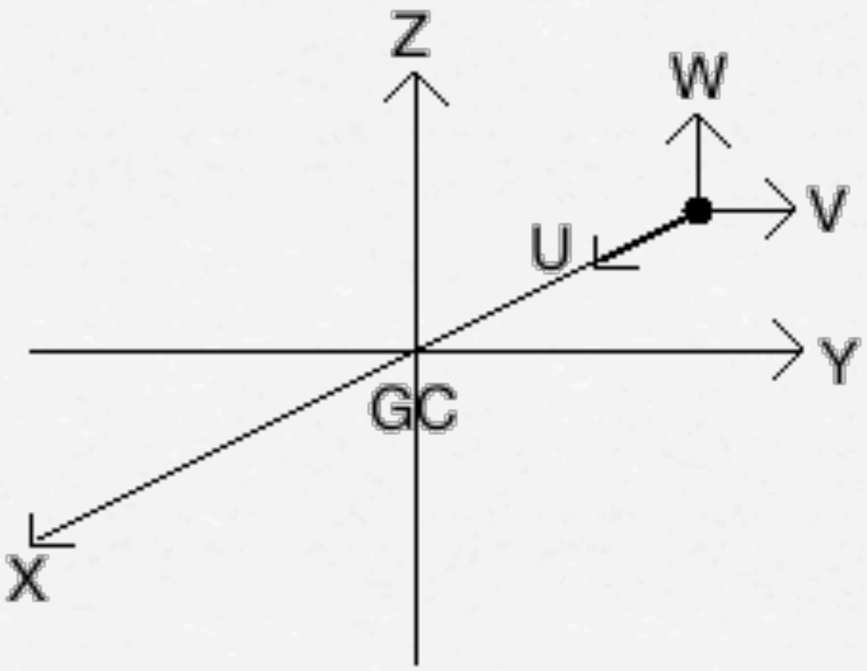
ICs for the Sun's birth cluster:

$500 < M < 3000\ M_\odot$

$0.5 < R < 3$ pc

$M_i\ (M_\odot)$	N	σ_r (pc)	σ_v (km/s)
518.80	1330	3.12	0.35
1059.06	2660	3.16	0.49
2037.0	5300	2.88	0.70

Model for the Milky Way:
Rigid potential

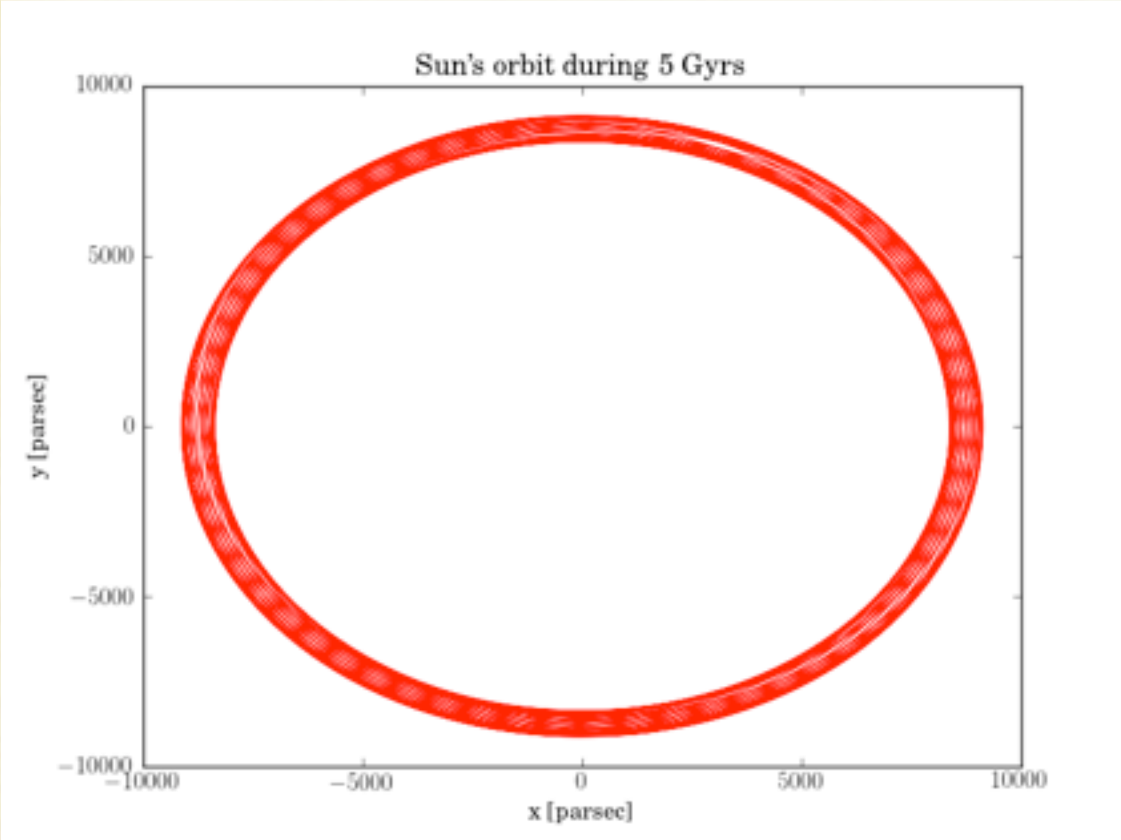


(X,Y,Z)= (-8.5, 0, 0) kpc
(U,V,W)=(9.96, 225.25, 7.07) km/s

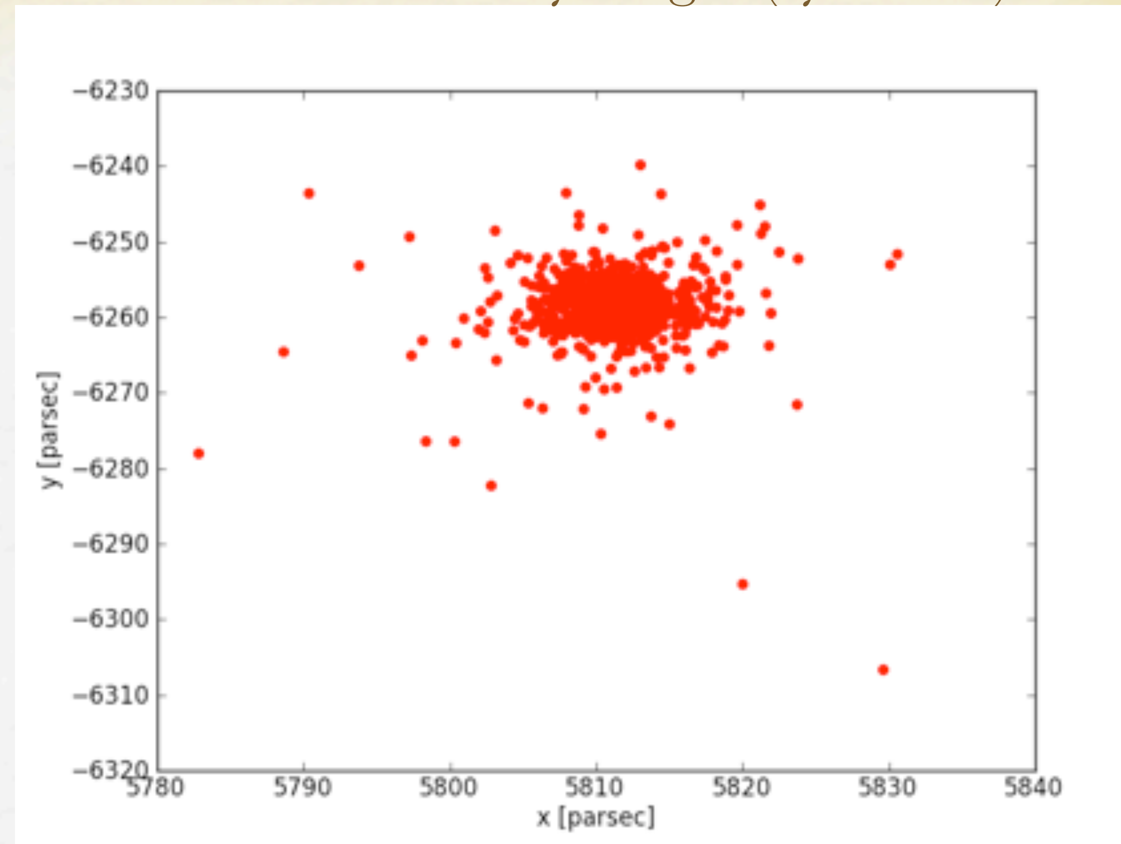
Methodology:

