

# Kinematics of Multiple Stellar Populations in Globular Clusters with Gaia

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Galfor – Galactic Archeology

# The GALFOR group



(From left to right)

→ E.P. Lagioia

→ A.F. Marino

→ A.P. Milone

→ G. Cordoni

→ M. Zennaro

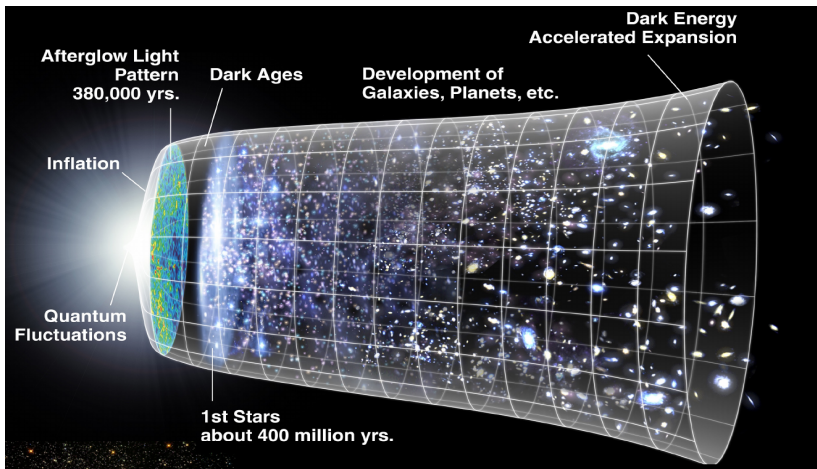
→ M. Tailo

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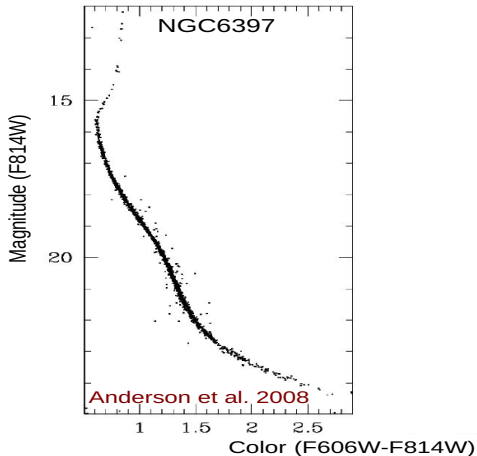


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# Old Globular Clusters

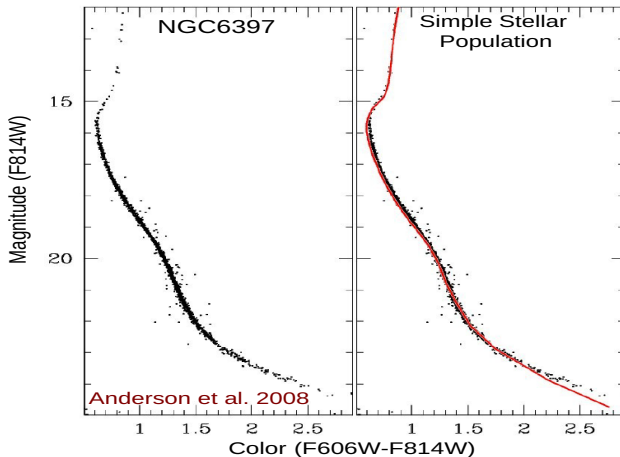


# Old Globular Clusters: a few years ago





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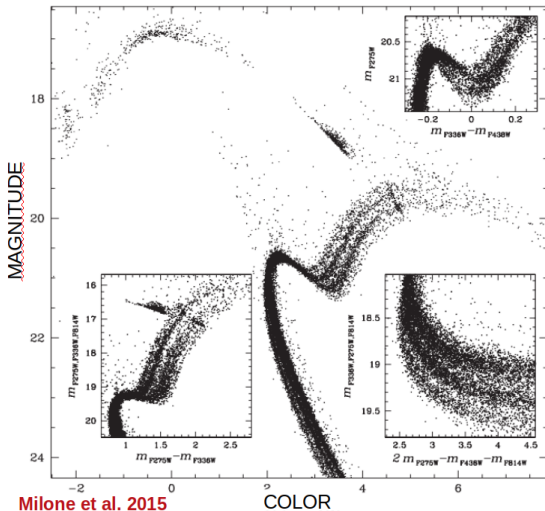
# Old Globular Clusters: a few years ago

