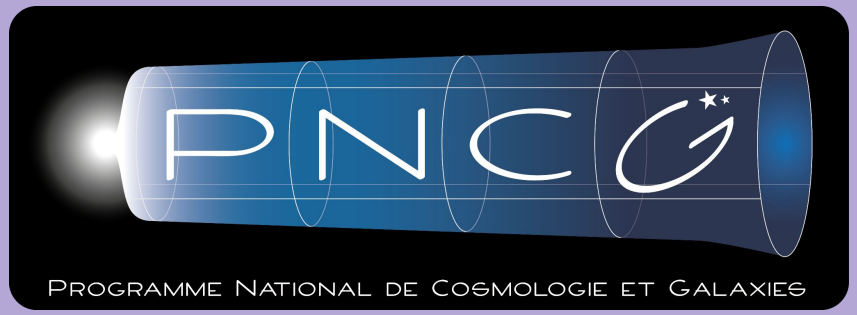
Strasbourg, June 20th 2022

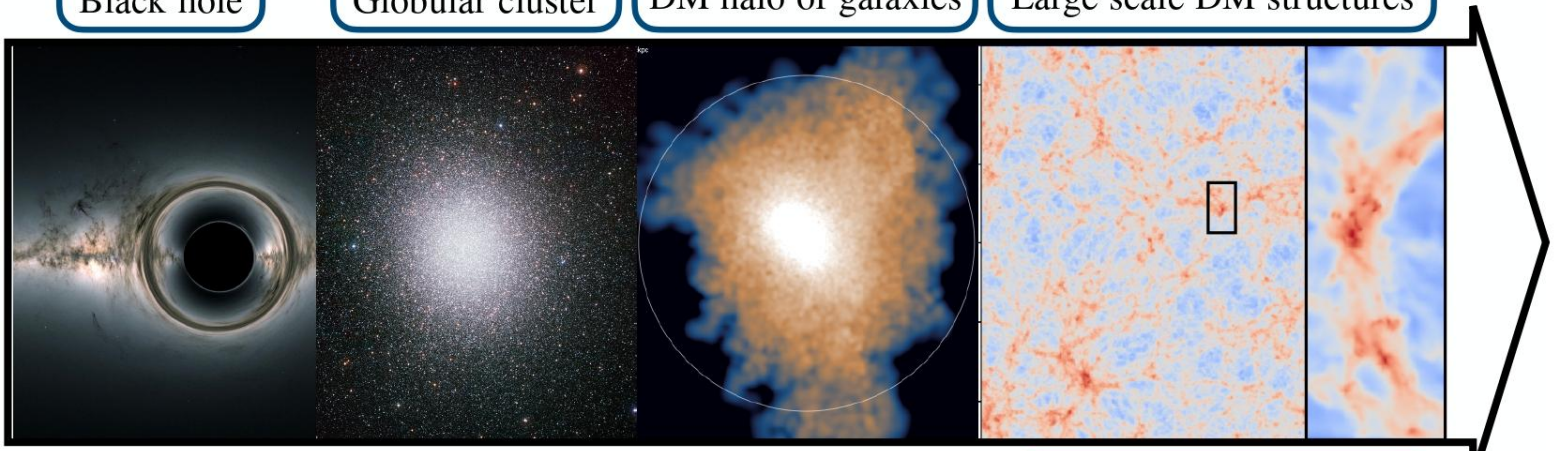
Inria

No globular cluster progenitors in Milky Way satellite galaxies

Pierre Boldrini



THE NATURE OF DARK MATTER



N – body simulations Cosmological simulations
Orbital integrations

Cosmological simulations
Optimal transport

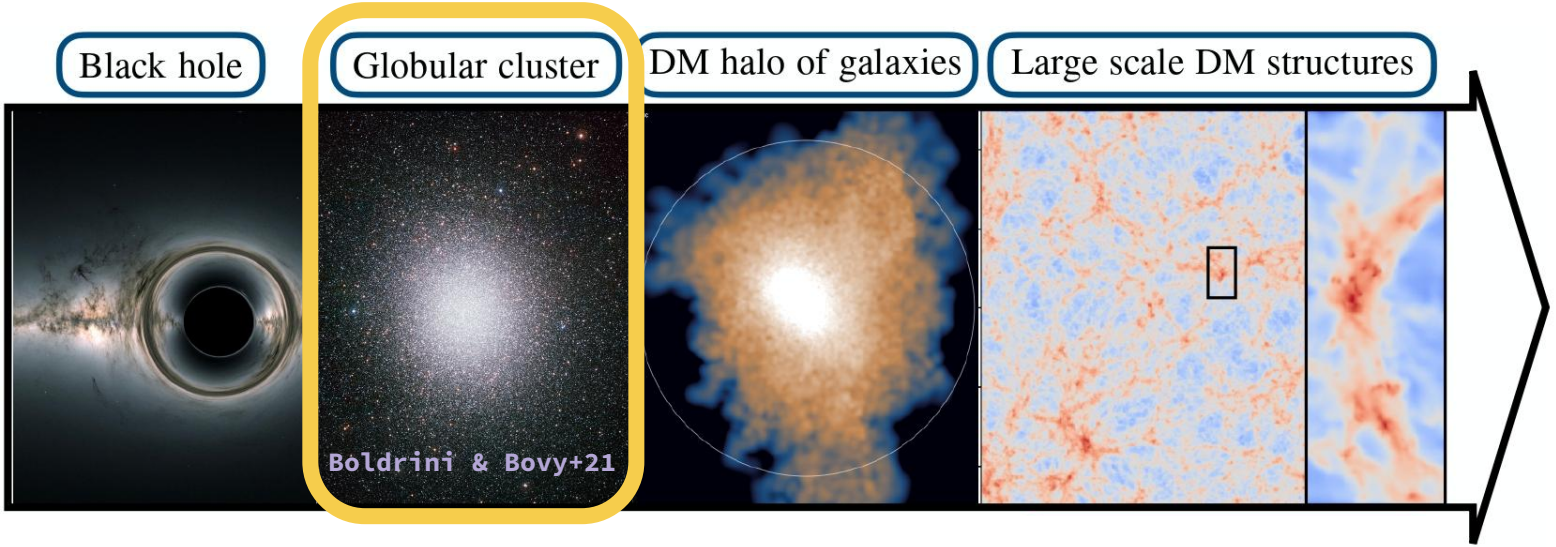
Boldrini+20c
Boldrini+20d
Chu+22,in prep

