# Evolution of the dSphs

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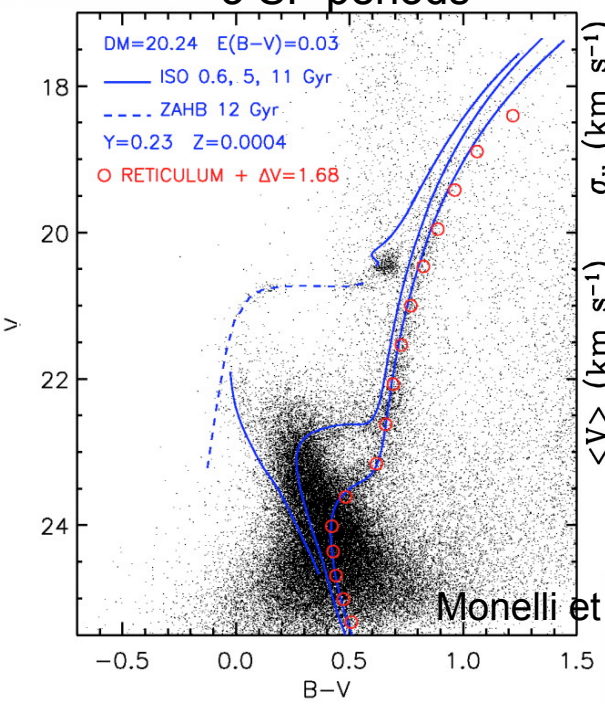
## CARINA

N>68000 (phot.)

