Energy Equipartition in Galactic Globular Clusters

Laura Watkins she/her

AURA for ESA, ESA Office, Space Telescope Science Institute

with Roeland van der Marel, Andrea Bellini, Mattia Libralato, Jay Anderson

DDA 52 · Virtual · May 2021

NASA, ESA and the Hubble Heritage Team (STScI/AURA)

Globular clusters are dense.
stars interact

Globular clusters are old.
lots of interactions

stars exchange energy

Energy Equipartition

Energy Equipartition

equal kinetic energy

$\frac{1}{2}\ m\ v^2$

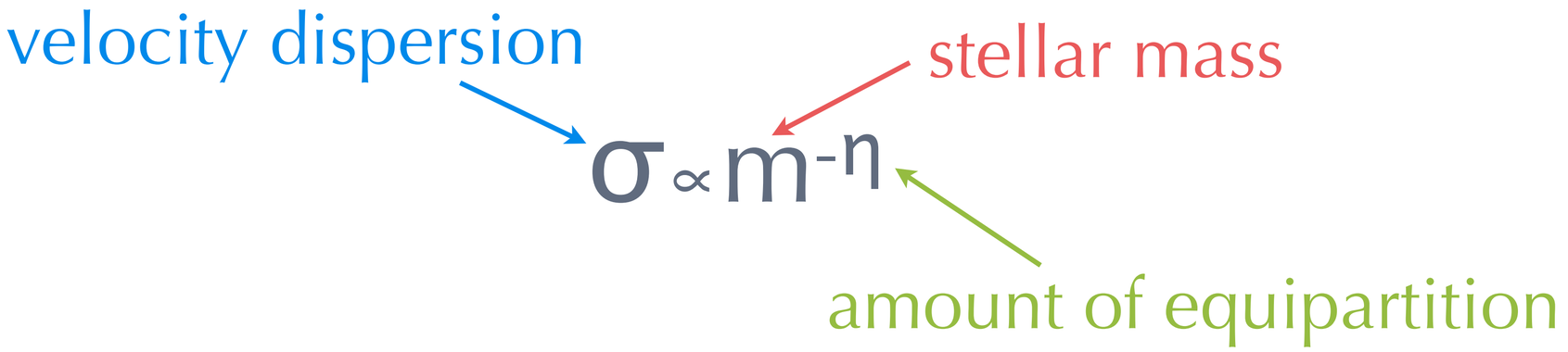
high mass : slow

low mass : fast

Energy Equipartition

equal kinetic energy

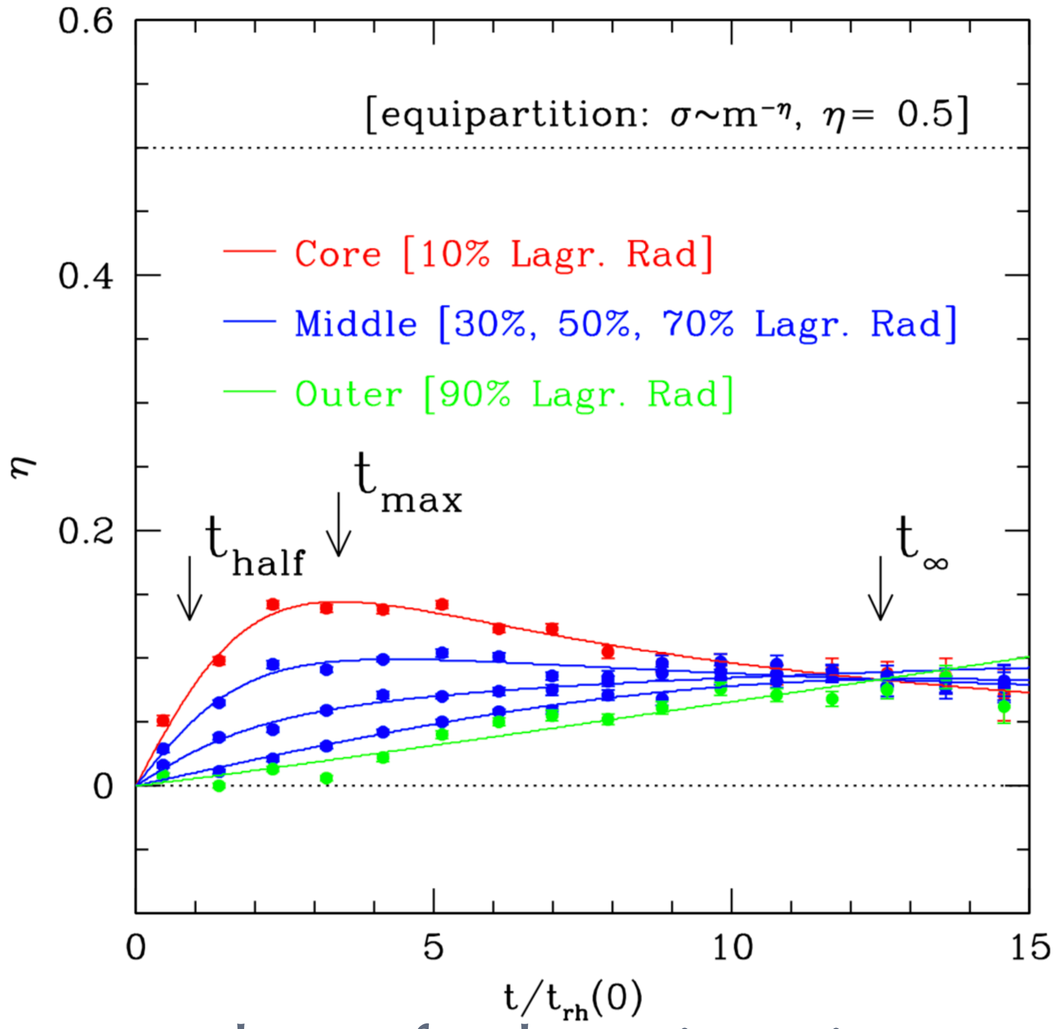
$\frac{1}{2}\, m\, v^2$



$\eta = 0$ (none)

$\eta = 0.5$ (full)