Boldrini+20b
Boldrini & Vitral+21
Boldrini & Bovy+21
Vitral+22,submit

Boldrini+19
Boldrini+20a
Boldrini+20e
Boldrini+21

Boldrini+22,in prep.

THE NATURE OF DARK MATTER



Origin of Globular clusters

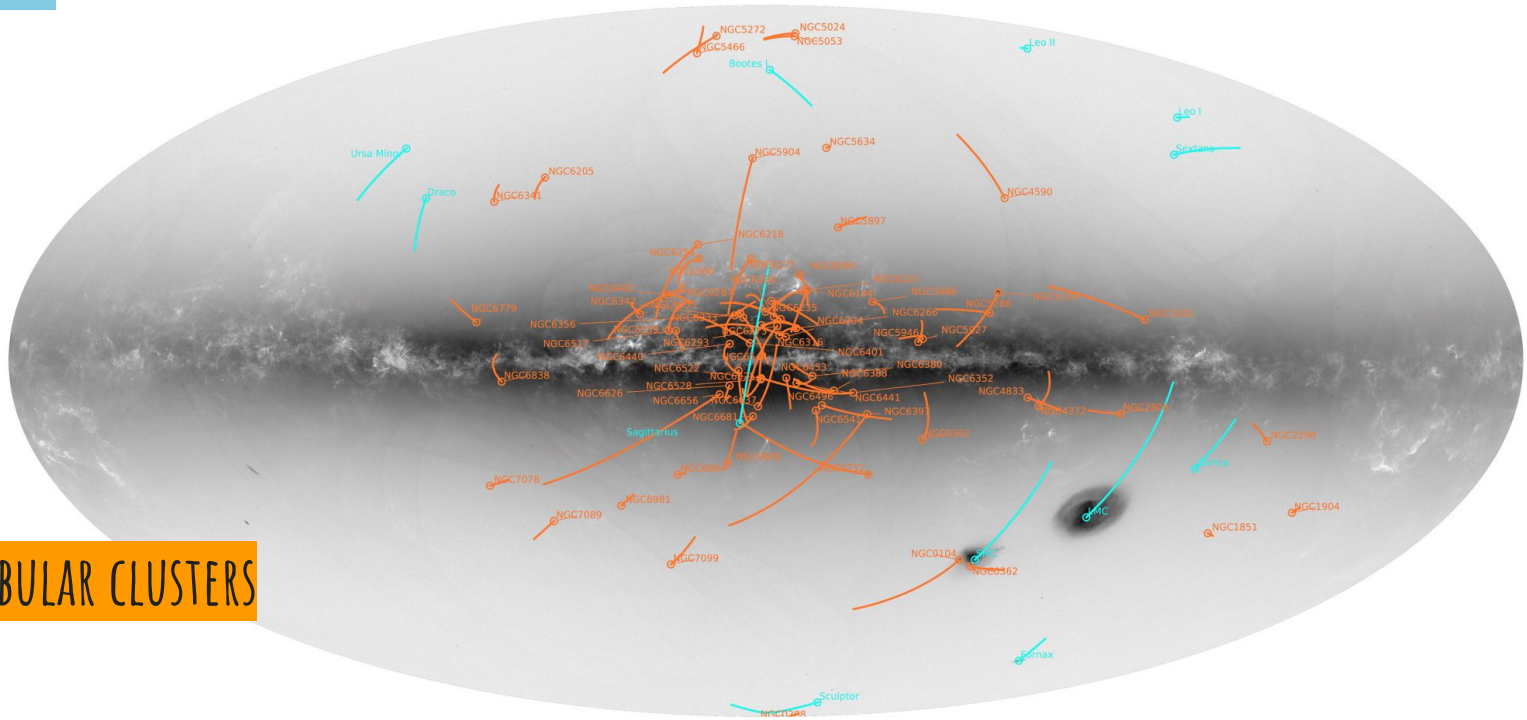
Relics of the epoch of the formation of galaxies