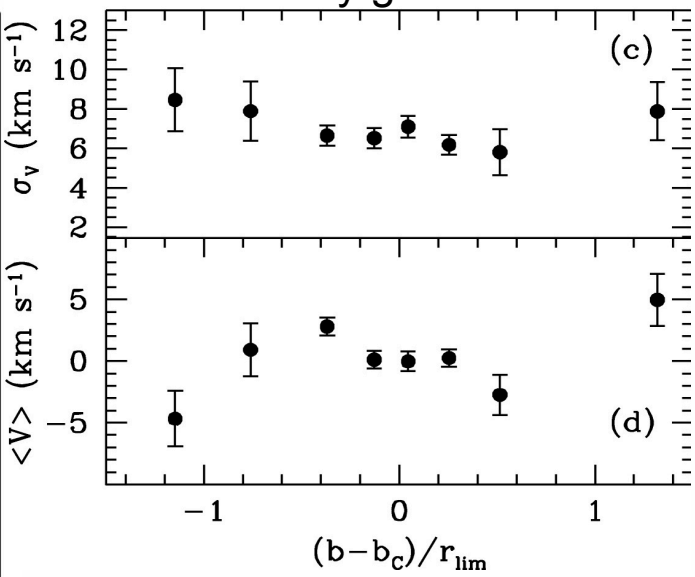
3 SF periods




Monelli et al. 2003

Increasing v. dispersion

Velocity gradient



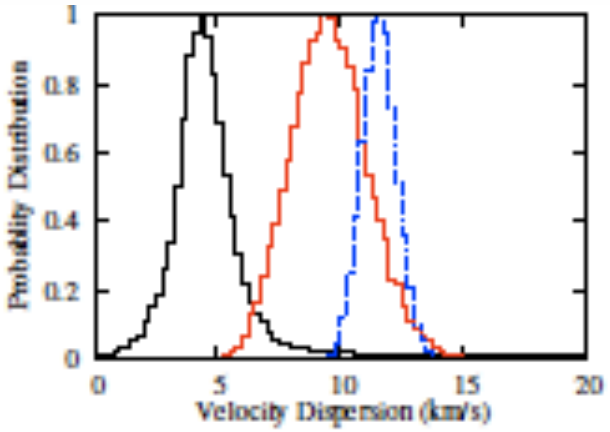

Muñoz et al. 2006

## Ursa Minor

Elongated

Only old stars

Kinematically cold substructure



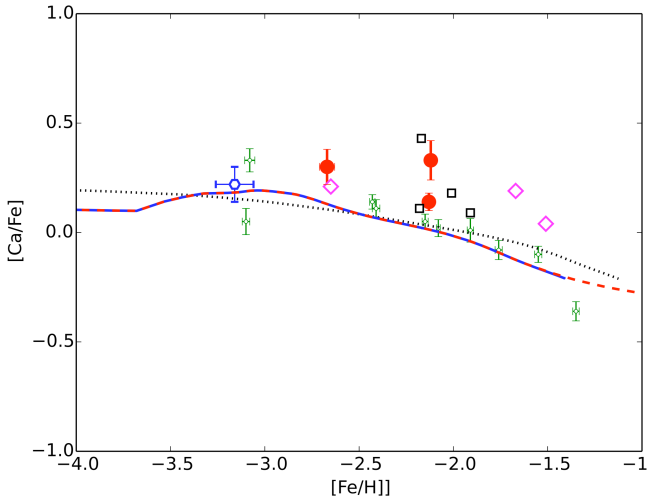

Pace et.al 2014

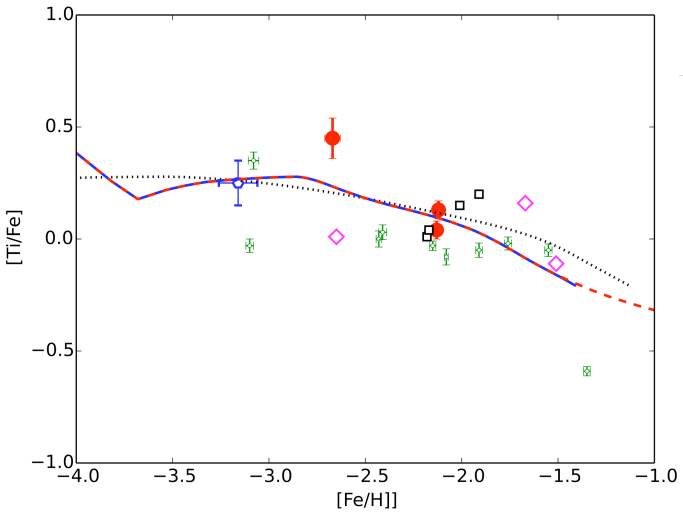
Tidally disrupting?
Accretion events?
Similar to the building blocks?

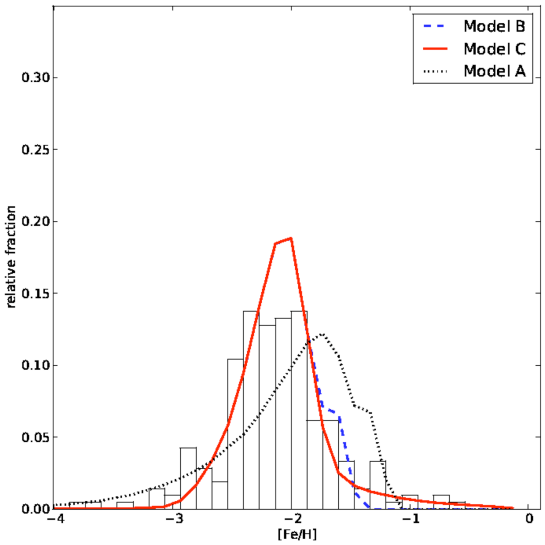
## MASS:

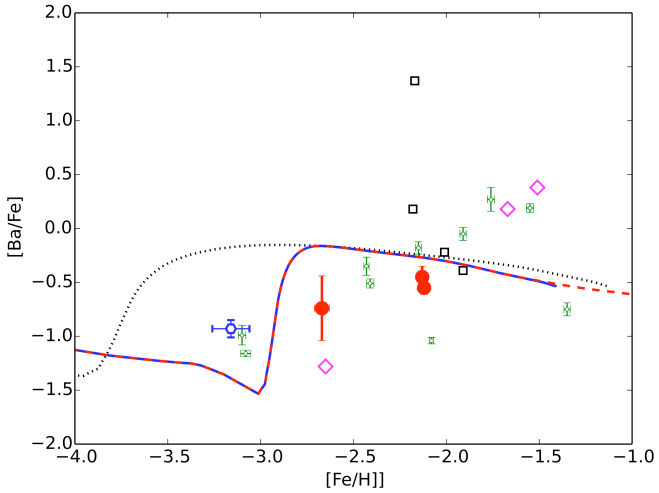
Jeans modelling: EQUILIBRIUM, ISOTROPY?
Muñoz et al. 2008, MFL: DEGENERACY?