Simulated Clusters

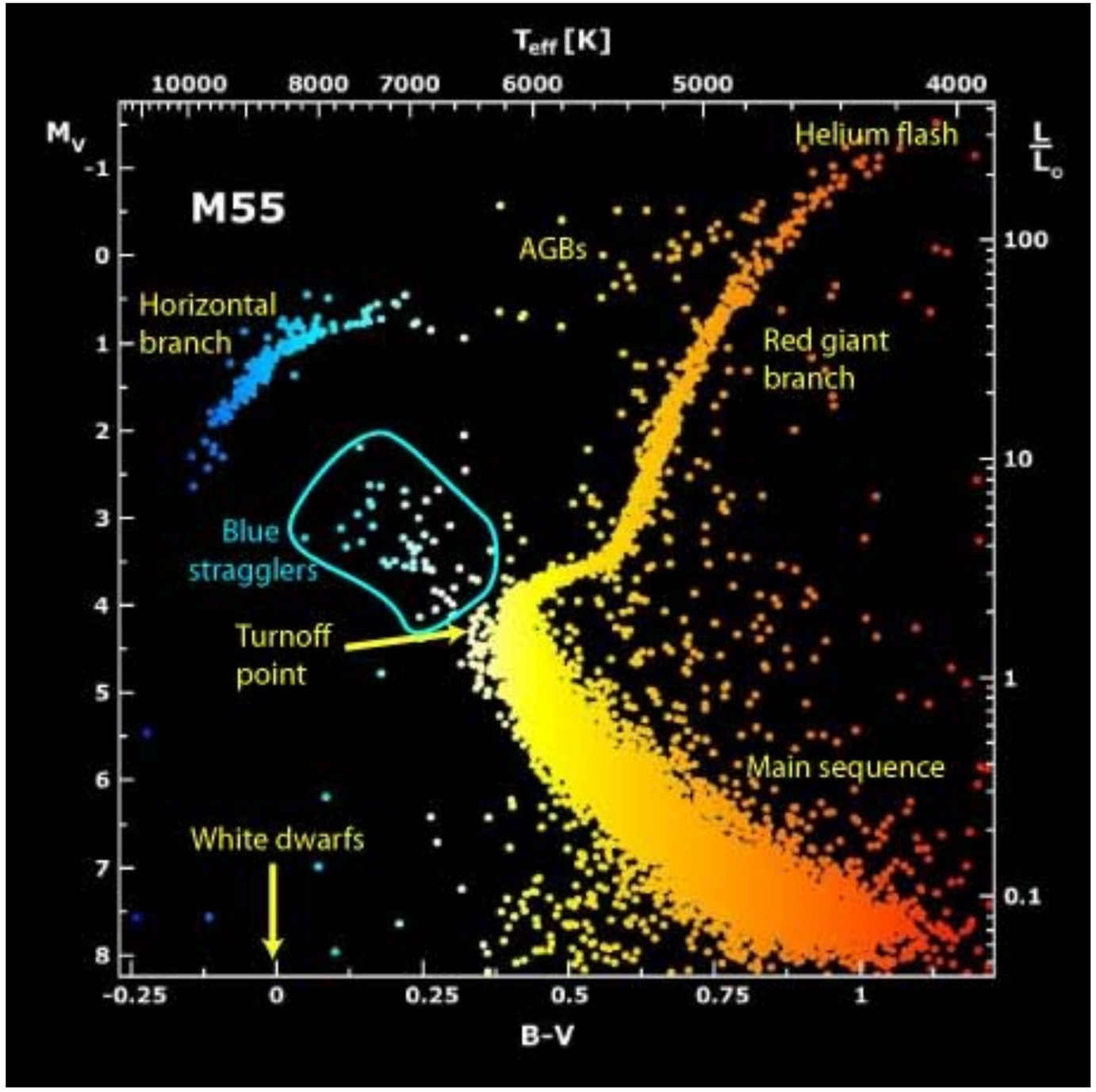


degree of equipartition

number of relaxation times

does not reach full equipartition

Trenti & van der Marel 2013



very small mass range