## Simple Stellar Population

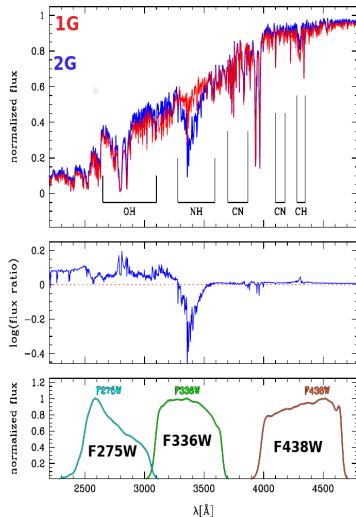
Globular Clusters were considered the prototypes of Simple Stellar Populations. All stars have

- same age
- same metallicity
- same chemical composition

# Old Globular Clusters: state of the art



Milone et al. 2015



# Old Globular Clusters: state of the art

## Simple Stellar Population

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- same metallicity
- same chemical composition

# Old Globular Clusters: state of the art

## Revolution

Old Globular clusters host **Multiple Stellar Populations**

- Different chemical composition (He,C,N,O,Na)
- Different number of stars
- Complexity increasing with cluster mass

# Scenarios

## Multi-Generations

- Multiple star-bursts
- 2G born out of 1G massive stars ejecta

## Single-Generation

- Single star-burst
- 2G changes chemical composition due to some exotic process (accretion)

# Theoretical predictions

## Multi-Generations

- Multiple star-bursts
- 2G born out of 1G massive stars ejecta



## Predictions

- 2G more centrally concentrated
- Non-flat  $N_{1G}/N_{tot}$  radial profile
- Different dynamics

# Our goal

## Gaia

Present-day cluster dynamics can give us clues on the origin of multi-populations. → Study of internal motion of cluster stars

## HST

- Few studied clusters ( $\omega$  Cen, 47 Tuc, NGC 2808)
- High precision
- Small field of view
- No radial profile