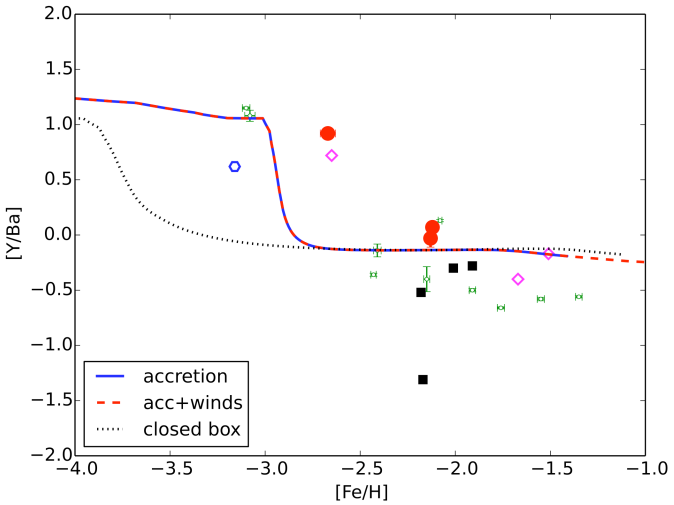
# Ursa Minor abundances (Keck/HIRES)



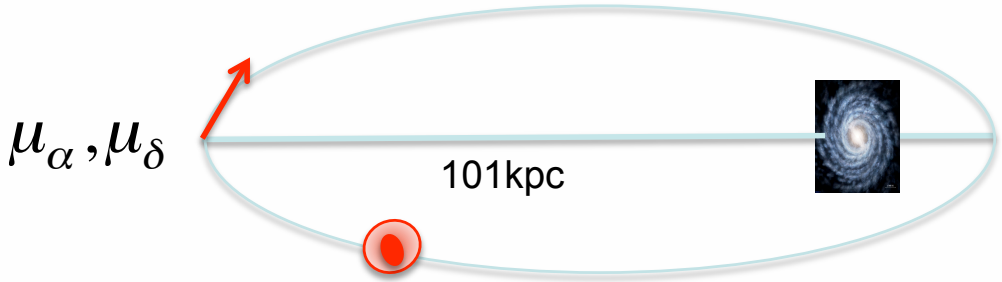




Ural et al. 2014 (submitted)

Literature data: Kirby+(2012), Cohen+(2010), Sadakane+(2004), Shetrone+(2001)