targets for kinematics

wide mass range

hard to get kinematics

HST

HST Proper Motion Catalogues

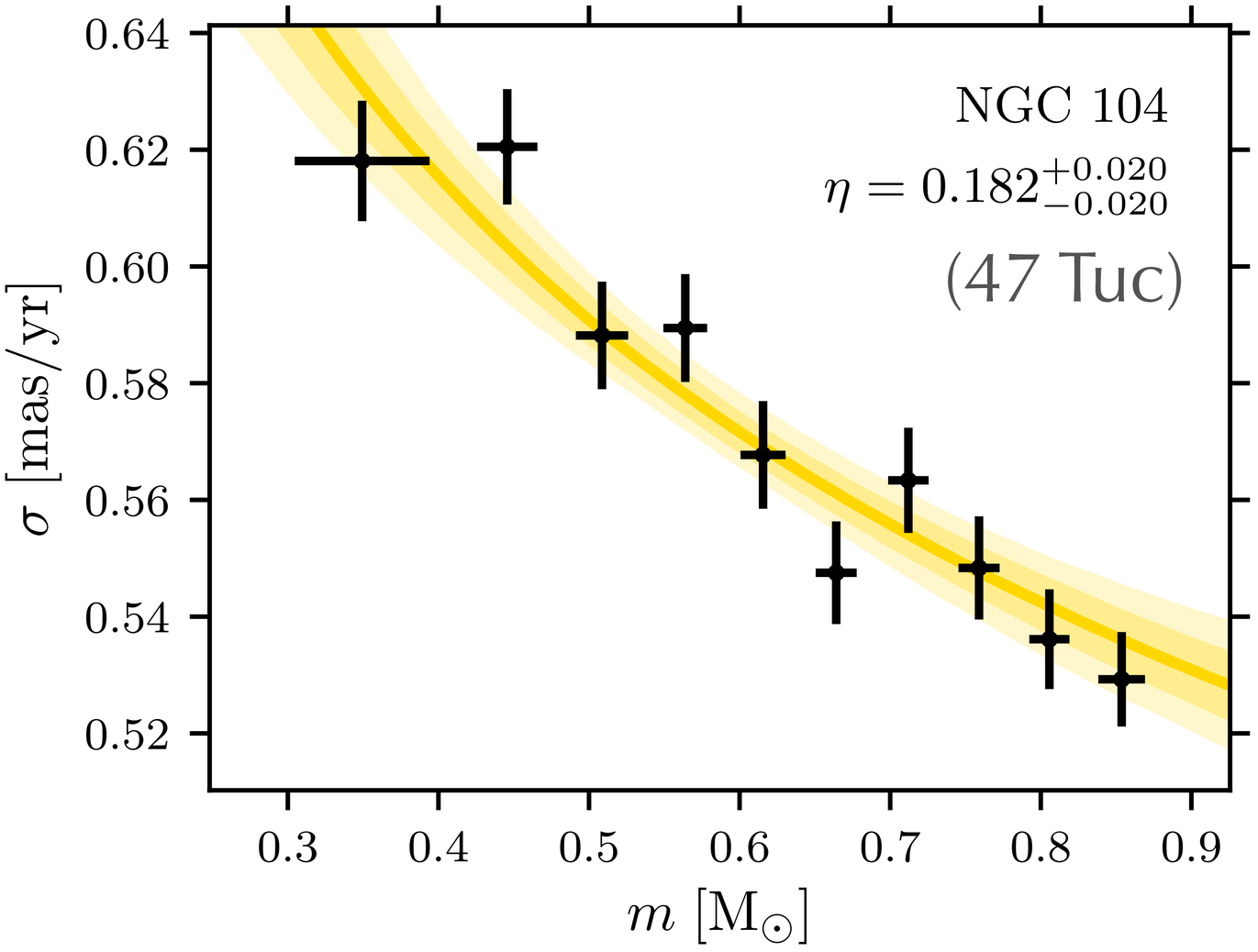
HST proper motions for 22 Milky Way globular clusters
Bellini+ 2014