1. Evolve backwards in time, using the present $\vec{r}$ and $\vec{v}$ of the Sun; up to 5 Gyrs.
2. Locate the cluster at the resulting position.
3. Evolve the cluster forwards in time up to 5 Gyrs. (gravity and stellar evolution)
4. Evolve the cluster particles backwards in time up to 5 Gyrs. (as test particles)

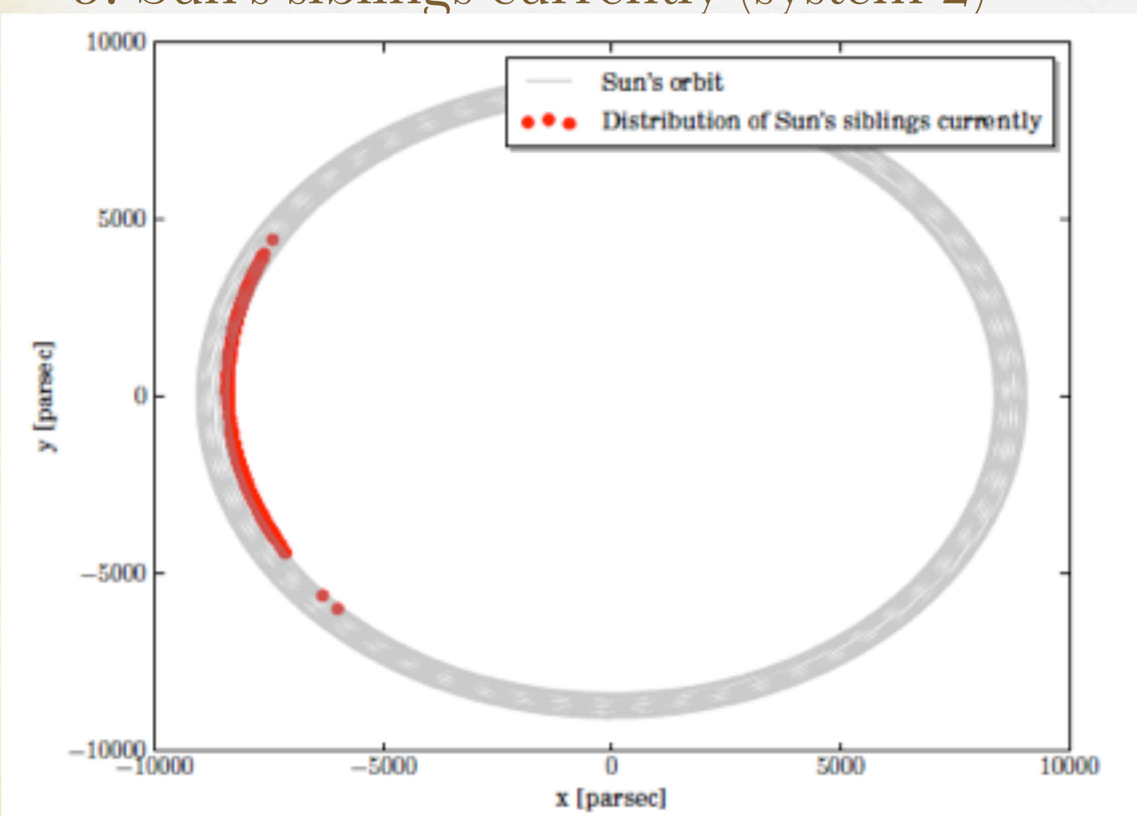
1. Evolution backwards in time



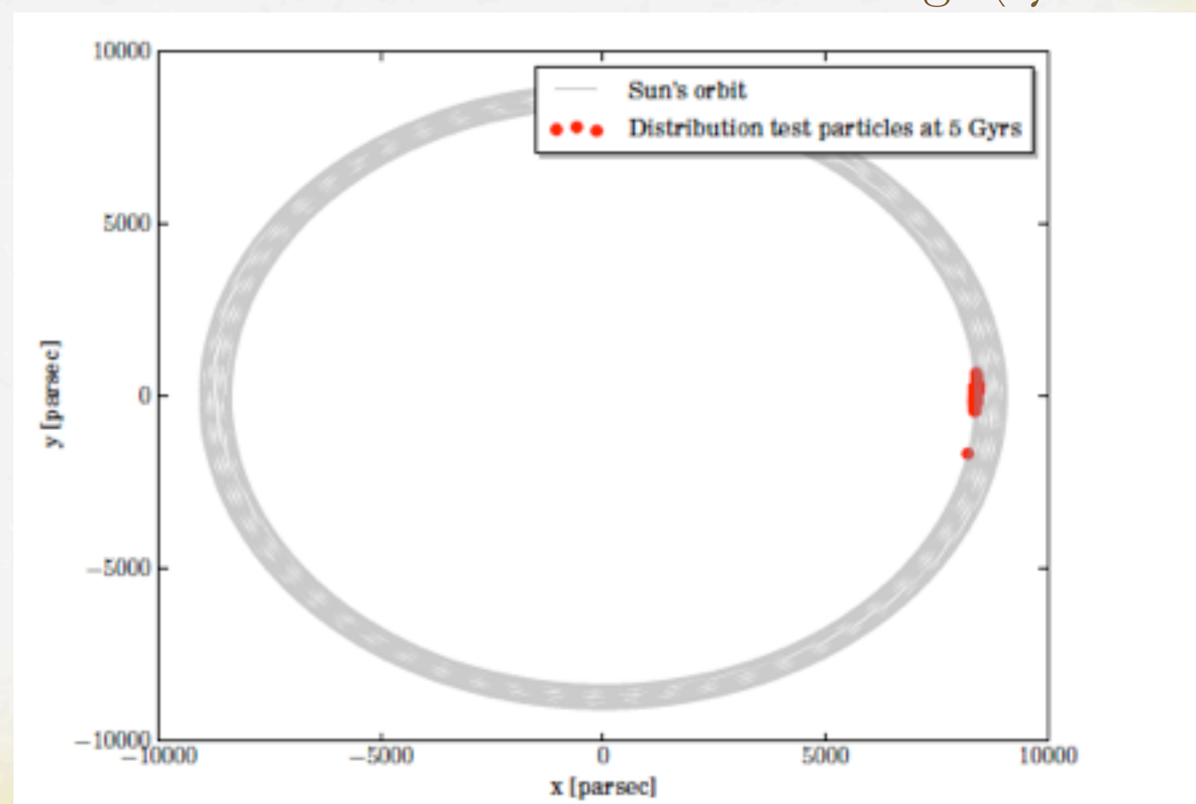
2. Cluster 5 Gyrs ago (system 1)



3. Sun's siblings currently (system 2)



4. Int. backwards in time Sun's siblings (system 3)



M=500 $M_\odot$; R=3 pc; N=1300   M=1000 $M_\odot$; R=3pc; N=2600   Kroupa IMF

M_i	V_{GC}	σ_r	σ_θ	σ_z	σ_{vr}	σ_{vt}	σ_{vz}
500	0.2	38.18	0.19	6.97	2.09	0.23	0.34
	0.5	32.35	0.33	3.77	2.00	0.18	0.69
	1.0	21.32	1.09	7.12	0.45	0.21	0.69
	1.2	79.46	9.73	3.80	0.72	1.51	0.87
	1.5	151.0	0.37	17.68	1.31	0.72	0.20
1000	1.0	30.0	2.24	9.37	0.79	0.27	1.26
2000	1.0	45.07	5.37	14.57	1.78	0.48	2.50

