

Star formation history of UGCA 92 and IC 342 group structure



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Abstract

We present quantitative star formation history of the nearby ($D=3.0$ Mpc) dwarf galaxy UGCA 92. This irregular dwarf is situated in the vicinity of the Local Group of galaxies in the zone of strong Galactic extinction (IC 342 group of galaxies). The galaxy was observed within our HST/ACS project number 9771 (PI I. Karachentsev) and resolved into stars including old red giant branch. We have constructed models of the resolved stellar populations and measured star formation rate and metallicity dependence on time. According to our measurements, the main star formation activity period occurred about 8 - 14 Gyr ago. These stars look mostly metal-poor, with the mean metallicity $[Fe/H]$ of about -1.5 - -2.0 dex. There are indications of recent star formation starting about 2 Gyr ago and enhanced moderately till to our time. It is very likely that the ongoing star formation period has higher metallicity of about -0.6- -0.3 dex. In our study we also have analysed the spatial structure of the IC 342 group and its possible influence on the star formation activity.

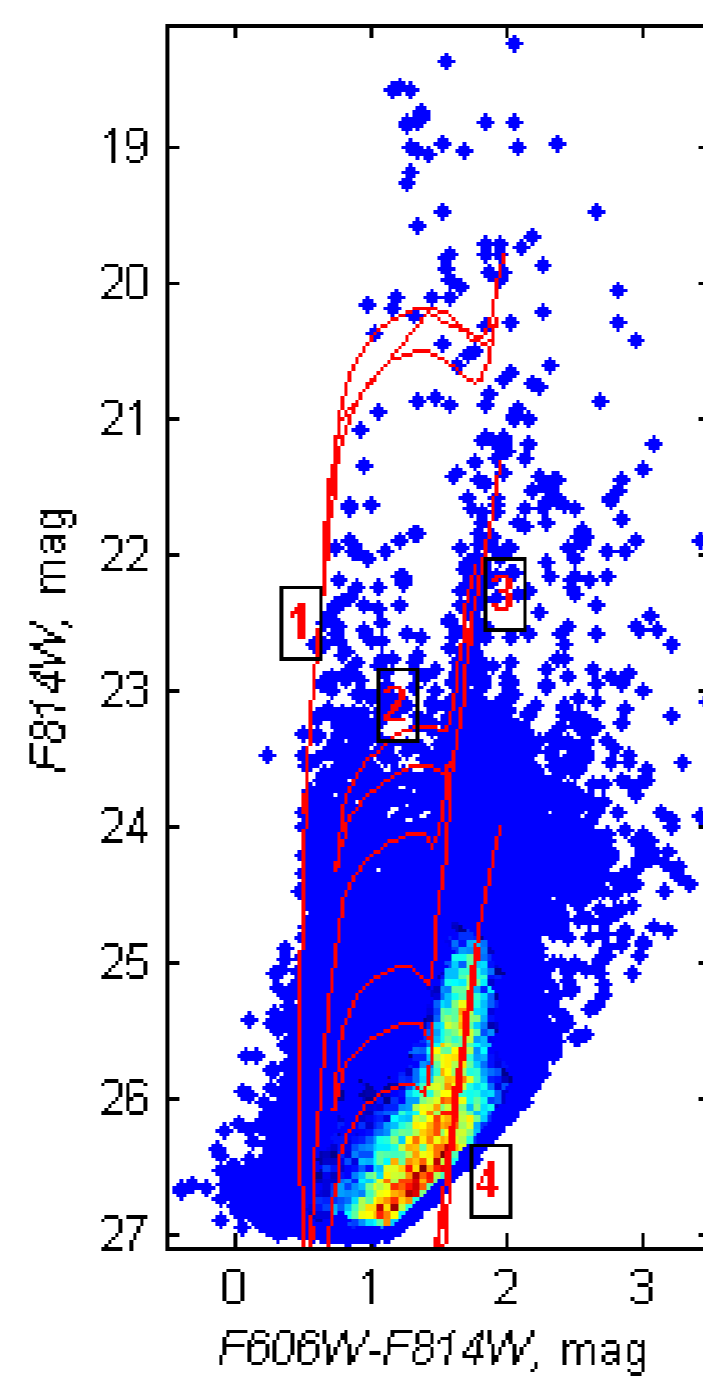
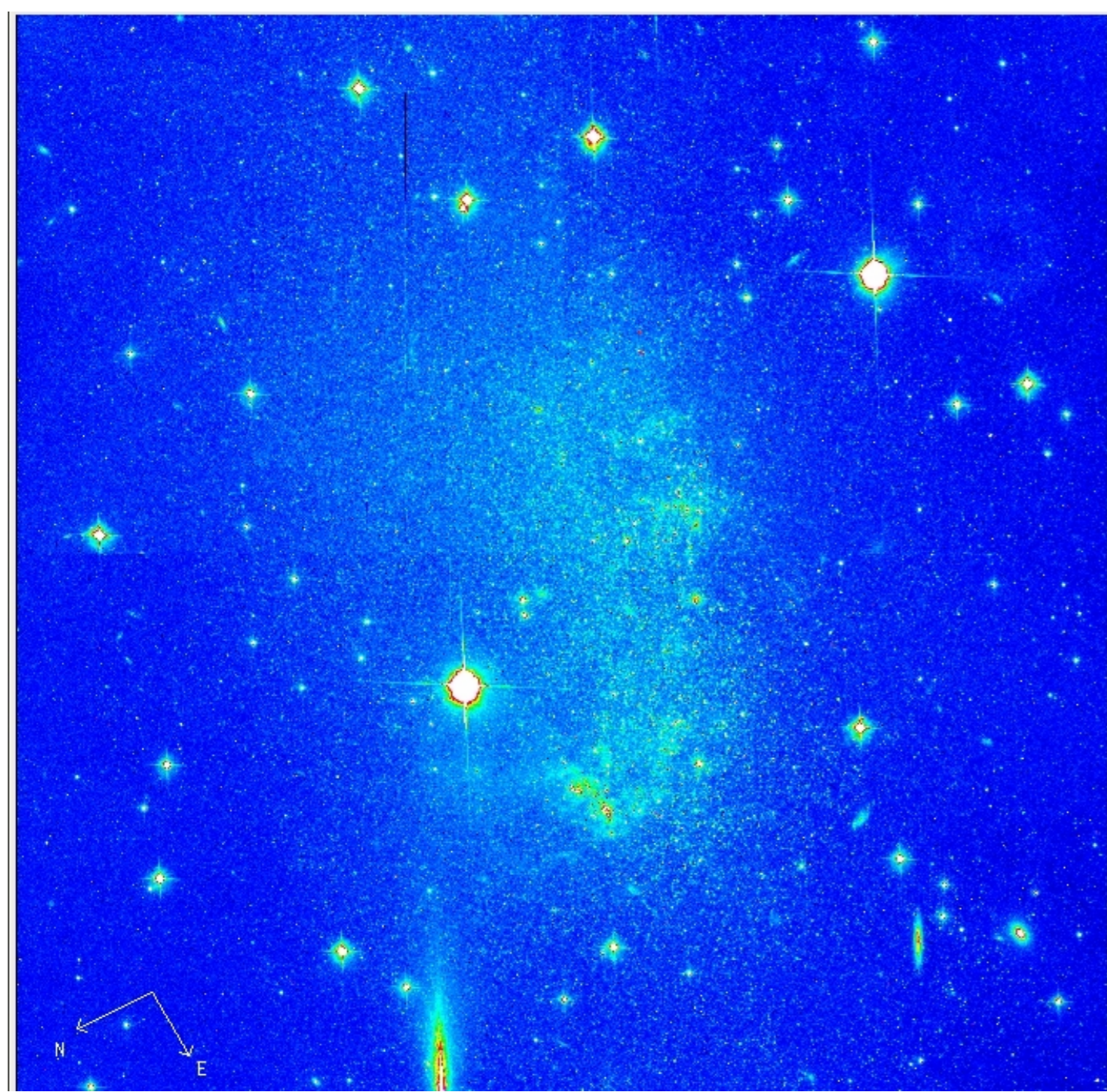


