STARLINGS IN THE KINEMATIC SUBSYSTEMS OF TWO NEARBY ELLIPTICALS

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The spatial distributions of the mean luminosity-weighted stellar age, metallicity, and α/Fe ratio along both photometric axes of two nearby elliptical galaxies have been obtained using Lick index measurements on long-slit spectra (Lehman telescope of ODP/LNA) in order to reconstruct the star formation history in their kinematically distinct subsystems. Lick indices were compared with those obtained for a single stellar population (SSP) models. A population synthesis method was also applied in order to help disentangling the age-metallicity degeneracy of these line-strength indices. The results show that the α-enhancement is correlated with the kinematics: they are older and α-enhanced in the not rotating bulge of NGC 1052 and counter rotating core of NGC 7796, while they show a strong spread of α/Fe ratio and age along the rotating disk of NGC 1052 and an outward radial decreasing of them outside the core of NGC 7796.

Abstract

The star formation history inside an early-type galaxy is determinate by its formation process (merging, accretion, monolithic collapse or other). Specifically, the stellar metallicity and age radial gradients are dependent on the galaxy merging history (Schectman 2004). Moreover, the stellar population parameters like the age and metallicity might be correlated with the stellar kinematics. In this context, we have studied two distinct elliptical with intermediate ages belonging to low density regions of the local Universe: The Lick prototype E4 NGC 1052, which belongs to a loose group and has a stellar rotating disk, and the E1 NGC 7796 of the field, which shows a kinematically decoupled core (KDC).

The two ellipticals

• NGC 1052
  - E4/S0, z=0.00504, Mv=-20.50 (r=33.7”, r0=391”) 
  - Lick prototype showing radial X-ray jets (two bright points of 11 members) 
  - roller+rotating disk (α=90°) 
  - relatively well studied, including its sub-stellar populations

• NGC 7796
  - E1, z=0.01097, Mv=-20.79 (r=21.2”, r0=666”) 
  - isolated, found in a system with a stellar rotating core, compared to a single stellar population not investigated yet.

Observations

Long slit spectroscopic observations along both photometric axes (J14020-3636A, R=1800, 2.01 Å/pixel, ssn=0.71 km/s or FWHM=33Å, slit size of 2.08”×20”) were carried on the ODP/LNA Lick telescope with the spectrometer to about 10° spatial resolution. The linear spatial scales were 181 pixel/pc and 21 pixel/pc for NGC 1052 and NGC 7796, respectively (h0=75). The signal-to-noise ratio per Å for the aperture spectra are: for NGC 1052: 9.38 ± 1.346; 5.40 ± 0.96, for NGC 7796: 17.26 ± 5.979; 1.47 ± 0.26. The radial profiles of the line-of-sight rotational velocity Vrots and the line-of-sight radial velocity Vhelio curves were successfully compared with other studies. We have confirmed the presence of a stellar rotating disk (major axis) and a not rotating bulge in NGC 1052. The stellar rotating rotating core of NGC 7796 was detected as well. Read Kinematics analysis’ Section.

Lick index radial gradients

The Lick indices from Fe4383 to Na D were measured on the aperture spectra and properly calibrated on the Lick System. For NGC 1052 only, the Mg b, Hβ and Mg, and Mg were corrected due to the effect of emission lines (Goudinoulij & Emmelmann 1996), while Fe5015 and Hβ were excluded from the analysis. The gradients of several Lick indices along both axes were also computed. The central values of some indices agree with the literature ones.

NGC 1052

• The n0 index gradients are null (within the errors) except for α/Fe that increases (<+0.05 dex) along the negative major axis
• The Mg index gradients are null (within the errors) except for Mg, that increases (<+0.05 dex) along the positive major axis
• Hβ gradient is independent in both axes

NGC 7796

• There are no radial gradients in the metallicity for any radial position

Methods and Results: Comparisons with SSP models and population synthesis

Firstly, the analysis of Lick indices suggests a possible radial dependency for the Mg/Fe abundance ratio for both galaxies (and maybe for the C and Na abundances). We have compared our Lick indices with the predictions of the single-age stellar population models of Thomas et al. (2003) that take the influence of abundance variations on them into account. We have also performed a stellar population synthesis for each extracted spectrum applying the method of Bressan (1988). The relationship between the [Mg/Fe] and the star formation timescale tMg of Thomas et al. (2005) was employed as well.

From the SSP comparisons, we have obtained that the stellar populations in the bulge of NGC 1052 have [α/Fe]=0.02±0.15 and [Z/Z0]=1.0 in the disk, there is a strong spread of the Mg/Fe ratio (65/[Fe]=59±6.5) associated with a possible outward radial decreasing of the global metallicity to the solar value. In the core of NGC 7796, the populations have nearly [α/Fe]=0.41±0.05 and Z/Z0=0.83±0.12, while there is an outward radial decreasing of the Mg/Fe ratio to the solar value associated with a possible decreasing of the global metallicity and age.

The result of the population synthesis indicate that the nucleus of both ellipticals is dominate by old metal rich stars (~13 Gyr & Z0). The populations are more homogeneous in the bulge of NGC 1052 than along its disk, where there is an outward radial decreasing of the presence of the older-rich components together with a respective rising contribution of the younger-massive population. The populations in the core of NGC 7796 are analogous older ages and higher metallicities in the nucleus but with similar radial behavior of age and Z along both axes.

Comparisons with SSP models


Adopted grids

• Ager: 2, 5, 10, 12 and 15 Gyr 
• [Z/Z0]= -2.25, -1.5, -0.33, 0.0, +0.35 and +0.67 dex
• [Fe/Fe] = -0.5, 0.0, +0.3 and +0.5 dex

Stellar population synthesis

The method of Bressan (1988) - uses integrated spectra of star clusters of the Galaxy → SSPs adopts flux normalized spectra at 3830Å computes all spectrum combinations → best solution + E(B-V) magnitudes → age determination

Selected base of Z components

• old (G1, G2, G3) 10, 13, 15 Gyr with [Z/Z0]=0.0, -0.4, -1.1 dex
• young (Y1, Y2, Y3) 10, 25, 50 Myr with [Z/Z0]=2.00, -0.4, -0.5, -0.5 dex

Conclusions: star formation history and chemical enrichment

In the observed regions of both ellipticals, the α-enhancement is not homogeneous: there is a monotonous radial dependency in NGC 7796. The global metallicity has an outward decreasing, while the iron abundance is nearly constant outwardly. The ages show a strong spatial dispersion possibly connected to the α/Fe spread.

The stellar populations are associated with their kinematical properties: they are older and very α-enhanced in the not rotating bulge of NGC 1052 and the KDC of NGC 7796, while there is a strong dispersion of α/Fe and age along the rotating disk of NGC 1052 and an outward radial decreasing of them in NGC 7796.

The KDCs in the bulges of NGC 1052 and KDC of NGC 7796 was formed in an ancient short episode having provided an efficient chemical enrichment by SN-II, while in the NGC 1052 disk and outer parts of NGC 7796 the star formation occurred later with larger temporal scales, having made the enrichment by SN-Ia important. Specifically, for NGC 7796 an inside-out formation is plausible, while a merging episode with a drawn out star formation is more acceptable for NGC 1052.

References

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