# MCMC (Metropolis-Hastings)




N Body simulation

$$L(\chi^2_{\Sigma,\sigma}) = e^{-\frac{\chi^2_{new} - \chi^2_{old}}{2}}$$

Accept

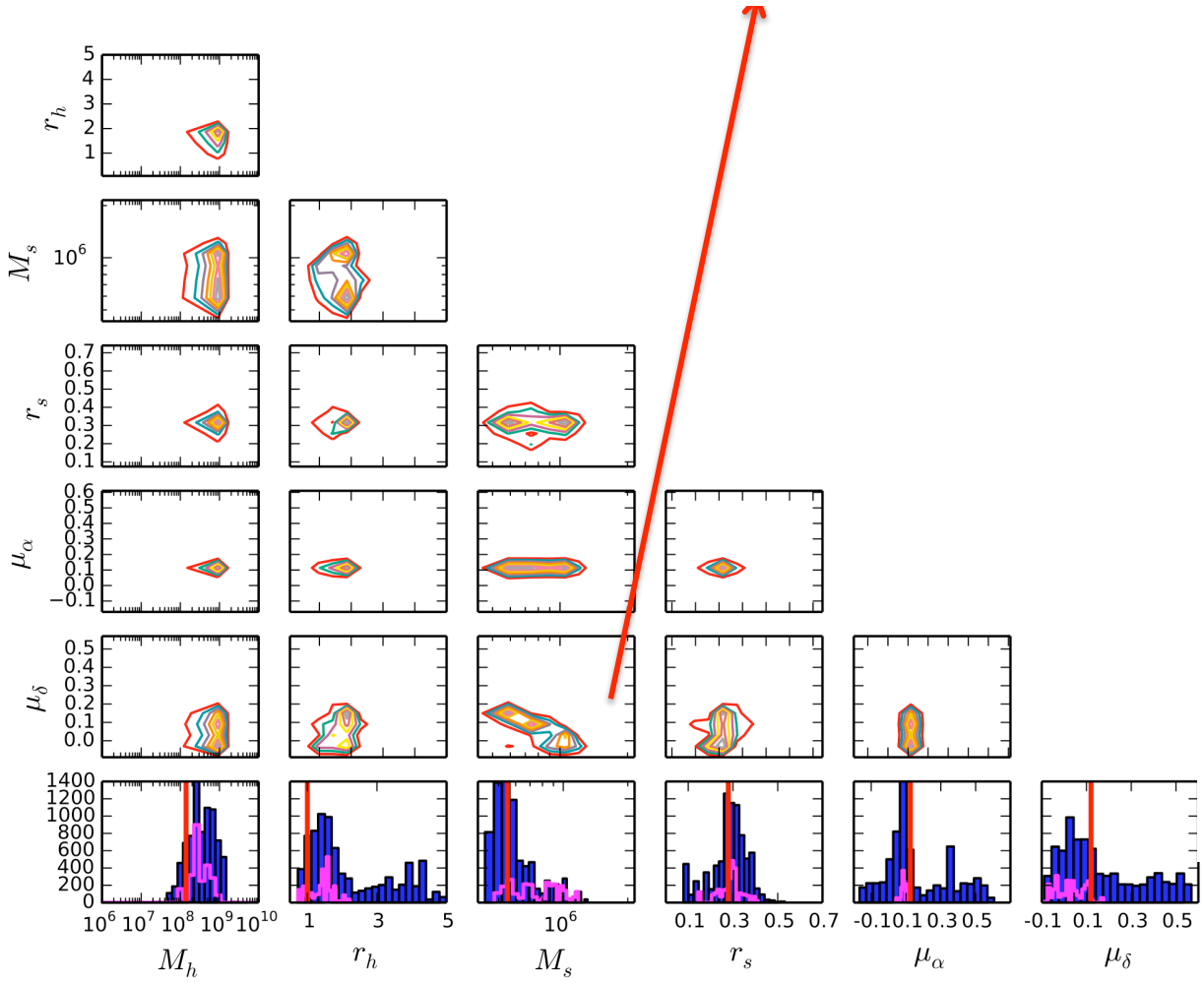
$$p_n = p_{acc} + dp \cdot ran$$

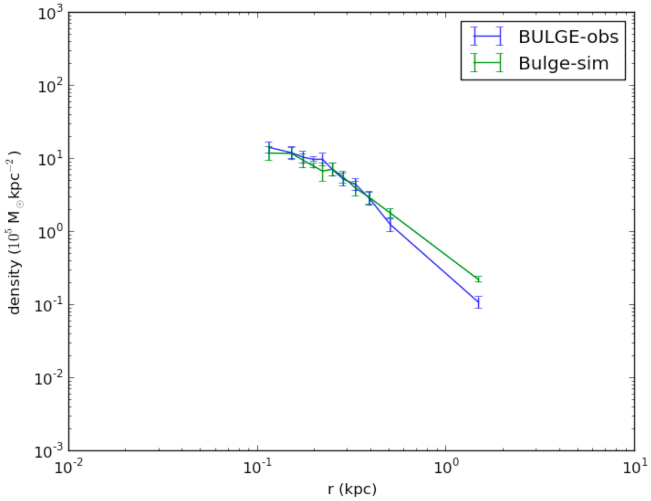
| | |
|---|---|
| $\mu_\alpha$ | $= 22 \pm 13 \text{mas/cent} (3\sigma\ CI)$ |
| $\mu_\delta$ | $= 24 \pm 11 \text{mas/cent} (3\sigma\ CI)$ |
| $M_*$ | $\leq 5 M_{obs}$ |
| $r_*$ | $[0.2\, r_{*_o},\ 2 r_{*_o}]$ |
| $M_{DM}$ | $[10^6 M_{sun},\ 10^{10} M_{sun}]$ |
| $r_{DM}$ | $[r_*,\ 5\text{kpc}]$ |