→ **First dark matter halos**

gaia

GAIA MISSION: FULL 6D PHASE SPACE

11 MW SATELLITES



170 GLOBULAR CLUSTERS

Origins of MW globular clusters

In-situ origin

62 of MW GCs likely formed in the MW

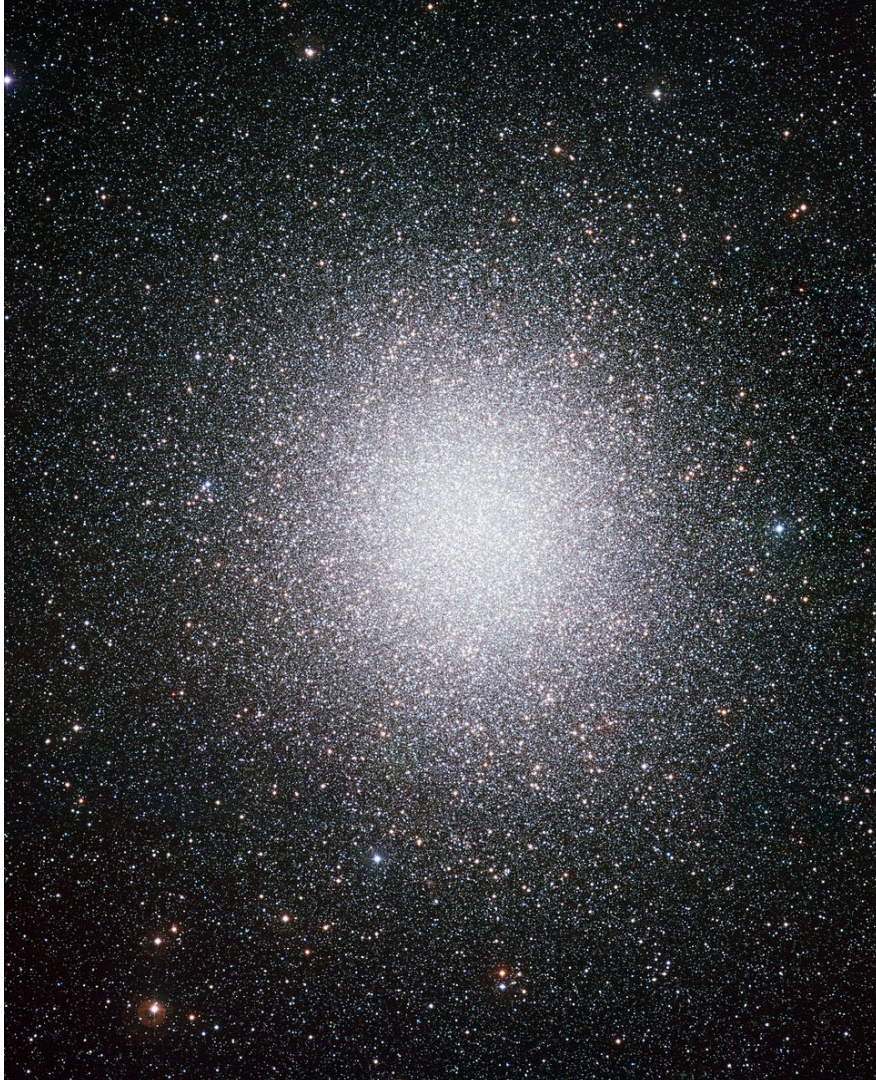
Ex-situ origin

55-65 of MW GCs have an extragalactic origin

Heterogeneous origin

The rest

Kruijssen+19, Massari+19,



Origins of MW globular clusters

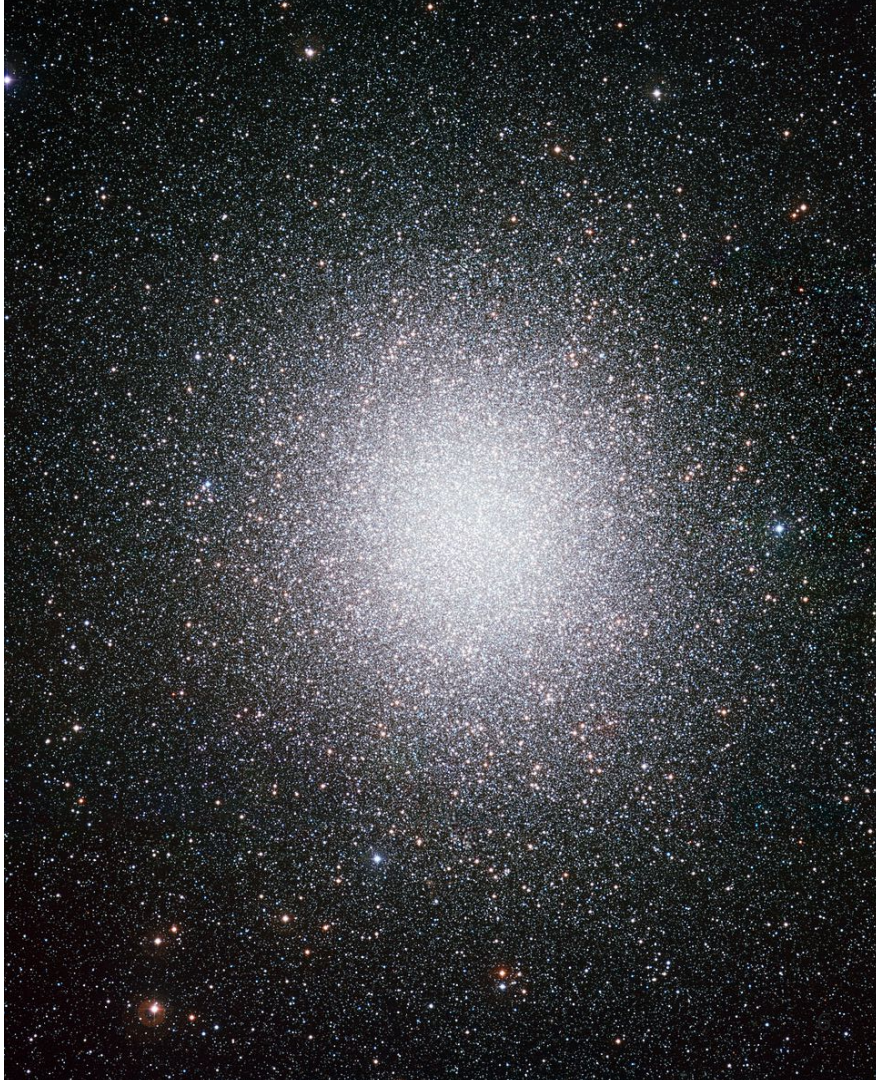
In-situ origin
62 of MW GCs likely formed in the MW