Fig.1 HST/ACS image of UGCA92 in F606W filter (left panel). The image size is 3.4×3.4 arcmin. The CMD of UGCA92 (right panel). Magnitudes are not corrected for Galactic extinction. The galaxy distance is 3.0 Mpc. Padova theoretical isochrones corresponding to the mean age and metallicity of detected star formation episodes were overplotted: "1" is $Z=0.008, t=10$ Myr; "2" - $Z=0.001, t=50$ Myr; "3" - $Z=0.0004, t=150$ Myr; "4" - $Z=0.0004, t=13$ Gyr.

Star Formation History

The star formation history (Fig. 2) was determined from the CMD using our **StarProbe** package (Makarov, Makarova 2004). According to our measurements, the main star formation event has occurred in the period 12 - 14 Gyr ago with the rather high mean star formation rate (SFR) about $1.4 \pm 0.1 \cdot 10^{-1} M_{\odot}/\text{yr}$. It is the total SFR over the whole galaxy. The metallicity range for the most stars is about $[Fe/H]=[-2.0:-1.5]$ dex. This initial burst accounts for about 86 % of the total mass of formed stars. There are signs of marginal star formation 4 - 8 Gyr ago. There are also indications of recent star formation starting about 1.5 - 2 Gyr ago and enhanced moderately till to our time. The mean SFR of the stars which were formed in the last 500 Myr is about $3.6 \pm 0.2 \cdot 10^{-2} M_{\odot}/\text{yr}$ and the mean metallicity is about -0.6 to -0.3 dex. The metallicity of the recent star formation event is determining with large uncertainty due to relatively poor statistic in comparison of sufficiently more numerous old stars.

Star formation and environment

The two galaxy subgroups, around IC342 and around Maffei1/Maffei2 could be seen in Fig. 3. Most of the complex members are dwarf irregular galaxies. The absence of dwarf spheroidal satellites subsystem in the group can imply that dSphs still were not discovered, because their lower surface brightness and high galactic extinction put serious observational limitation. UGCA92 is traditionally considering as the companion to famous starburst galaxy NGC1569. They have close radial velocities ($V_{LG}=89$ km/s for UGCA92 and $V_{LG}=88$ km/s for NGC1569). The linear distance between the galaxies is $D=0.36$ Mpc. The influence of UGCA92 often considered as probable reason of the burst of star formation in NGC1569. However, all the data known to date could not give us the particular age, when the series of distinct intensive star bursts in NGC1569 was started. Our data on recent star formation in the companion UGCA92 galaxy show substantial and continuous star formation in the last 500 Myr, which, probably, does not indicate direct connection between recent star formation in the two galaxies.

Observations and photometry

The dwarf irregular galaxy UGCA 92 was observed aboard HST using Advanced Camera for Surveys within our project number 9771 (PI I. Karachentsev). Two exposures were made with the filters F606W (V) and F814W (I). The photometry of resolved stars in the galaxy was made with the DOLPHOT package. ACS image of the galaxy and resulting colour-magnitude diagram are presented in Fig.1. All resolved stars are significantly shifted to the redder colours due to high extinction in the zone of the Milky Way ($E(B-V)=0.79 \pm 0.13$, Schlegel et al. 1998).