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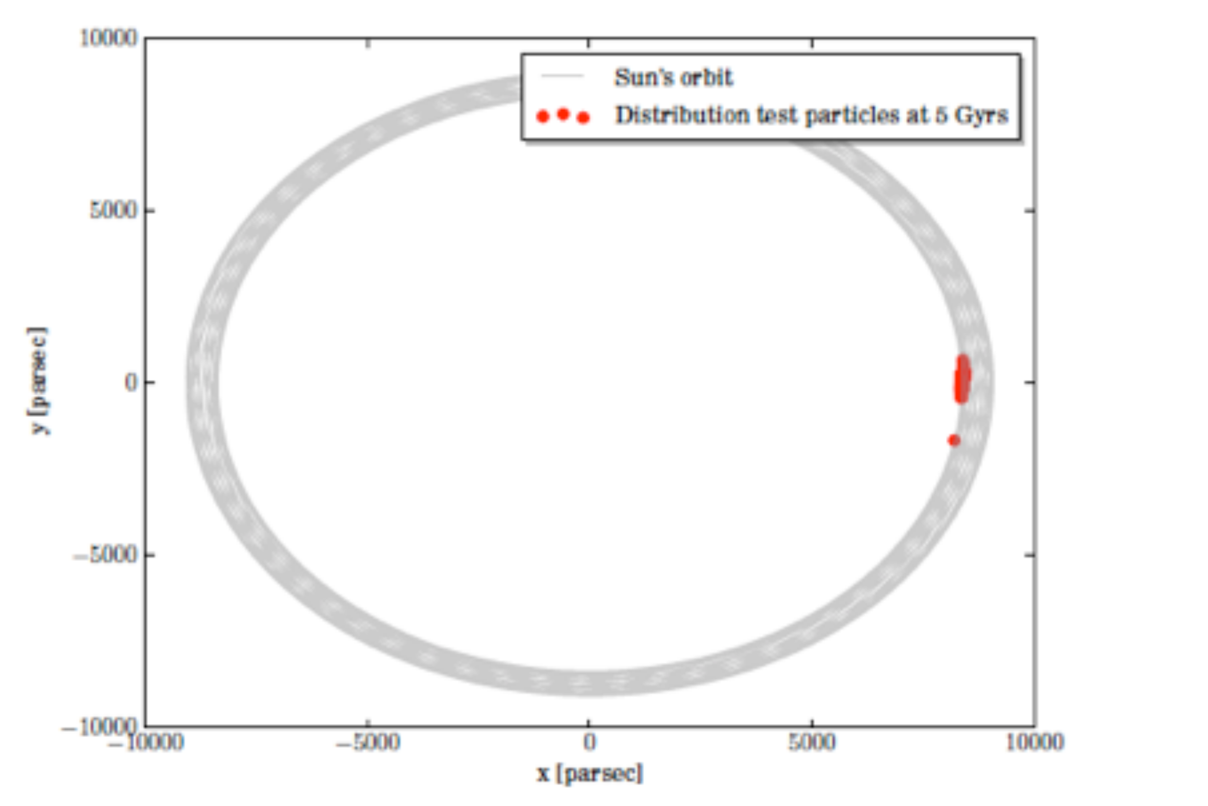

1. Radial dispersion depend on initial tangential velocity of cluster and also on its initial mass.

2. No matter how eccentric the orbit is, we will always be able to determine very accurately the initial position and velocity of a cluster when we take a rigid potential model for the galaxy.

3. The internal dynamics and evolution of the cluster does not affect the estimation of the initial position of the Sun's birth cluster.

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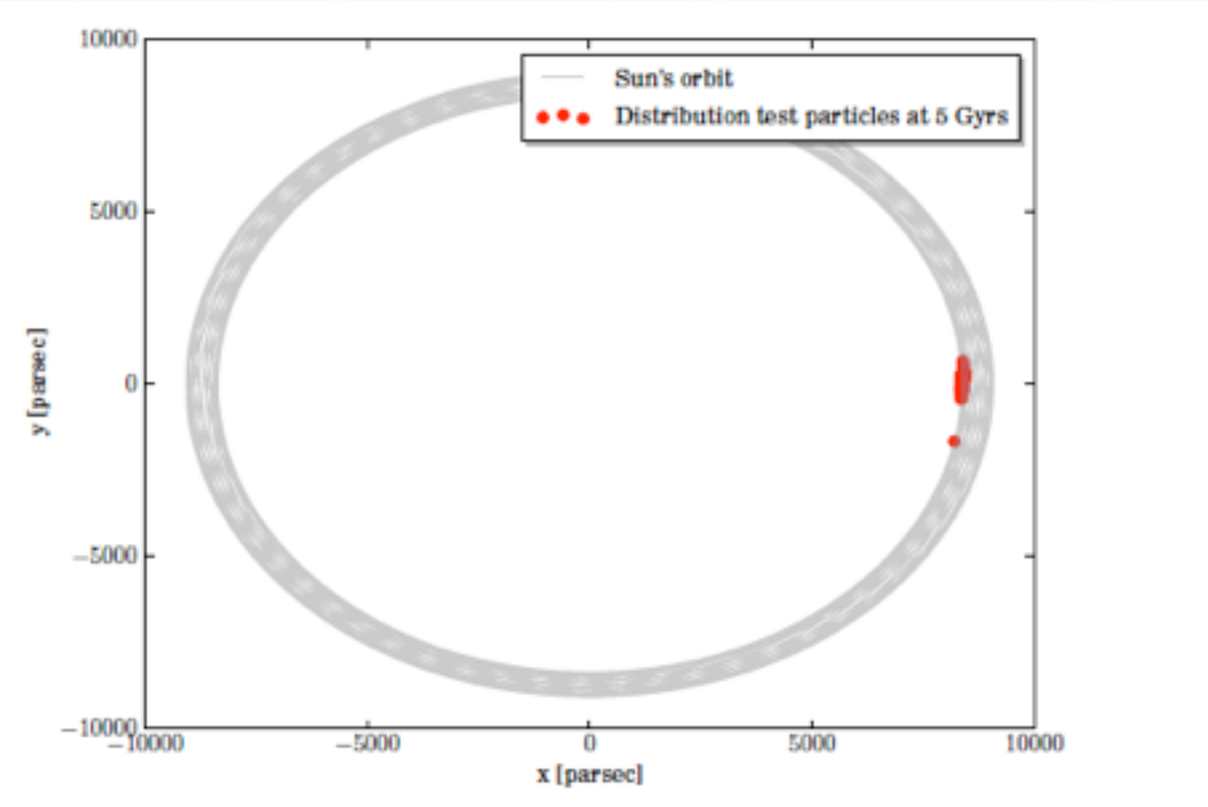

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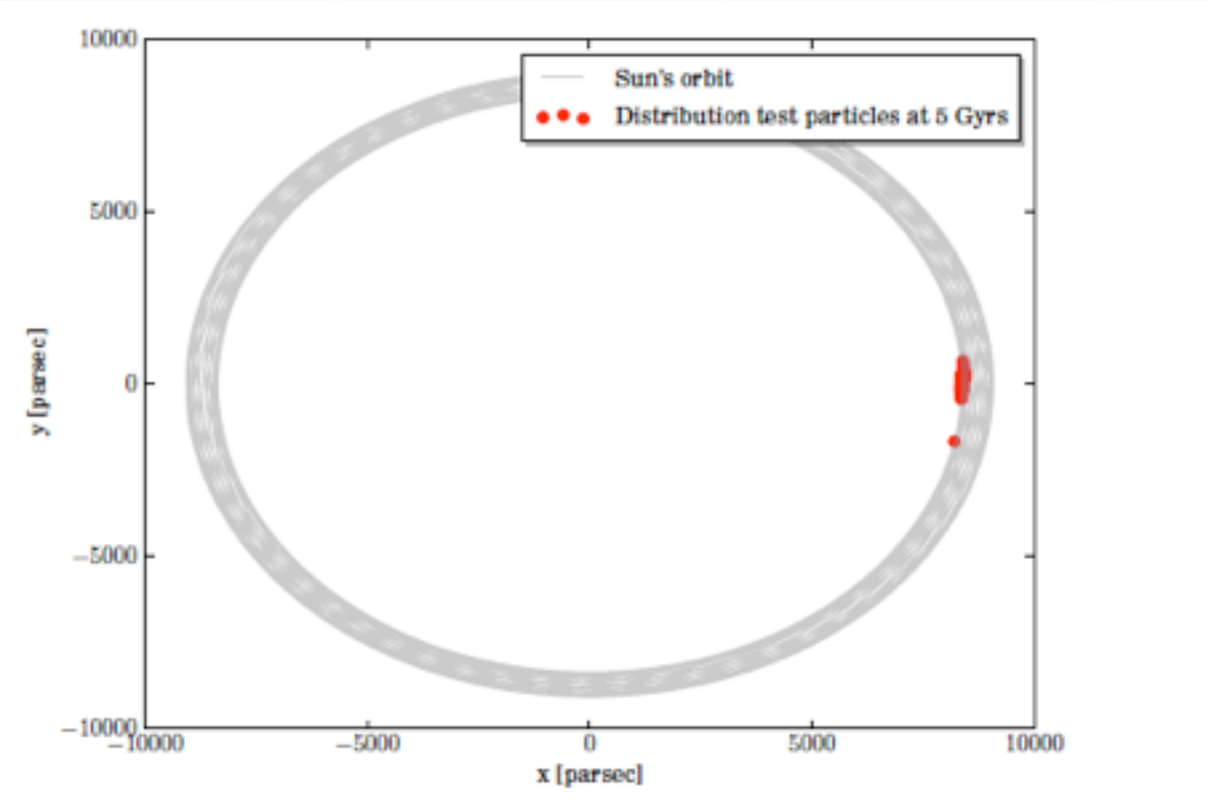