Ex-situ origin
55-65 of MW GCs have an extragalactic origin

35% of MW GCs possibly associated with accreted dwarf galaxies

Heterogeneous origin
The rest

Kruijssen+19, Massari+19,



Origins of MW globular clusters

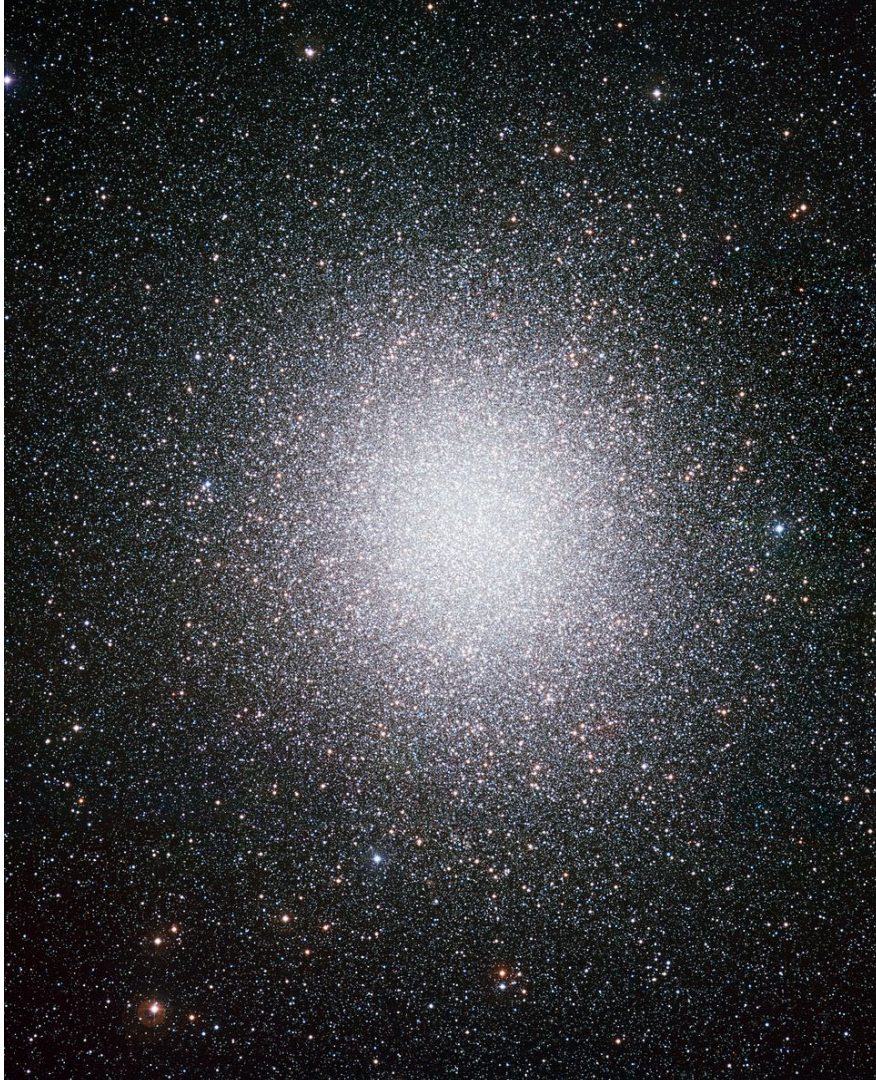
11 MW satellite galaxies