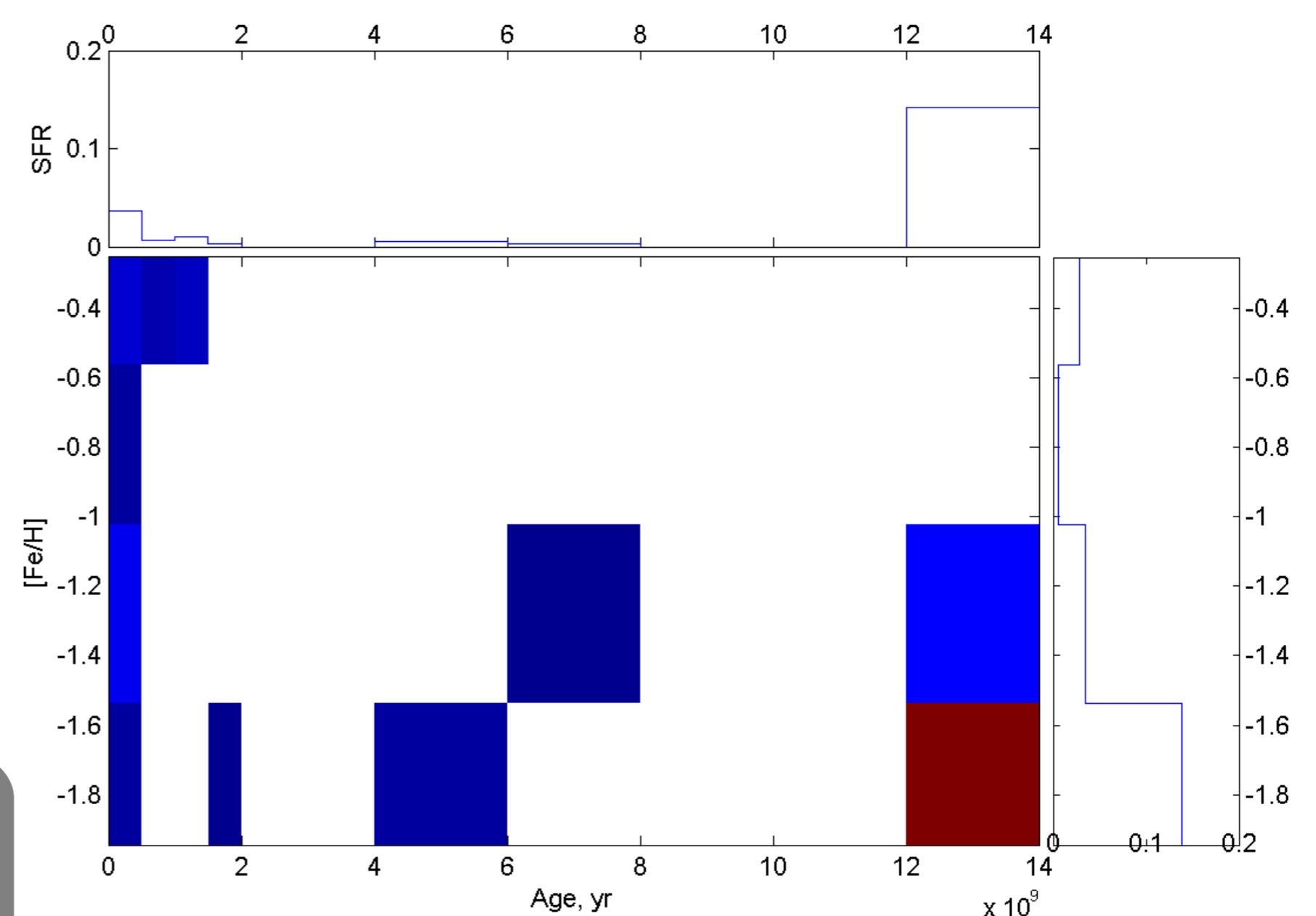


Fig. 2 The star formation history of UGCA92. Top panel shows the star formation rate (M_{\odot}/yr) against the age of the stellar populations. The bottom panel represents the metallicity of stellar content as function of age.