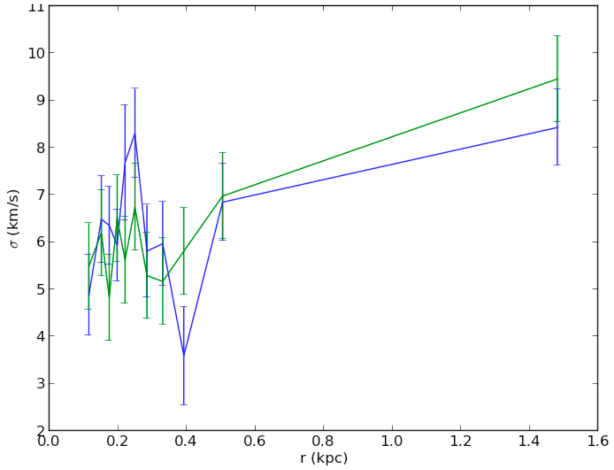
Codes used:
Orbit, Lux
falcON, Dehnen
PkdGRAV, Staedel

# Artificial Data: Cusps

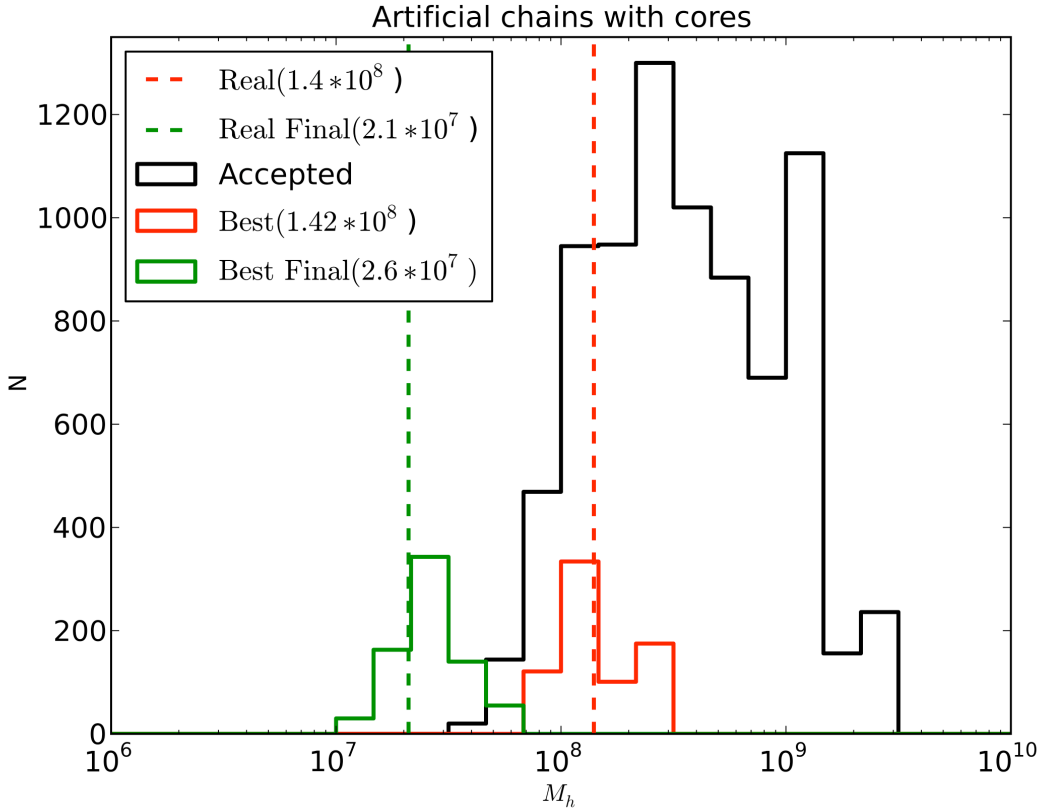
Degeneracy between proper motion and Ms emphasised by noise in the outermost data points