Progenitors of some of MW GCs

Orbital integration code

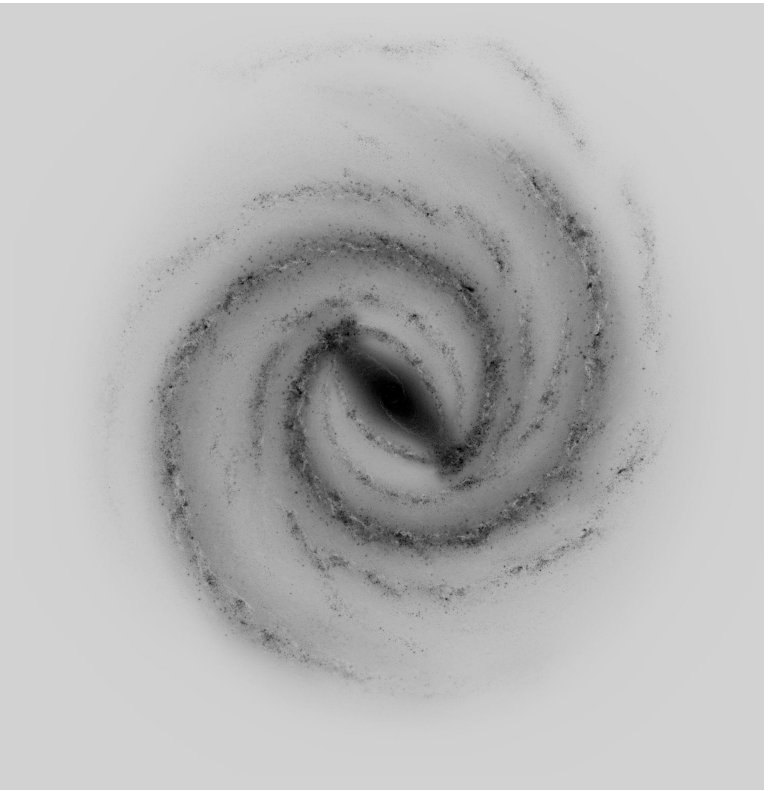
Bovy+15

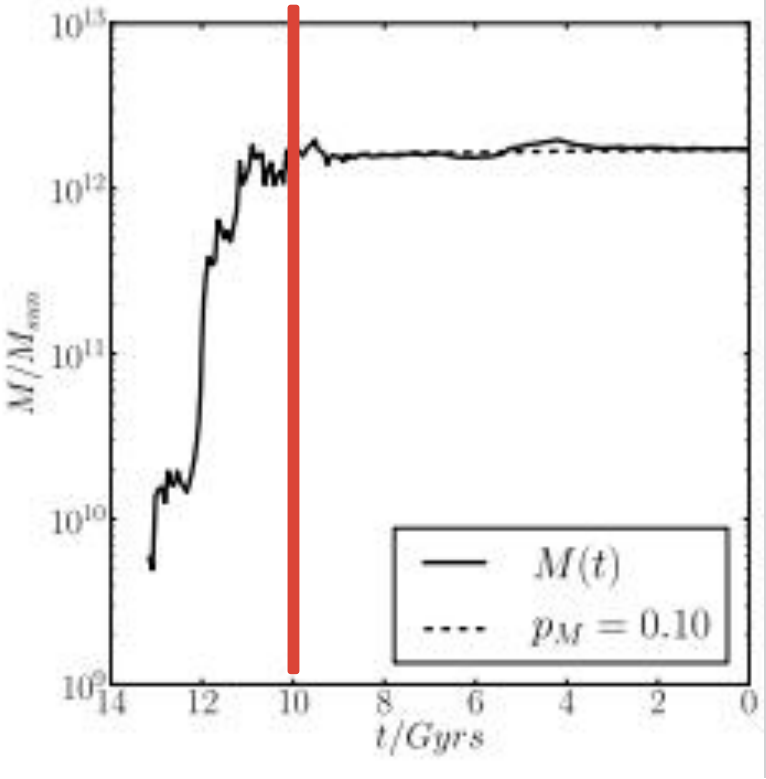
galpy



THE MW ENVIRONMENT

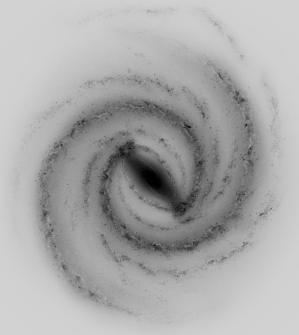
Diemand+07, Lux+10





THE MW ENVIRONMENT

11 MW SATELLITES



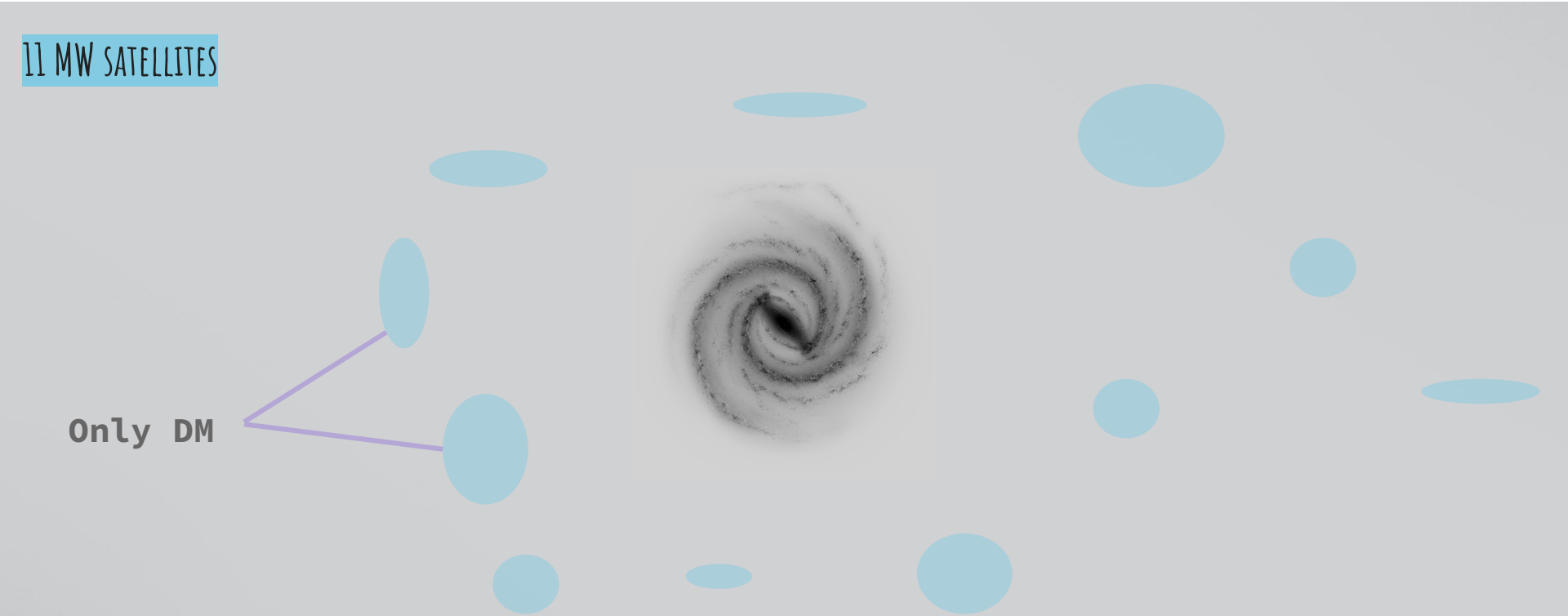