- all archival data
- 1.4 million stars (datasets ~3k to ~300k each)
- few km/s accuracy (~35 μas/yr = ~ 1.4km/s)
- different environments
- different dynamical states
- global statistics

5 closest clusters

preliminary

HST: kinematics with stellar mass



proper motion velocity dispersion

stellar mass

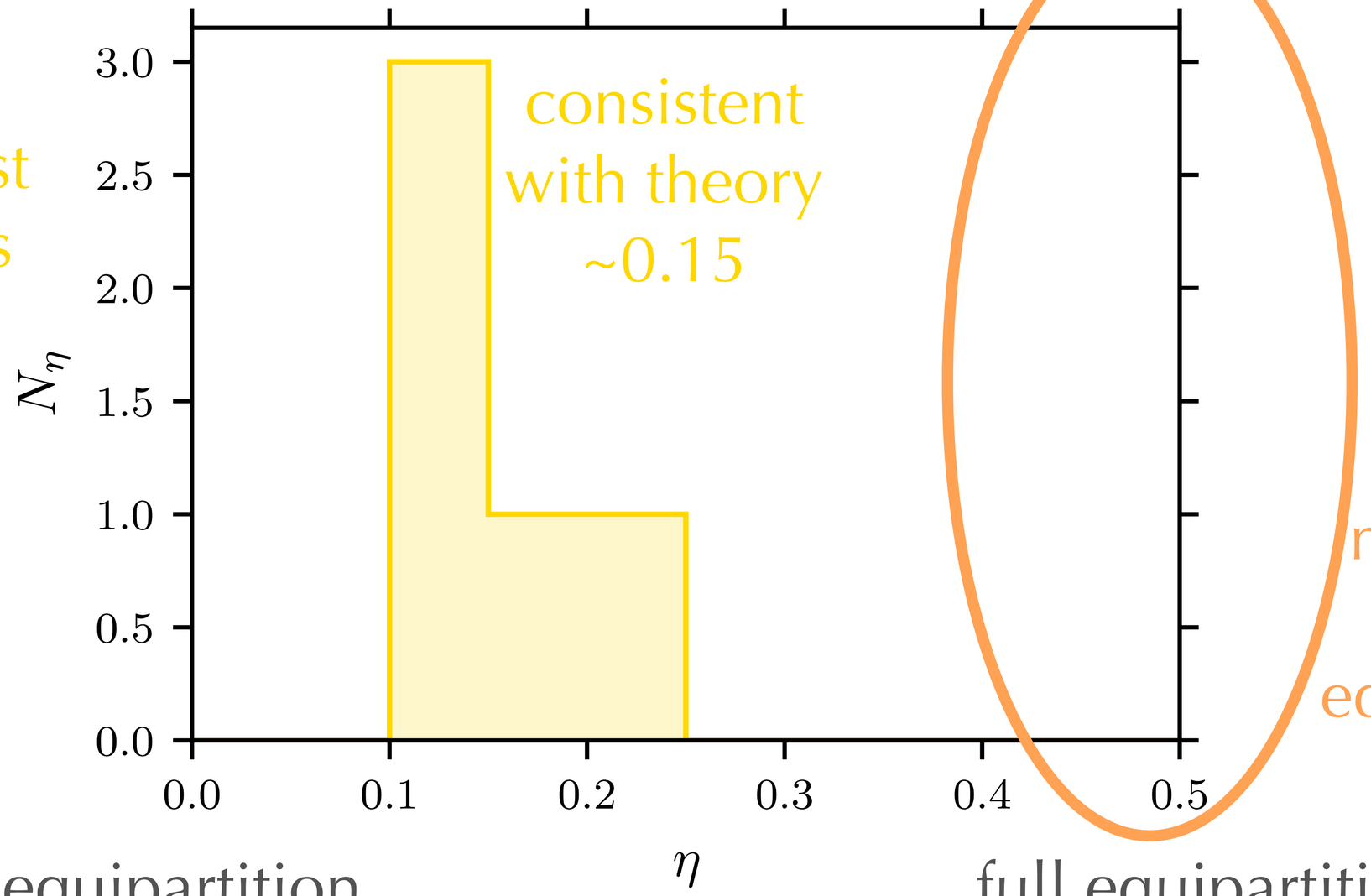
$\sigma \propto m^{-\eta}$

Watkins+ in prep

preliminary

HST: kinematics with stellar mass

5 closest clusters



no clusters in full equipartition (0.5)