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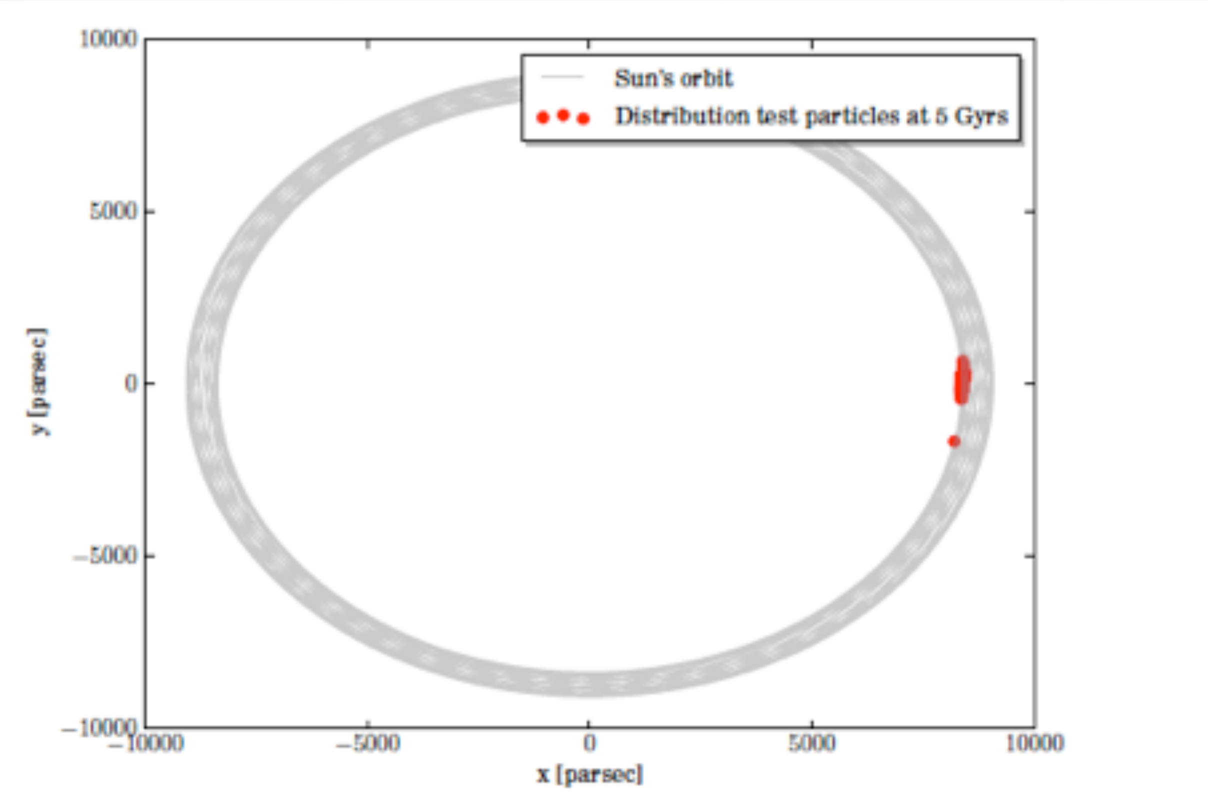