MWPotential2014

Bovy+15

THE MW ENVIRONMENT

$$t_{friction} \sim \frac{M^{MW}(<r)}{M^{sat}} t_{dyn}$$

11 MW SATELLITES



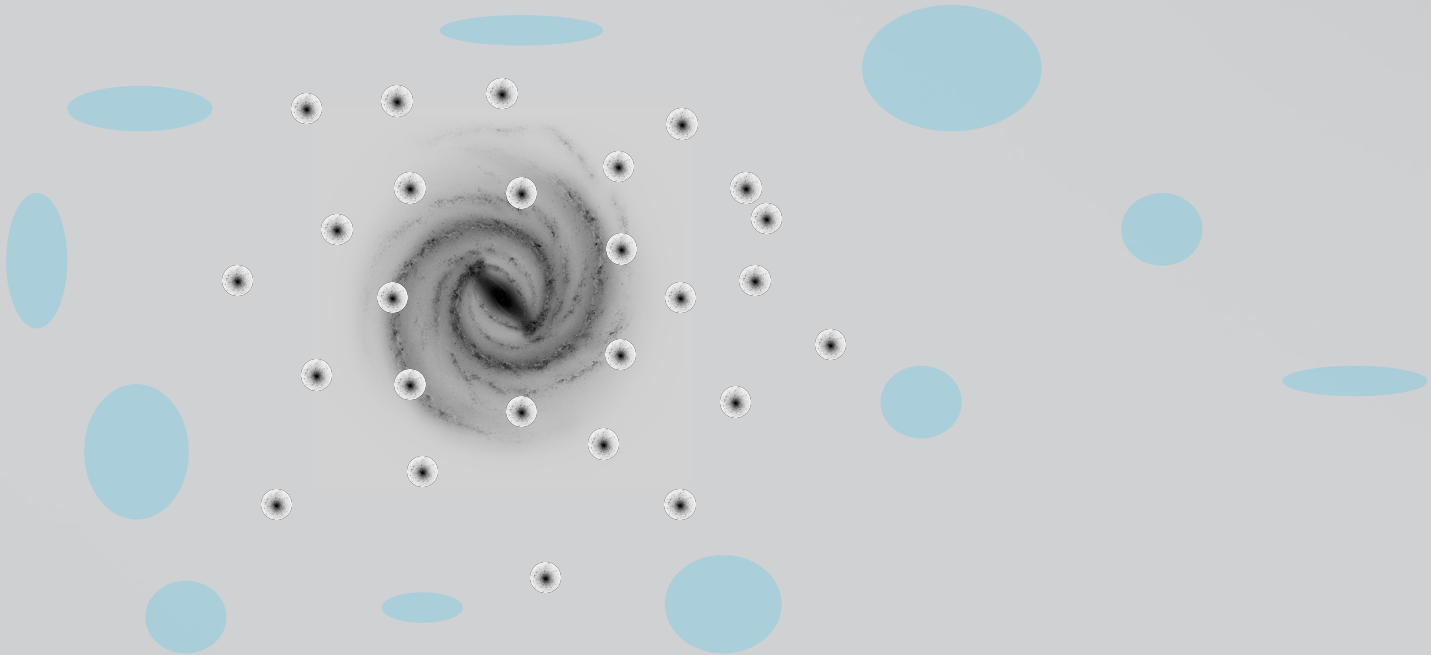
Only DM

THE MW ENVIRONMENT

$$t_{friction} \sim \frac{M^{MW}(<r)}{M^{GC}} t_{dyn},\ M^{sat} \sim 1000\ M^{GC}$$