no equipartition

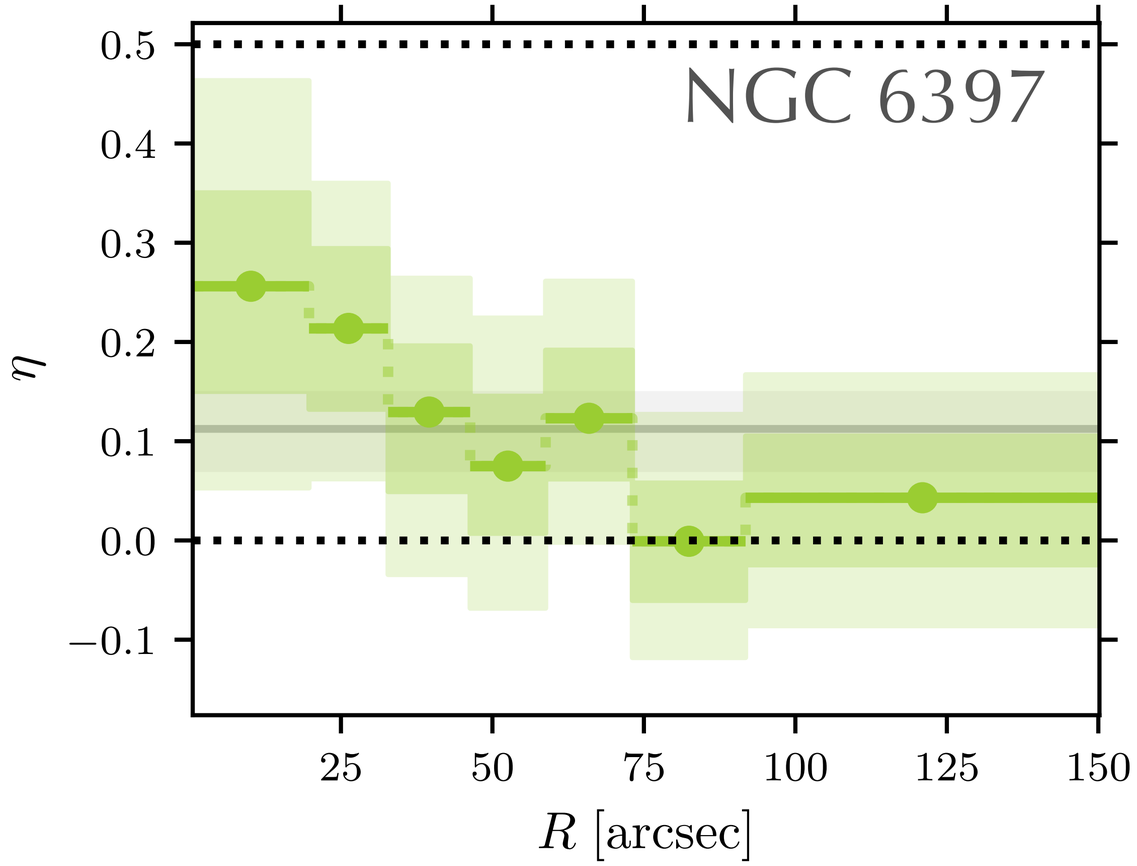
full equipartition

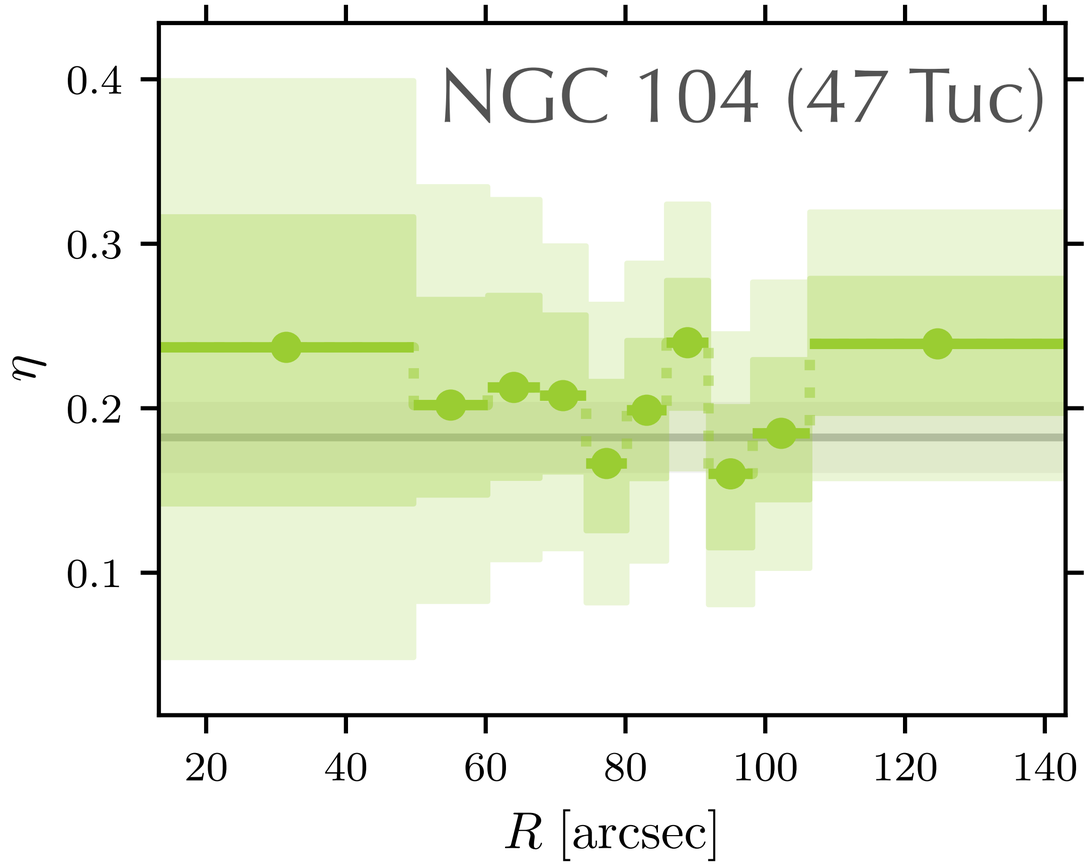
Watkins+ in prep

preliminary