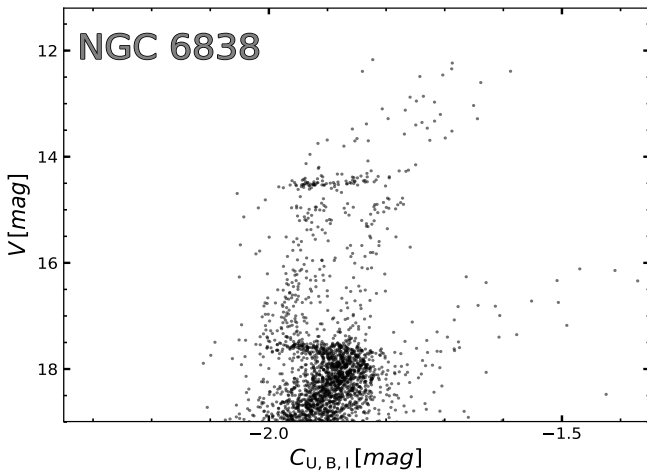
## Gaia

- Available for many clusters
- Wide field of view
- Radial profile

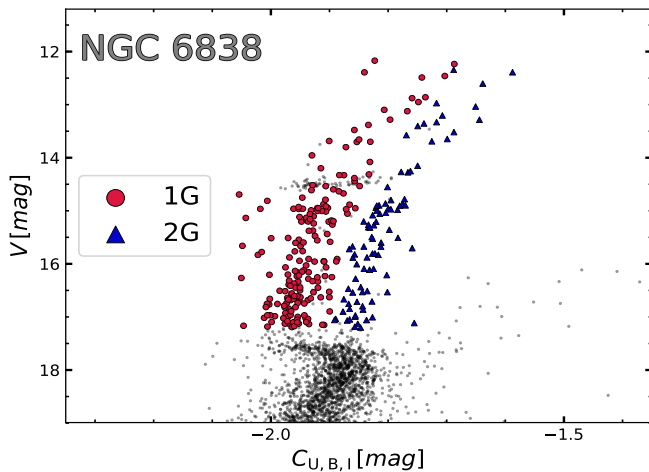


# Stars sample

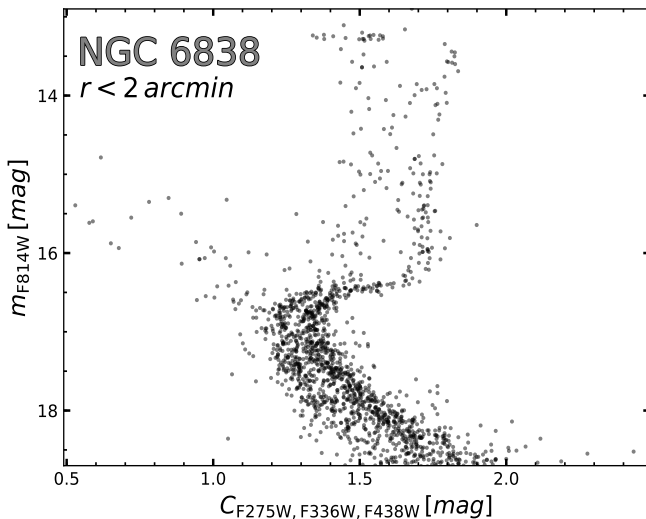
# Solution



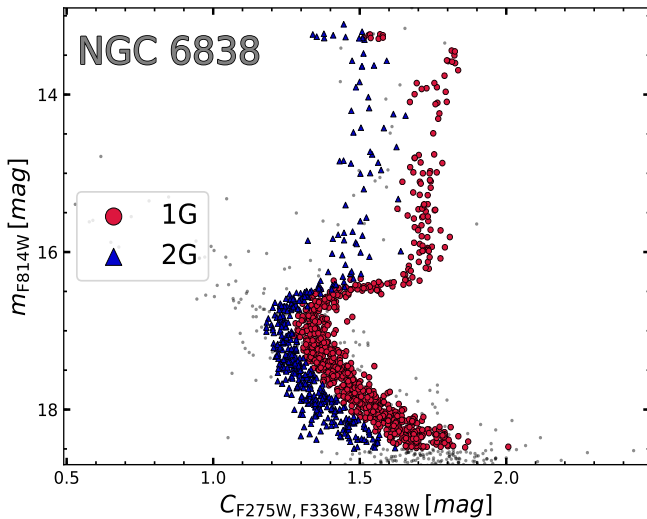
# Solution



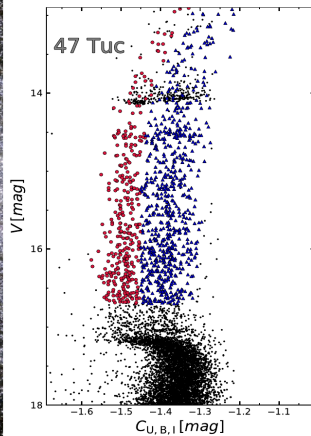
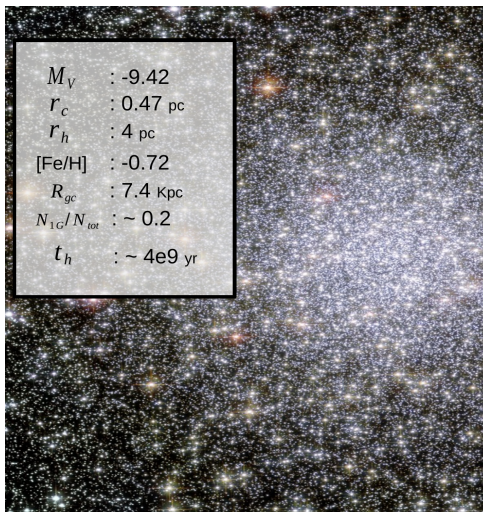
# HST wonder