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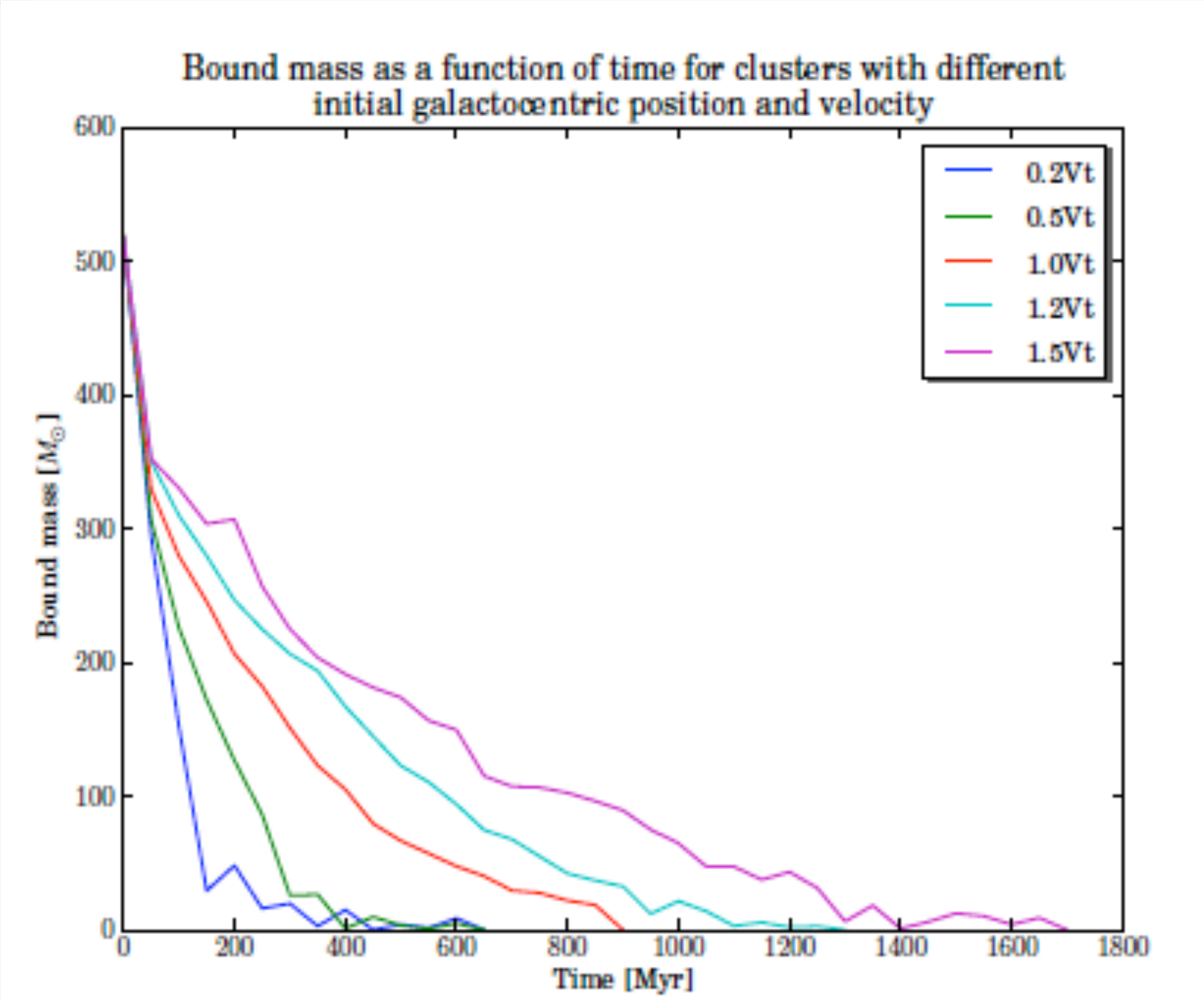
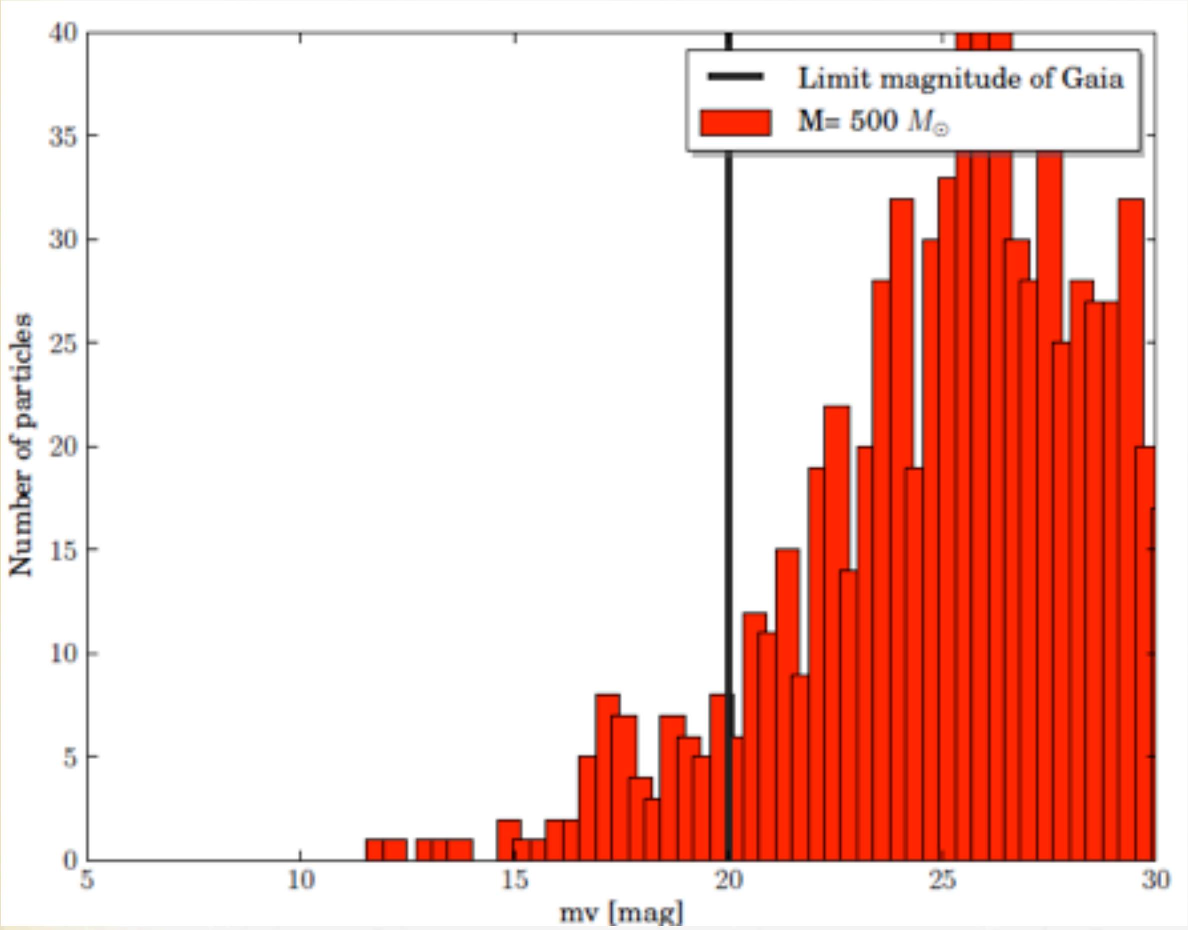
BOUND MASS IN THE SIMULATED CLUSTERS

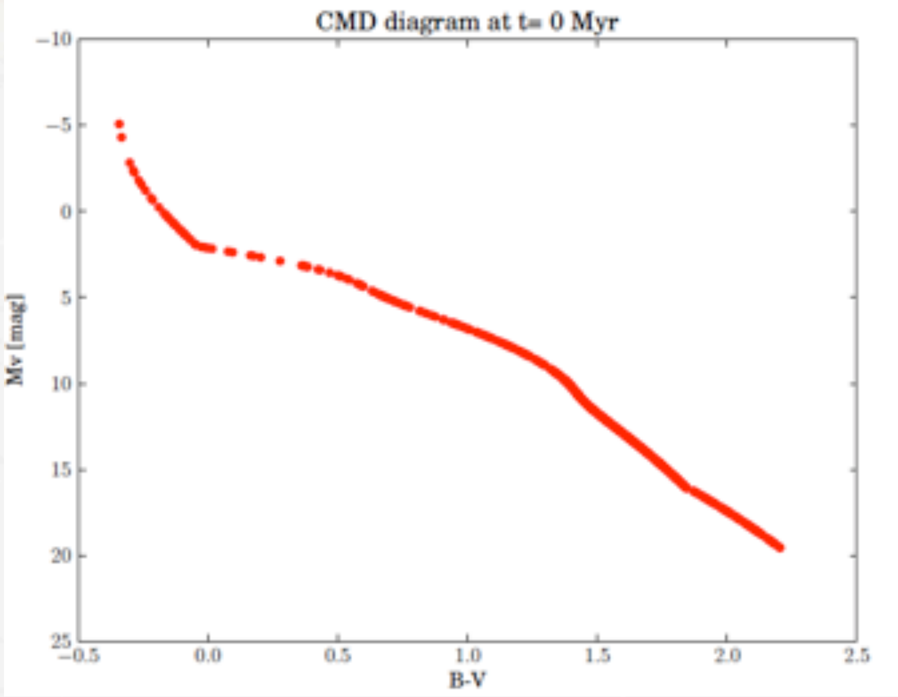


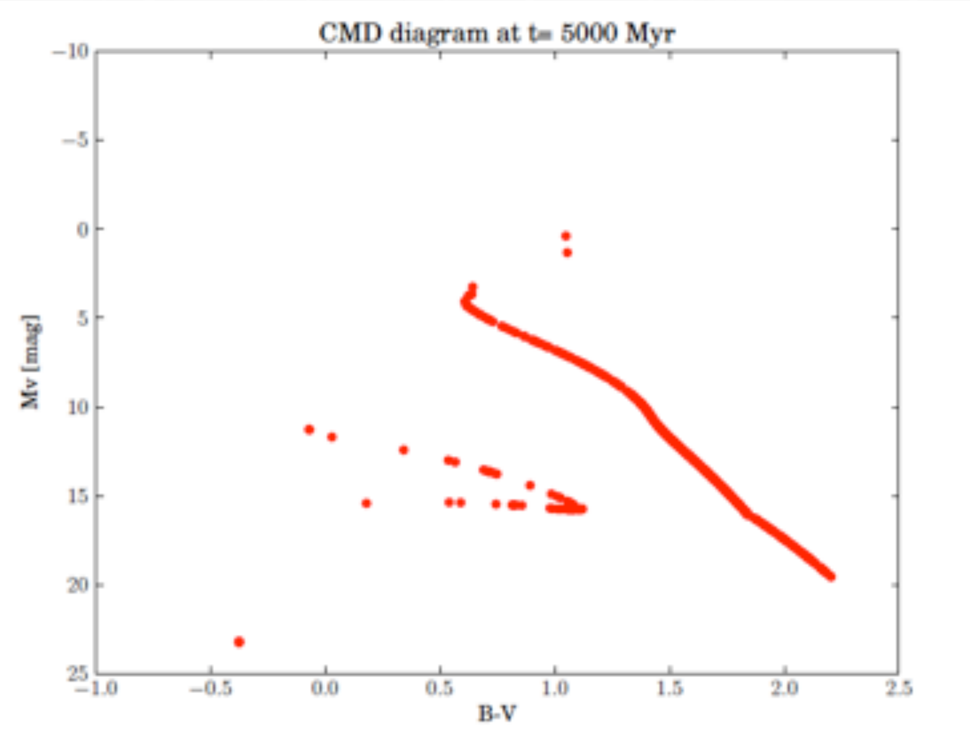
In case of the Sun's birth cluster:
M= 500 $M_\odot$, Lt= 900 Myrs
M= 1000 $M_\odot$, Lt= 1450 Myrs
M= 2000 $M_\odot$, Lt= 2750 Myrs