HST: kinematics with stellar mass

$$\sigma \sim m^{-\eta}$$

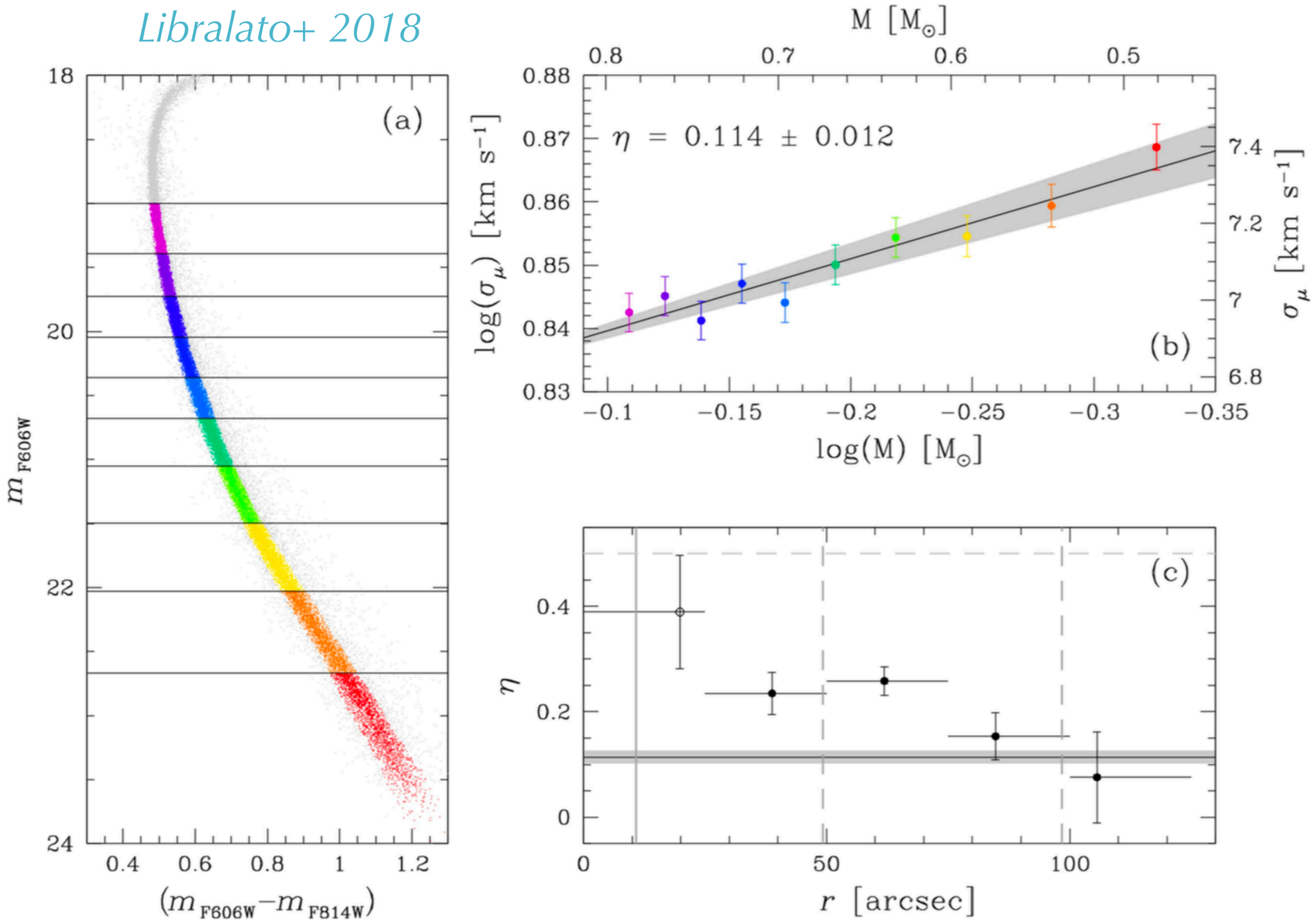




Watkins+ in prep

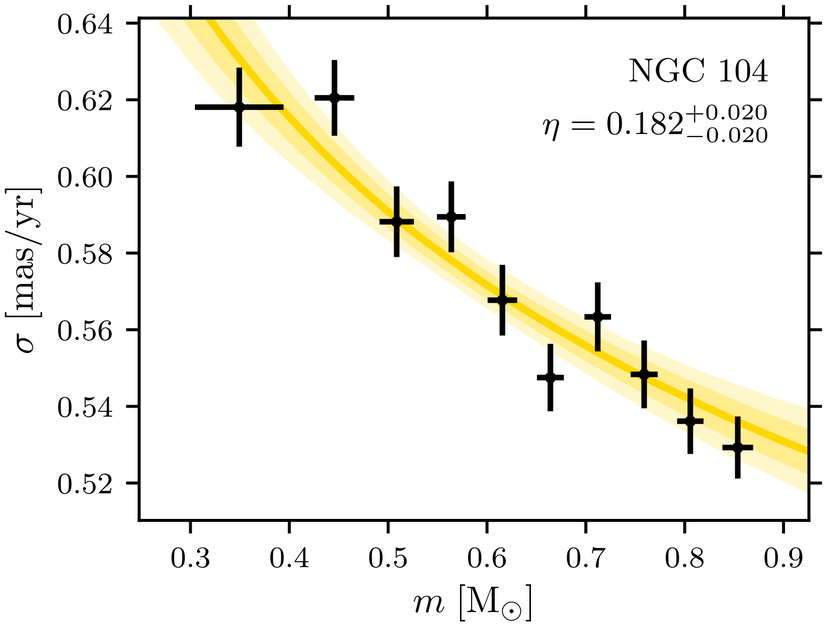