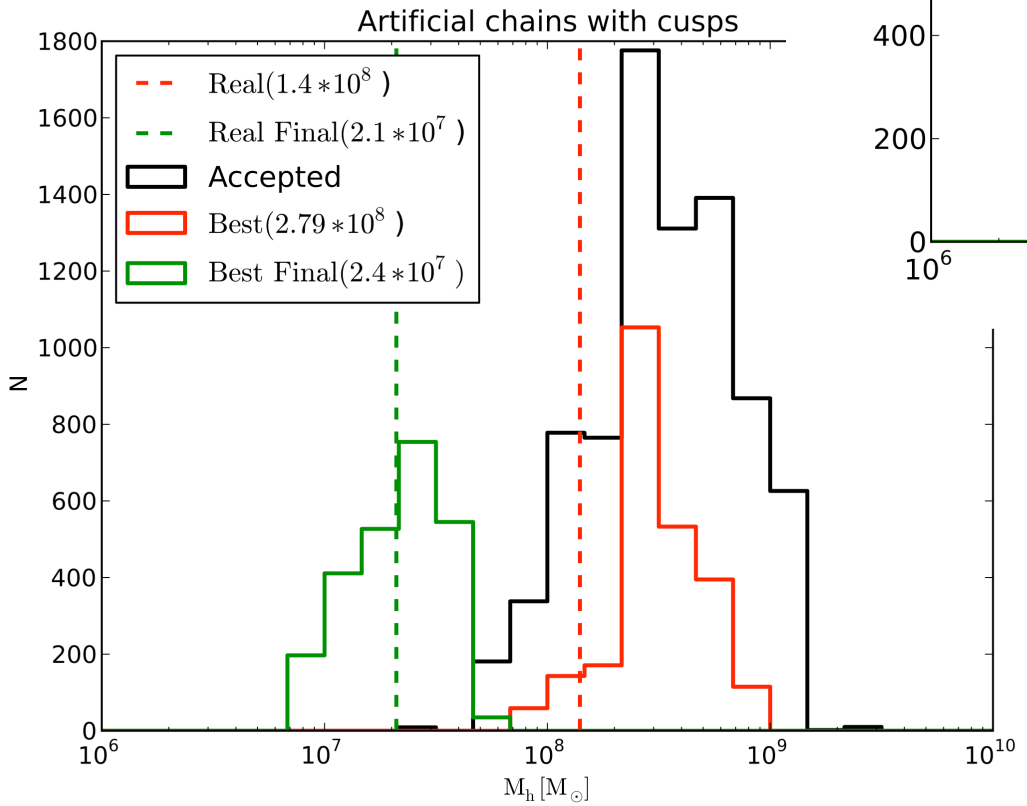


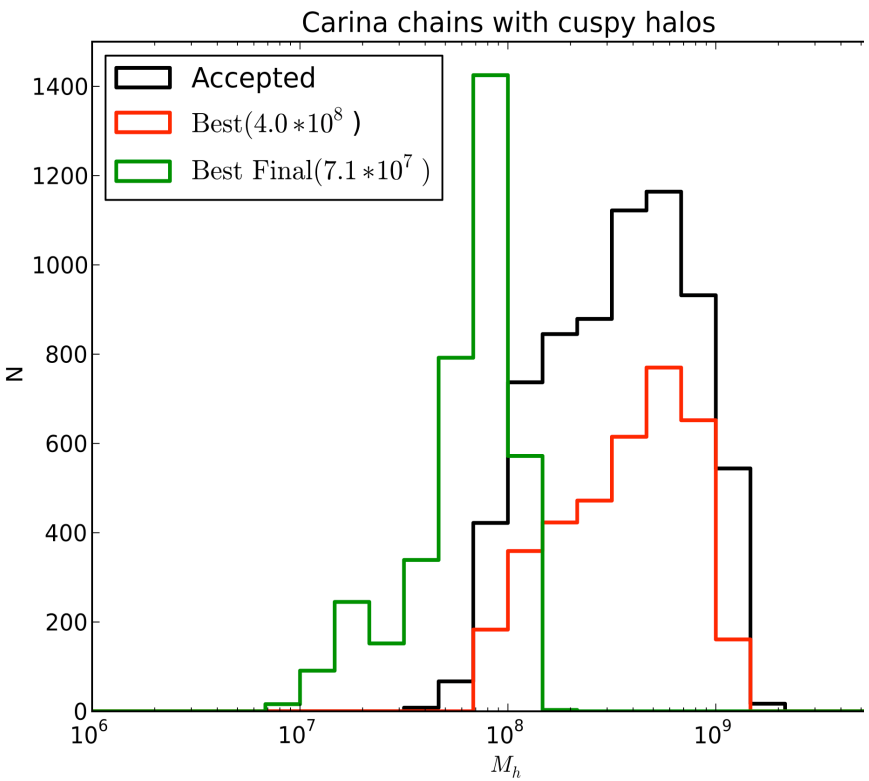



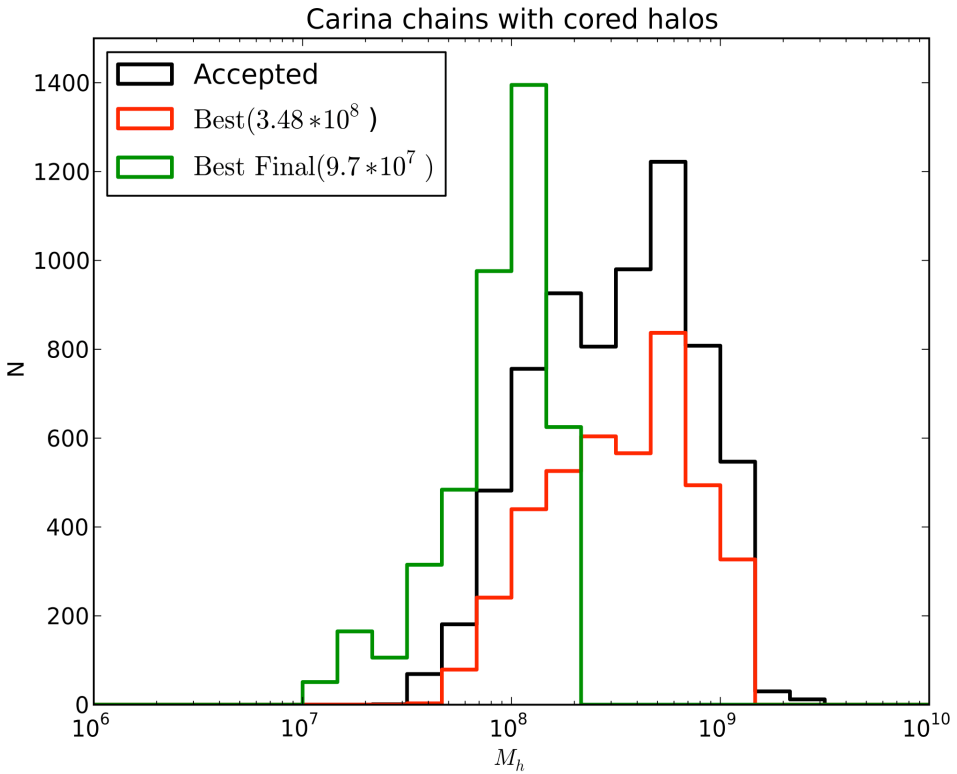