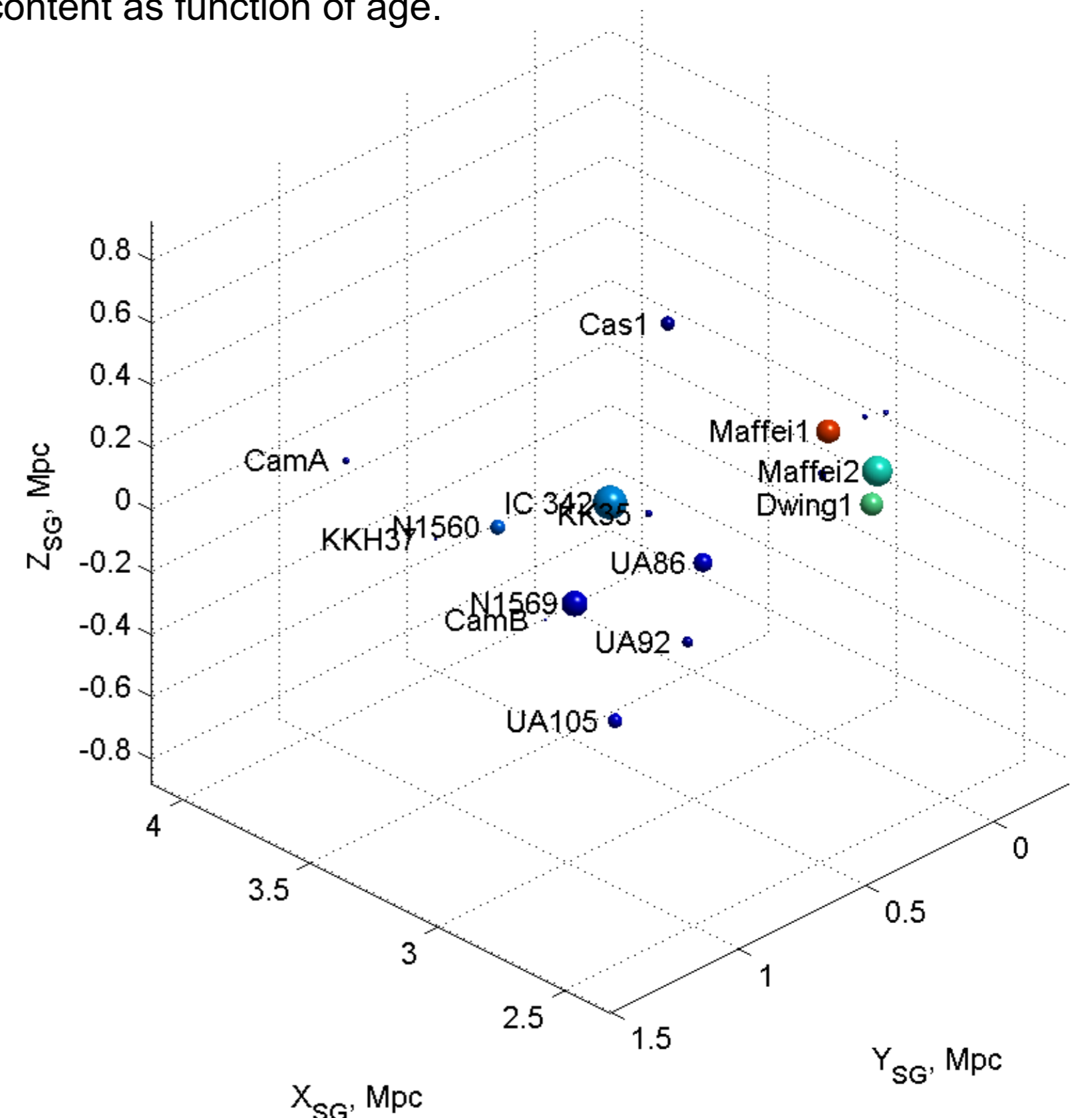


Fig. 3 The 3D structure of the IC342 group. Size of the data cube is $1.8 \times 1.8 \times 1.8$ Mpc. IC342 is placed in the center. The morphological types of the objects are coded by colour from the early types (E, red) to the late types (Irr, dark blue).