NGC 362

Libralato+ 2018

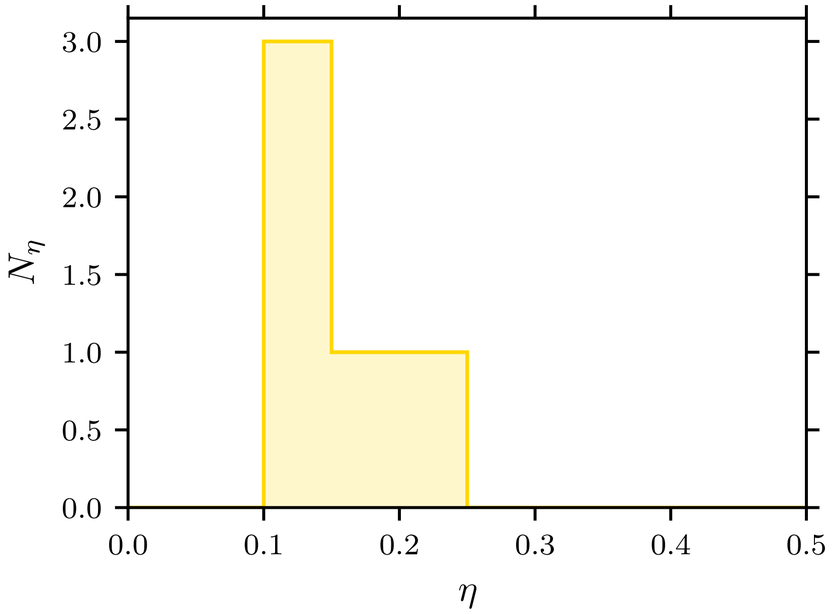


improved catalogue

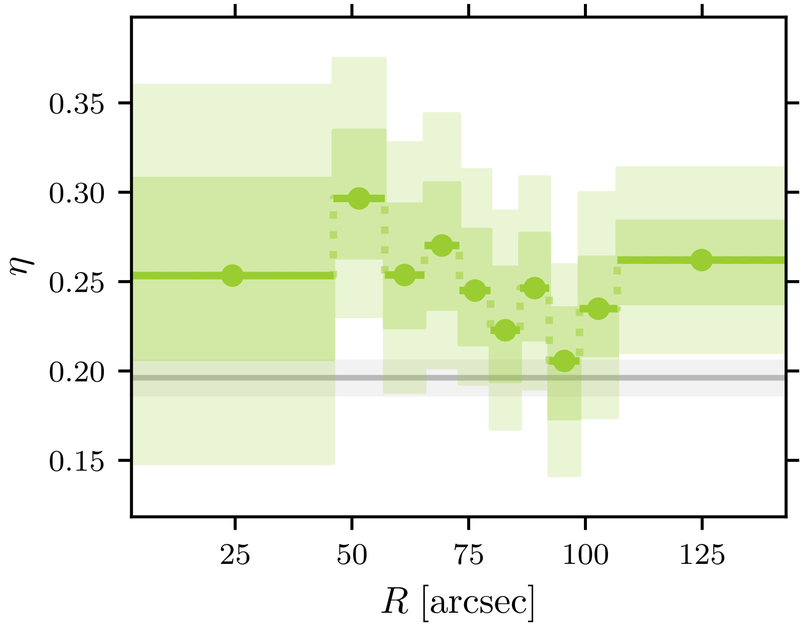
Energy equipartition in MW GCs with HST proper motions.



equipartition on main sequence



no full equipartition



equipartition with radius

Laura Watkins · ESA-AURA, STScI