11 MW SATELLITES

170 GLOBULAR CLUSTERS

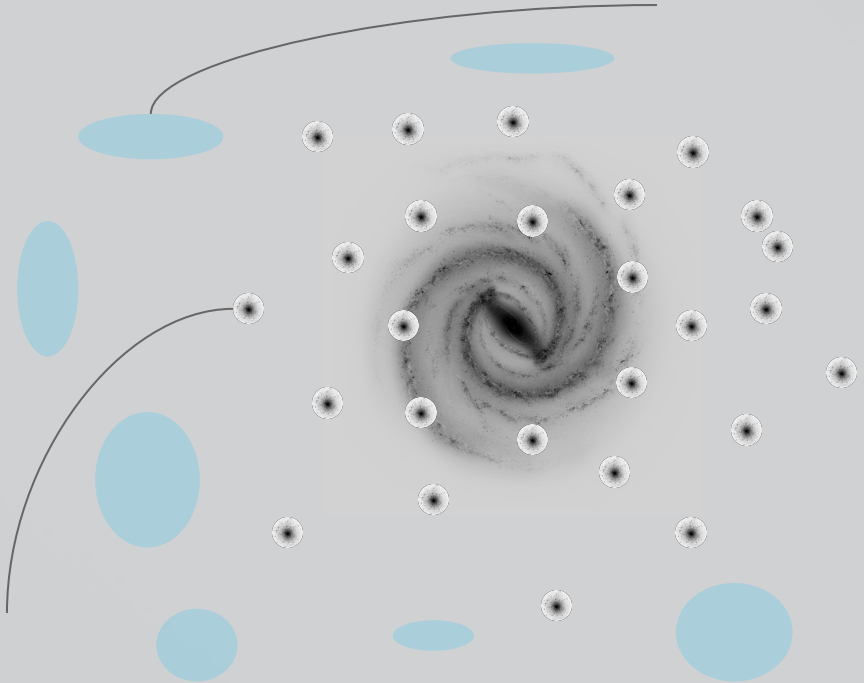


MW+satellite potential

THE MW ENVIRONMENT

11 MW SATELLITES

170 GLOBULAR CLUSTERS



gaia

MW+satellite potential

Globular cluster-Satellite association criteria

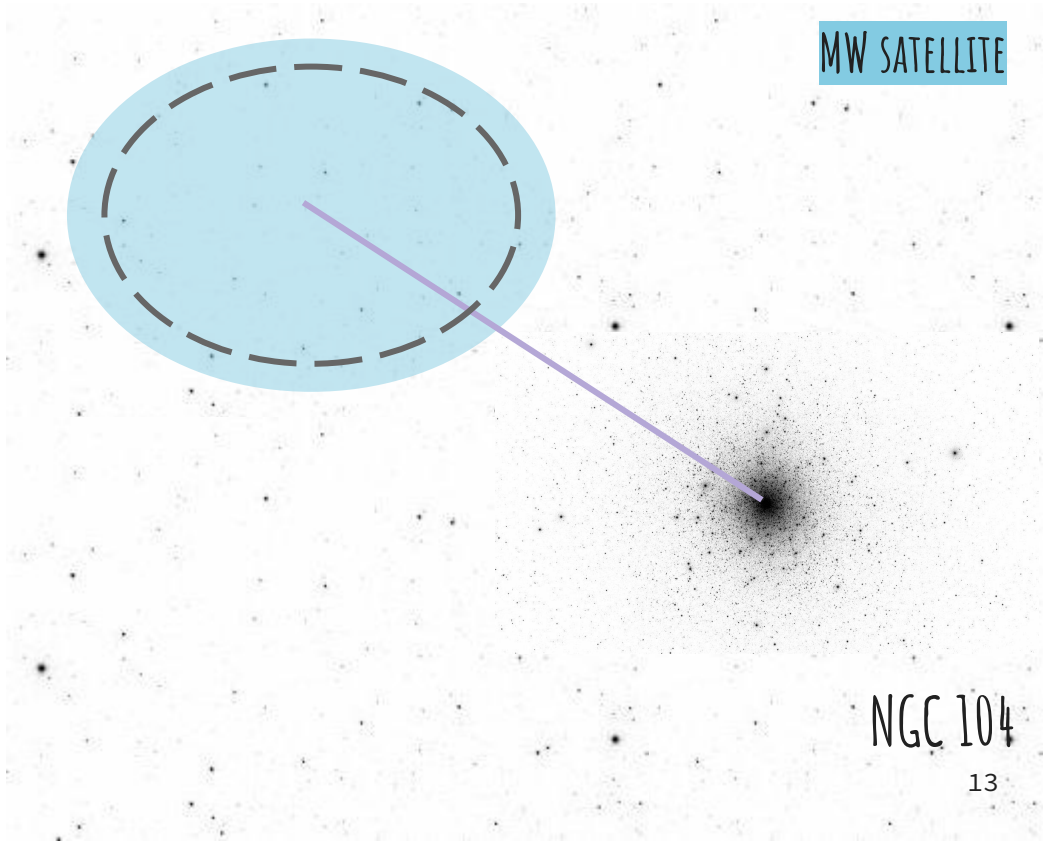
Distance criterion

D^{GC} < Tidal radius of the satellite

Velocity criterion

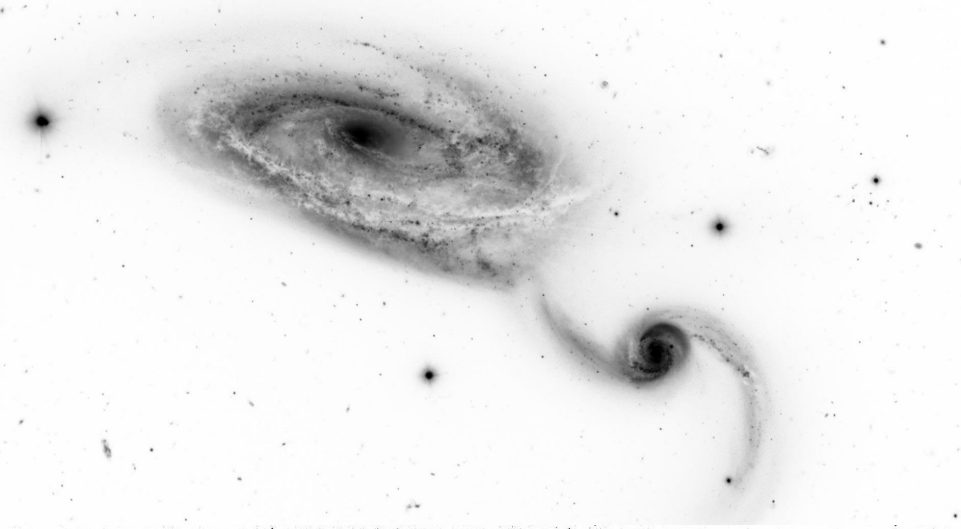
V^{GC}< Escape velocity of the satellite

$P_{GC}(\text{MW satellite})$ = Probability of having been bound to a MW satellite



None of the 170 globular clusters show any clear association with the 11 MW satellites