# Recovering the Mass for Artificial Data



# Mass Estimate for Carina

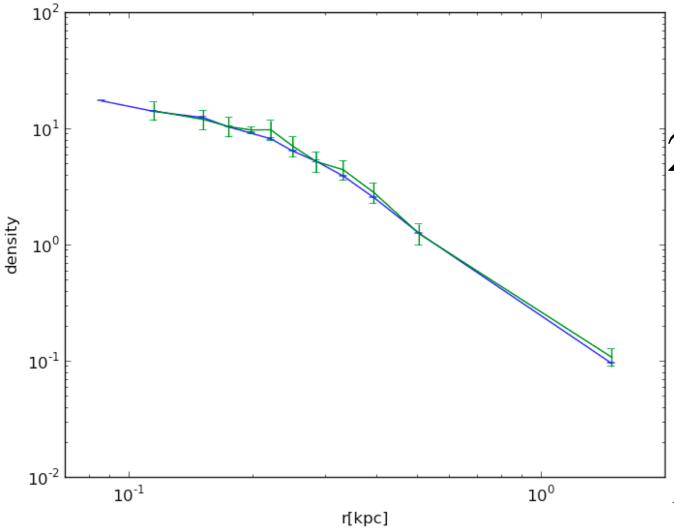



Ural et al. 2014
(in preparation)