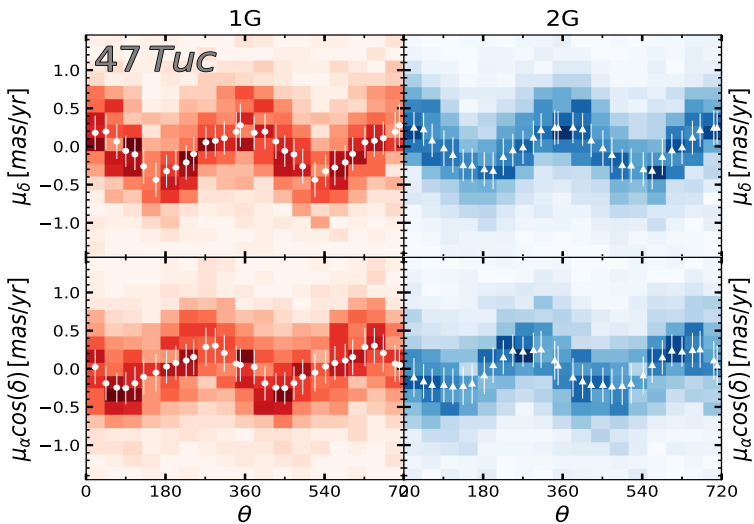
# HST wonder



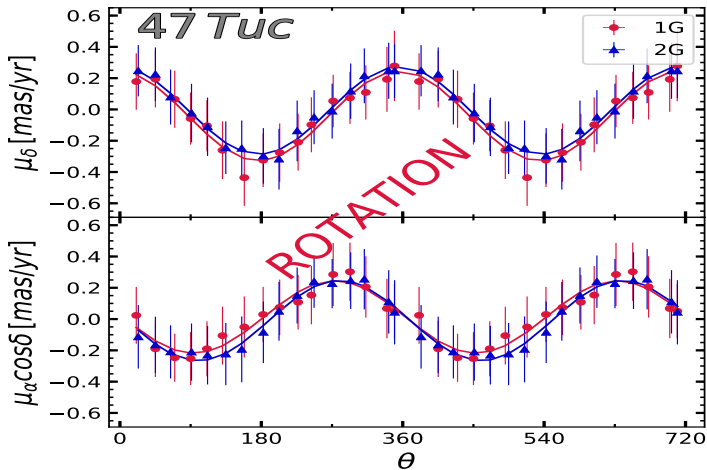
# The case of 47 Tuc



# The case of 47 Tuc

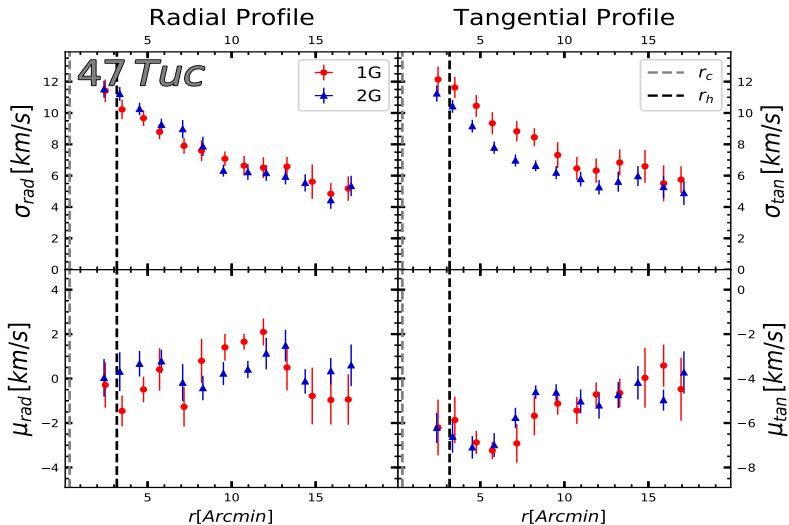


# The case of 47 Tuc





# Velocity profile

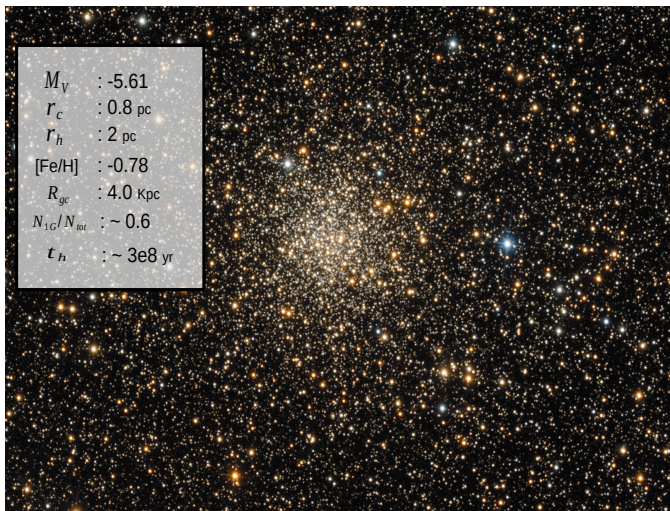


# Results

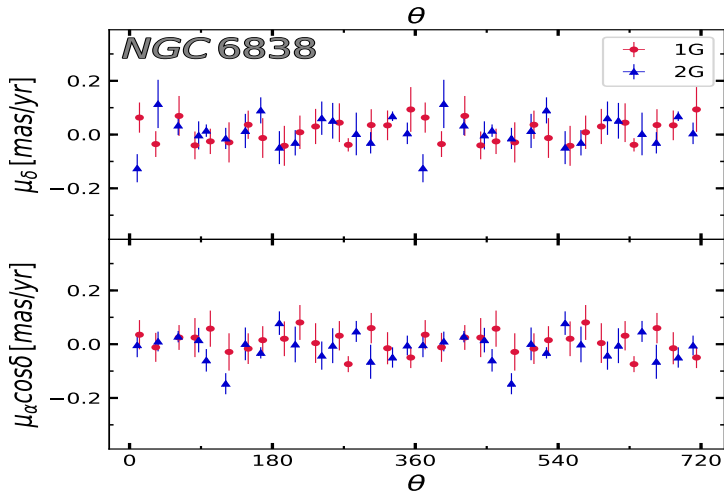
## 47 Tuc

- Same rotation
- Different tangential dispersion
- Different radial profile
  - MPs are not homogeneous