Here, R= 3 pc

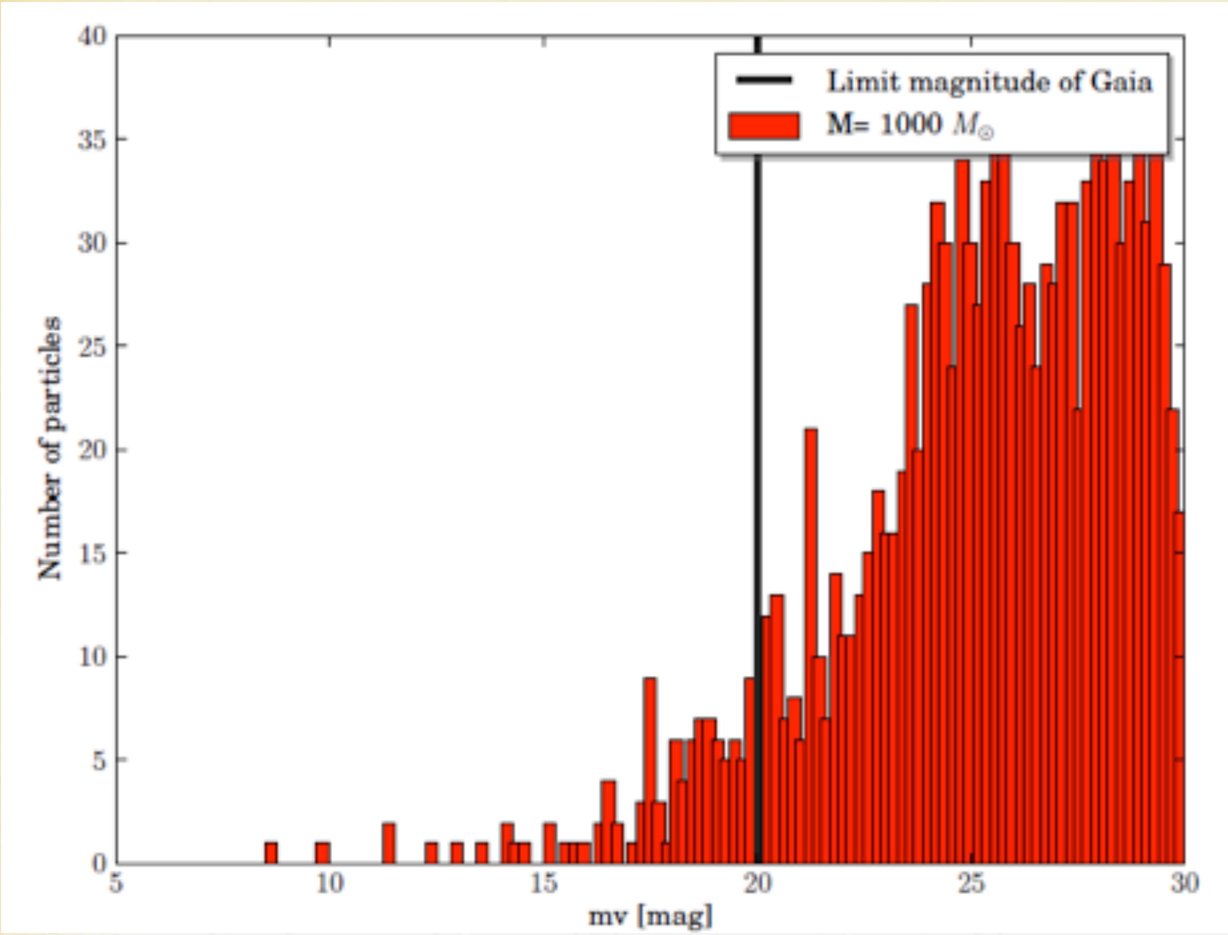
STARS OBSERVED

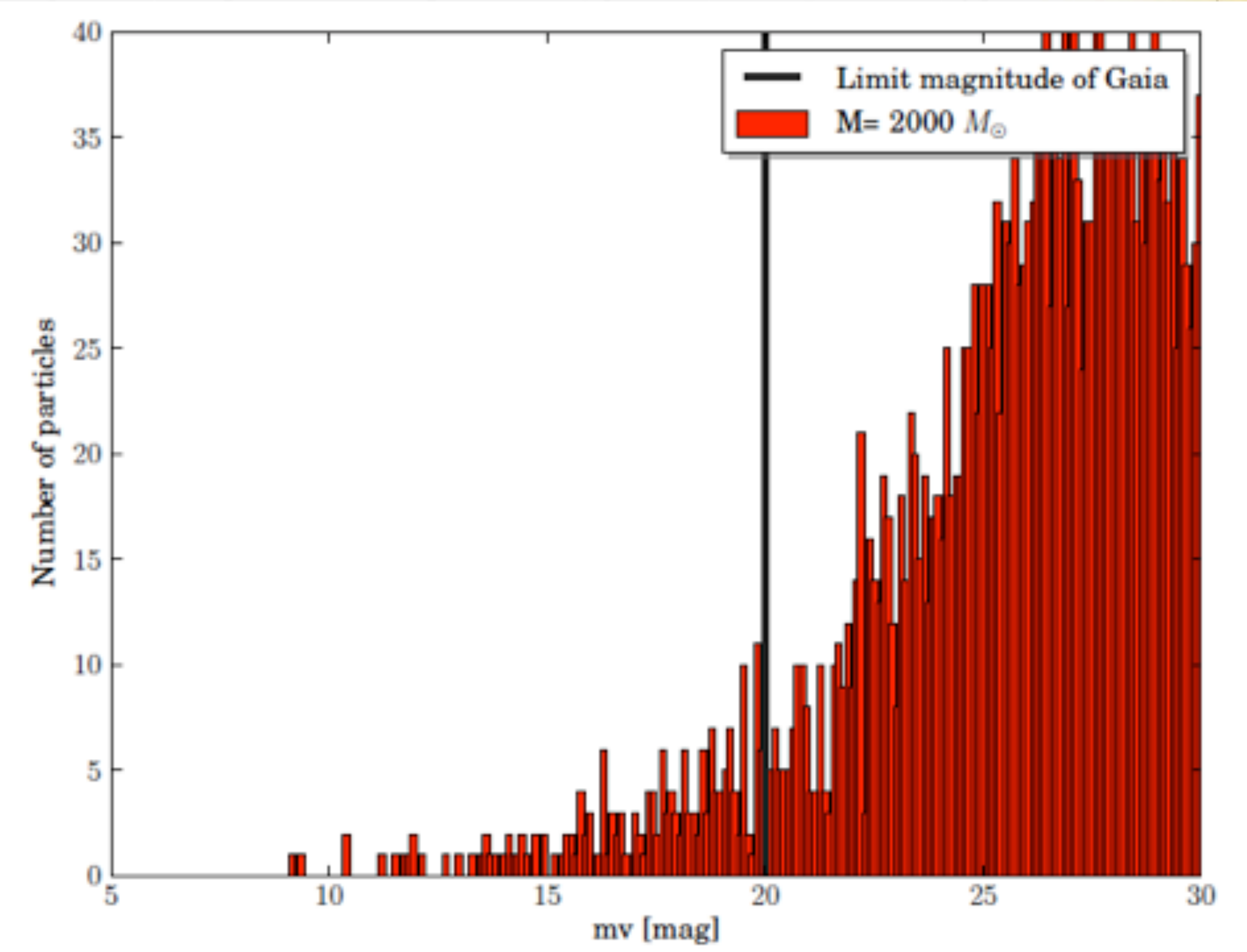






M= 500 $M_\odot$, N= 66
R= 3 pc

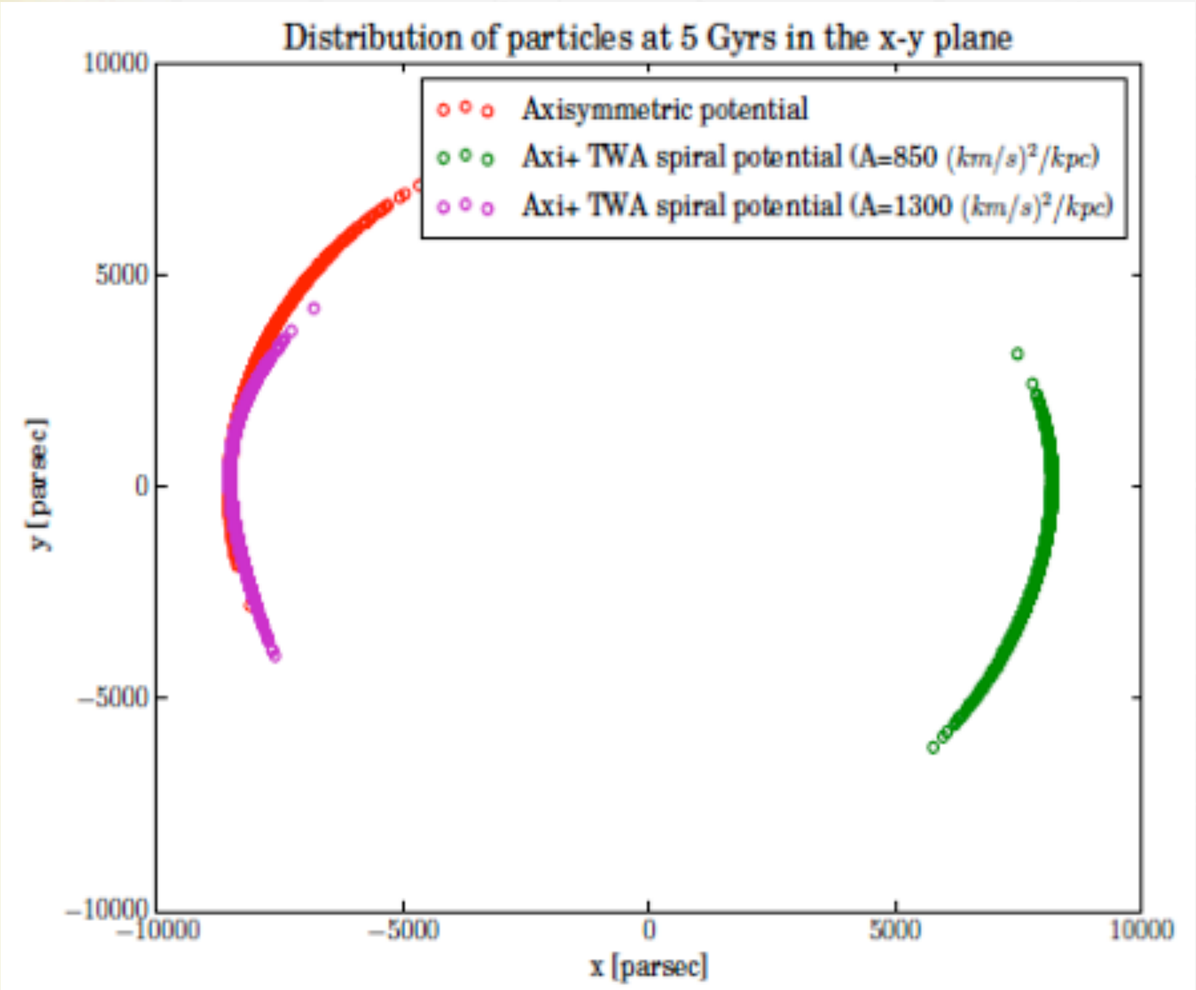


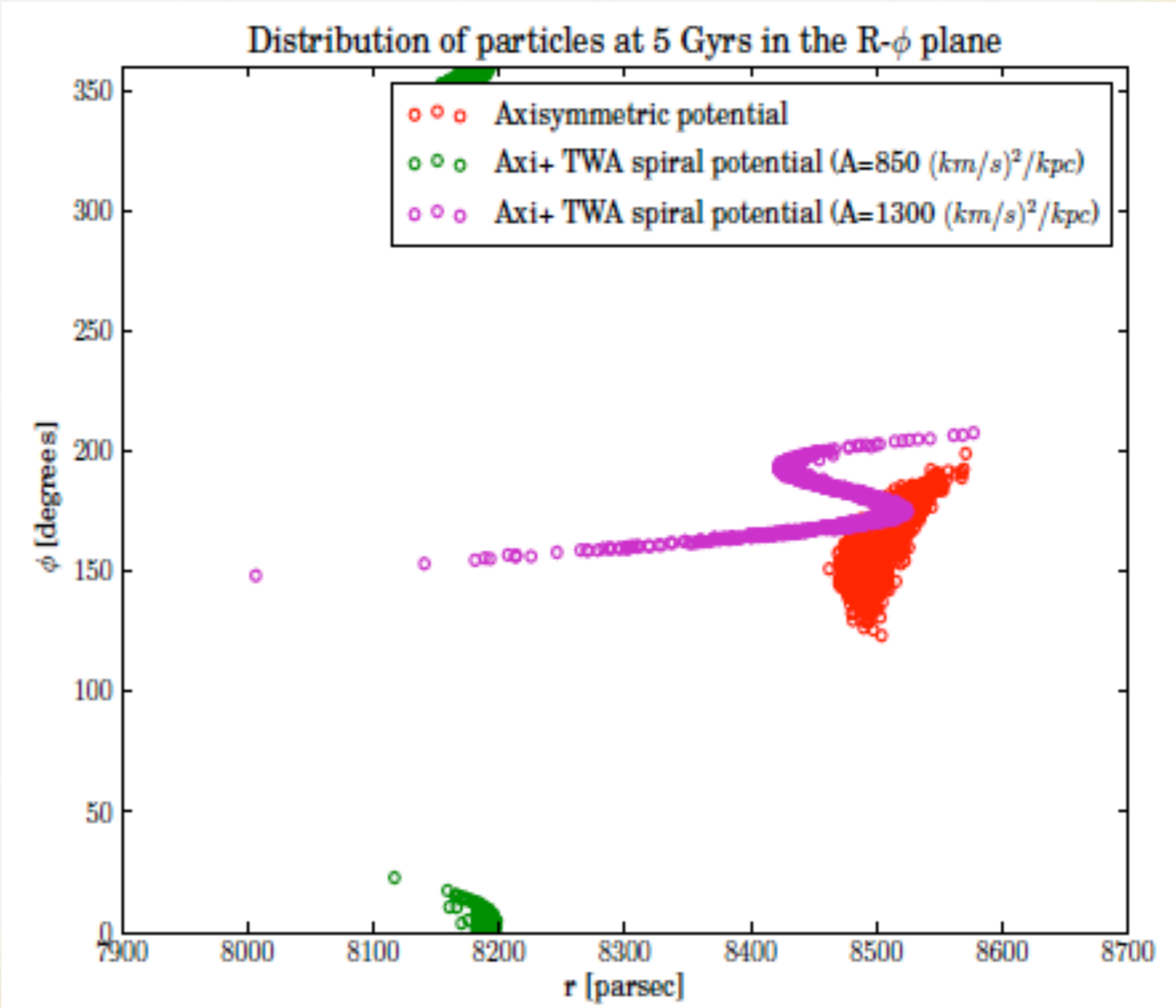


M= 1000 $M_\odot$, N= 105
R= 3 pc

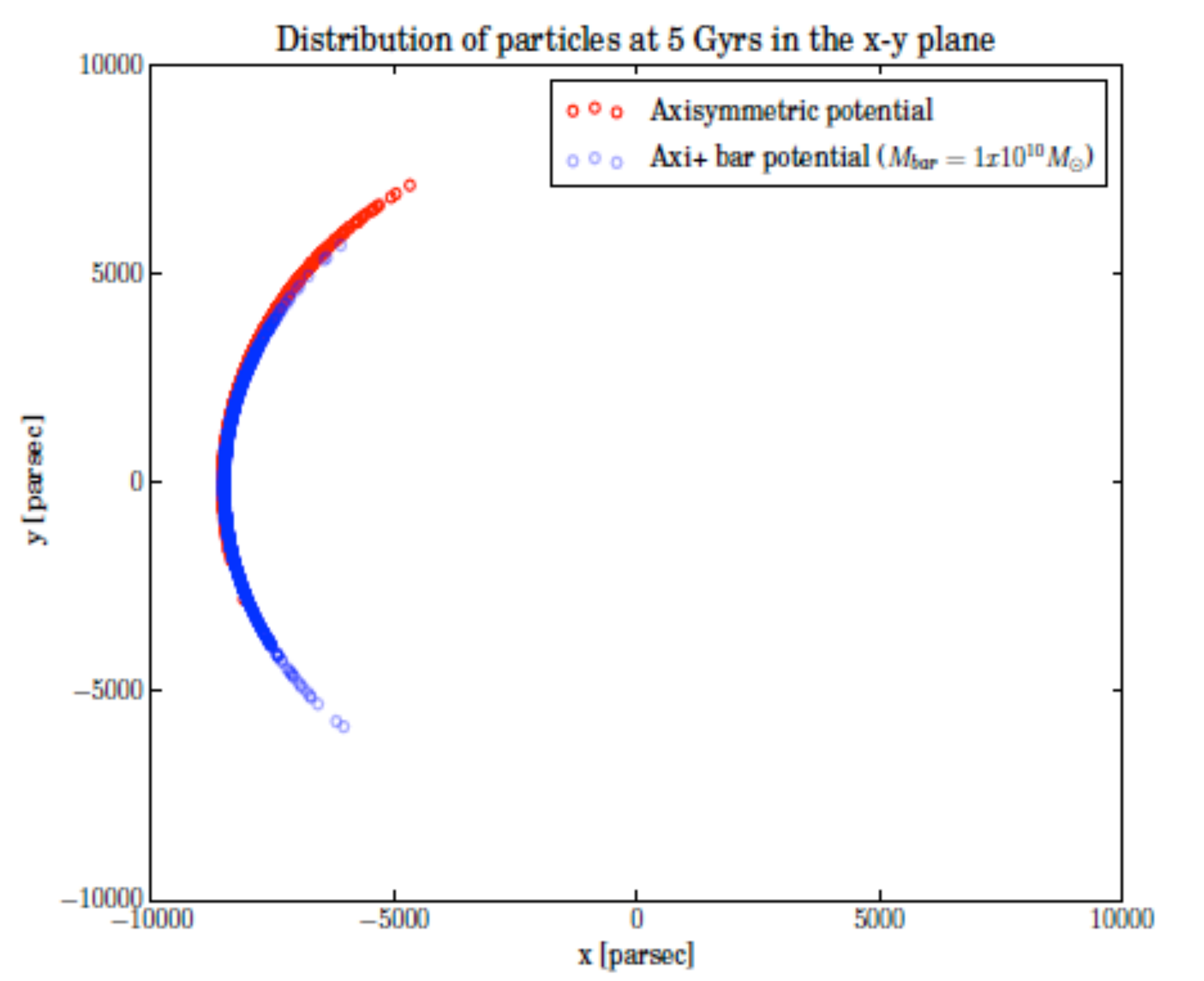
M= 2000 $M_\odot$, N=185
R= 3 pc

INFLUENCE OF SPIRAL ARMS AND A CENTRAL BAR





Parameters TWA spiral: (Antoja et al. 2011)