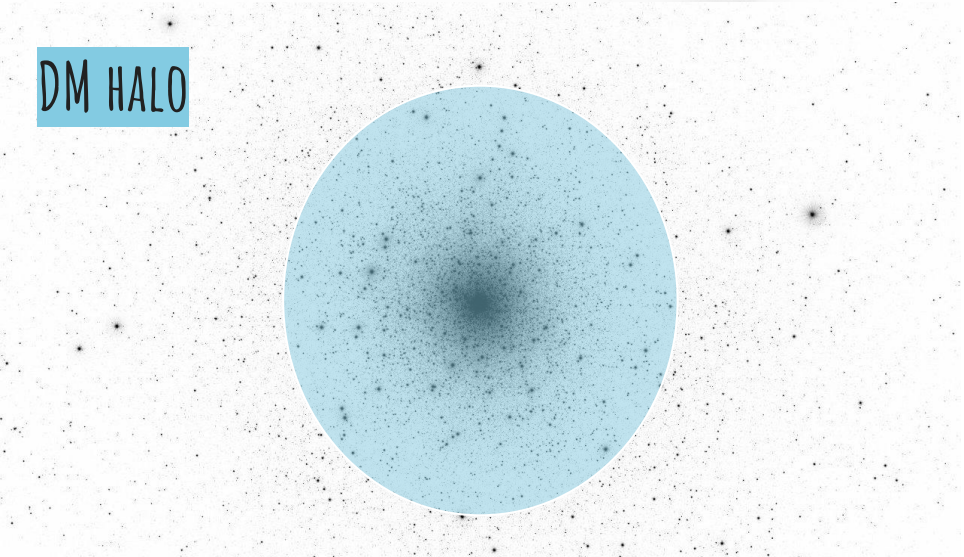
Boldrini&Bovy+21



IMPLICATIONS?

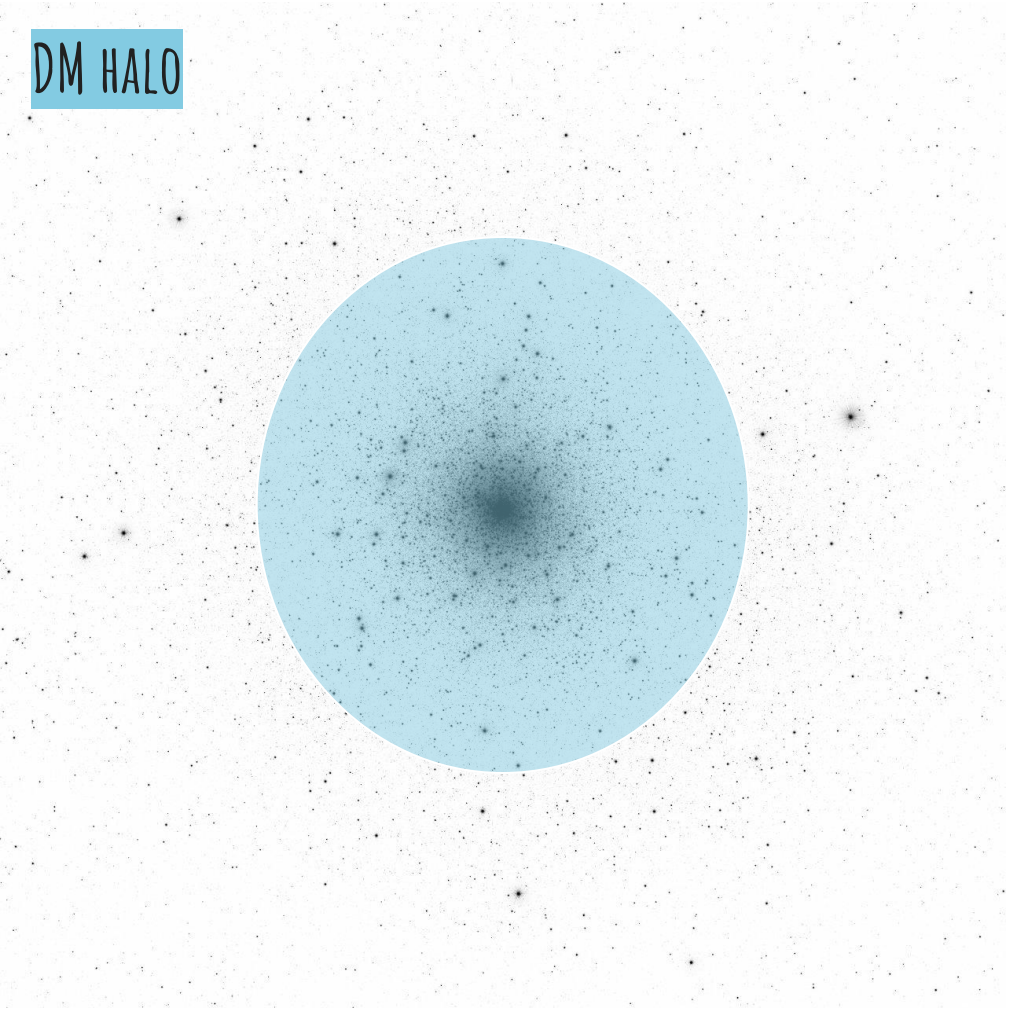
OPTION 1

Now disrupted satellites



OPTION 2

Globular clusters may have had a dark matter halos



HOW TO GO FURTHER?

Evolving MW potential

MW has drastically grown before z = 2 due to mergers

Globular clusters with DM halo

Investigating their orbital history backwards in time