  - Consistent with theoretical predictions

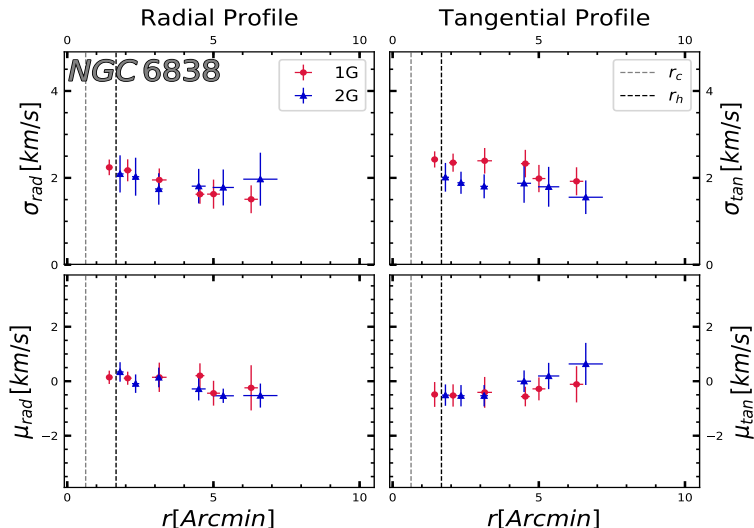
# The case of NGC 6838



# The case of NGC 6838



# Velocity profile



# Results

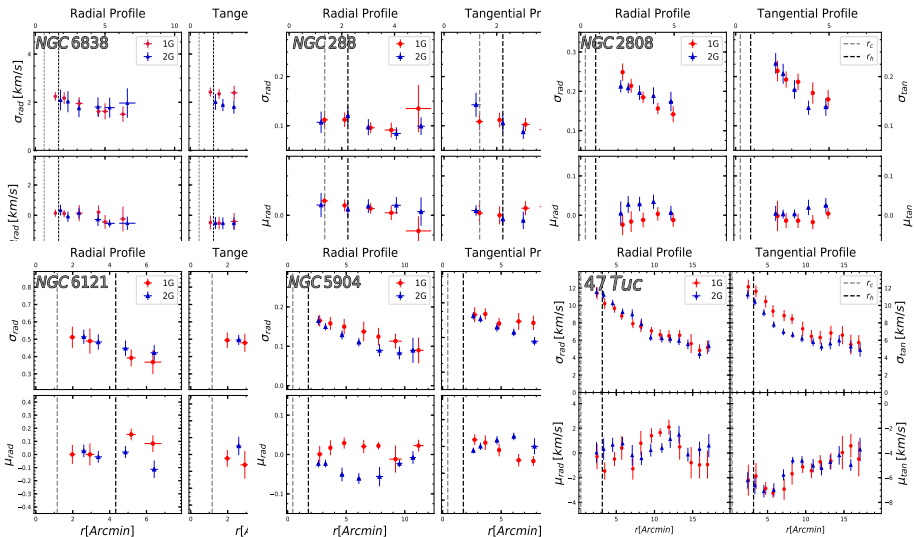
## NGC 6838

- No rotation
- No different dynamics

2 Possibilities:

- I) Relaxed Cluster, MPs are NOW mixed together
- II) 1G,2G are homogeneous

# Conclusions



# THANK YOU FOR THE ATTENION



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