N= 100
Pitch angle= 15.5
$\Omega_b = 20kms^{-1}kpc^{-1}$
$A_s = 850, 1300(kms^{-1})^2kpc^{-1}$

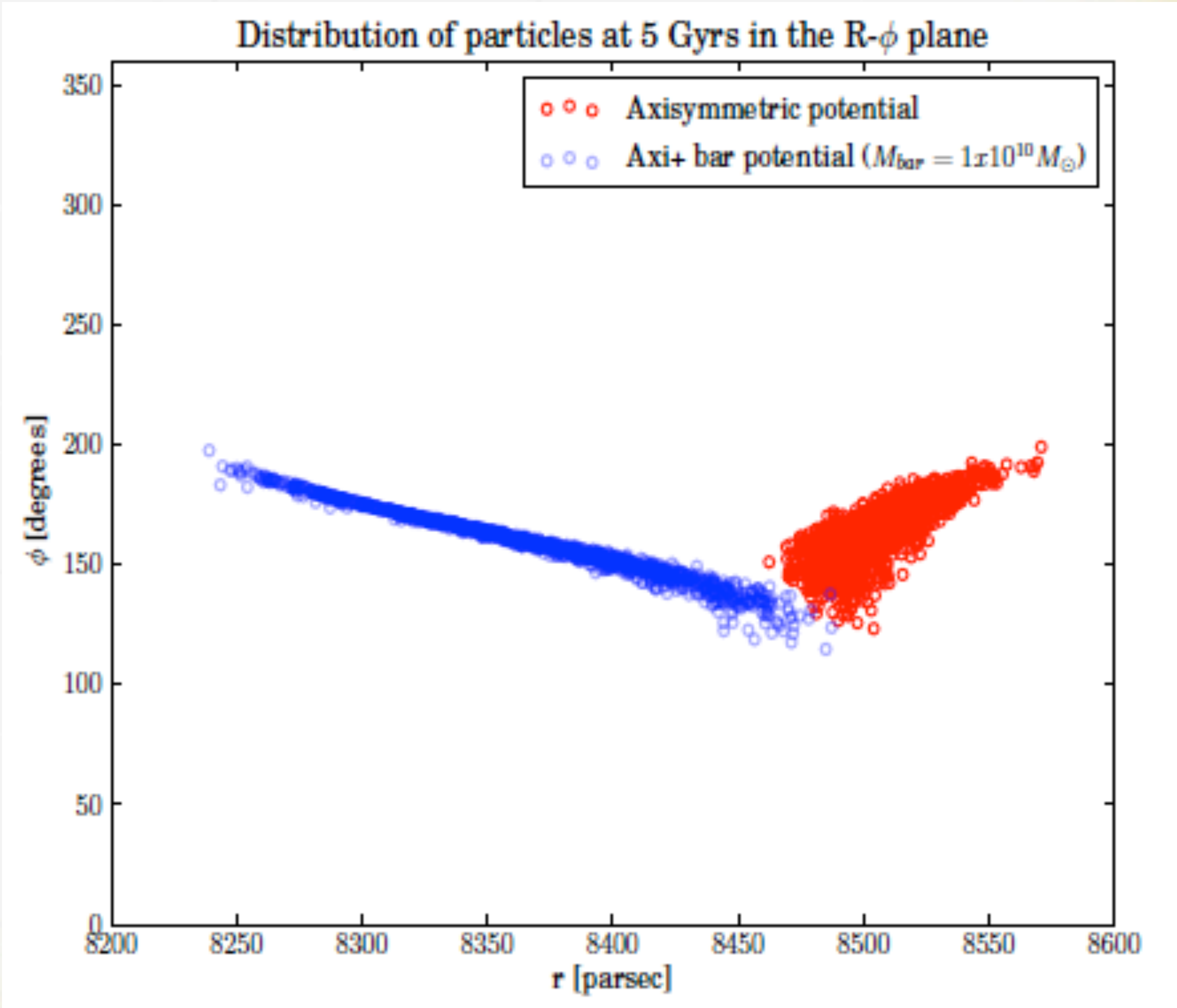


Bar Ferrers: (Romero-Gómez et al. 2011)

a=3.13 kpc
b=c= 1 kpc

$M_b = 1 \times 10^{10} M_{\odot}$

$\Omega_b = 50 kms^{-1} kpc^{-1}$



Such a bar does not produce strong effects in the final distribution of the particles

CONCLUSIONS

- Radial dispersion depends on the initial tangential velocity of cluster and its mass.
- No matters how eccentric the orbit, we always can determine very accurately the initial position and velocity of a cluster when we take a smooth axisymmetric model for the galaxy.
- The internal dynamics and evolution of the cluster does not affect the estimation of the initial position of the Sun's birth cluster.
- A central bar or a spiral arm produces radial migration in the galaxy.

Thank you