# Best Models for Carina

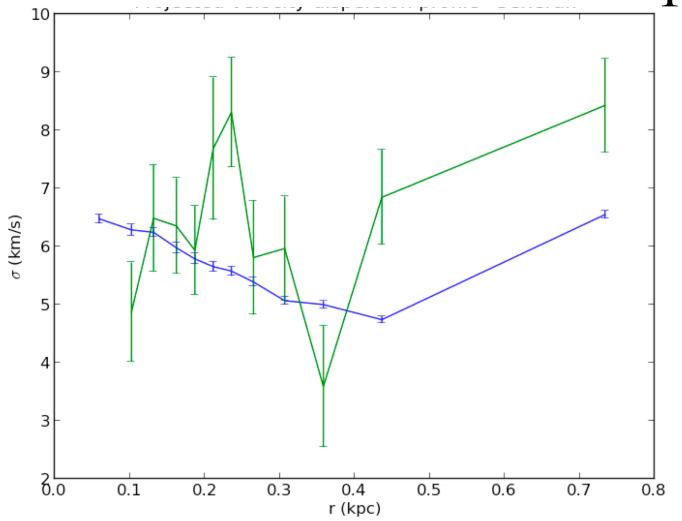
CUSP




$2.2 \times 10^8 M_\odot$

Mass loss

$1.5 \times 10^8 M_\odot$

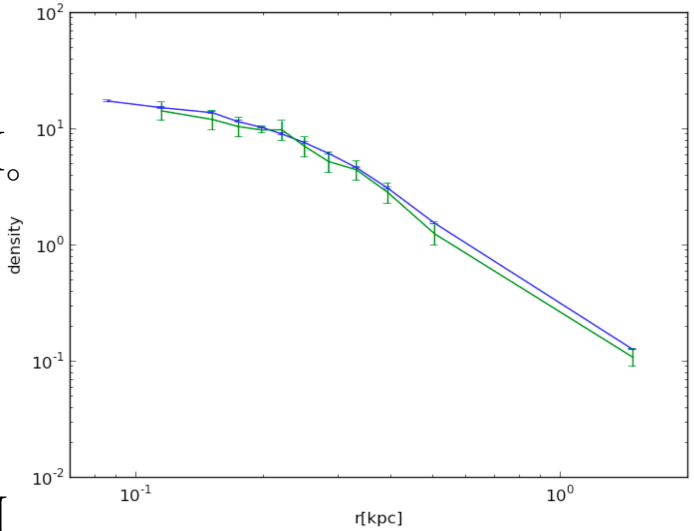


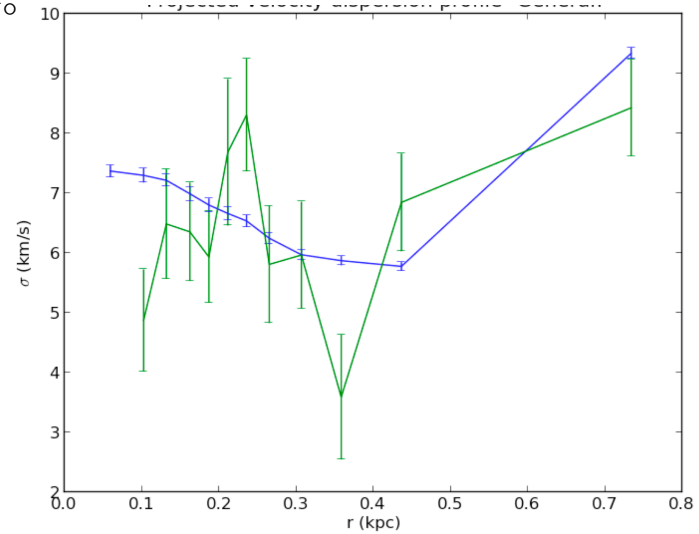

CORE

$1.3 \times 10^8 M_\odot$

Mass loss

$2.1 \times 10^7 M_\odot$



# SUMMARY

- MCMC to estimate masses
  - (50000 simulations with N=200.000)
- Carina's mass
  - Independent from model (Mass loss in 6Gyrs 70-80%)
- Carina stars in the Milky Way
- UMi abundances consistent with the outer halo
  - But different timescale where the downturn in [α/Fe] indicates SNIa enrichment
- Extended star formation for 5Gys [-1.3dex] with very low SF efficiency + Accretion +Winds
- An outlier at [Fe/H]=-2.7 dex (inhomogeneous mixing)