2D Kinematical study in local Luminous Compact Blue Galaxies. Starburst origin in UCM2325+2318

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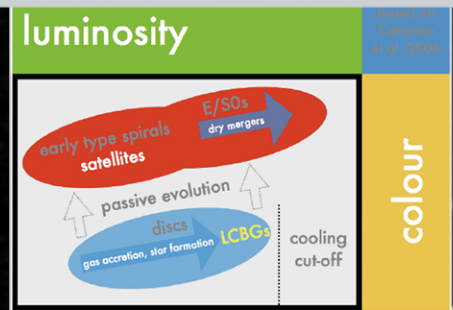
Abstract

Luminous Compact Blue Galaxies (LCBGs) are high surface brightness starburst galaxies bluer than a typical SBc and with typical luminosities ~L*, which are undergoing a major burst of star formation. LCBGs are the closest counterparts to the large population of starburst galaxies observed at high redshift, including Lyman-break galaxies at z~2. However, because LCBGs are very rare in the nearby Universe, their properties are still largely unknown. We have selected a representative sample of LCBGs from the SDSS and UCM databases which, although small, provides an excellent reference for comparison with current and future surveys of similar starbursts at high-z. We are carrying out a 2D optical spectroscopic study of this LCBG sample, including spatially resolved maps of kinematics, extinction, SFR and metallicity. This will help us to answer questions regarding the nature of LCBGs: (i) What is the role of mergers or other interactions in triggering the burst of star formation?; and (ii) What is the role of Active Galactic Nuclei (AGN) and supernova (SN) driven galactic winds in quenching the star formation and limiting the stellar mass?
Here we show our results on the kinematical analysis for 22 galaxies in the local LCBGs sample. The analysis of the physical properties for each galaxy in on progress and we show here the case of UCM2325+2318 as an example.

What mechanisms are responsible for triggering and quenching the current star formation in LCBGs?



LCBGs may be key to test the evolutionary scenario between the "blue cloud" and the "red sequence.

Observations and analysis

Objects from our sample were observed using PPAK IFU mode CAHA. Two different configurations were used: 300 lines/mm grating (V300) centered at 5316 A (10.7 A FWHM spectral resolution) and 1200 lines/mm grating (V1200) centered at 5040 A (2.78 A FWHM spectral resolution).
Emission lines were fitted by single Gaussian profiles both in the V300 (Hα) and V1200 ([OIII]λ5007) configurations. In some cases the presence of double emission line components was addressed by a double Gaussian profile fit in the data with higher spectral resolution.

The **velocity fields** of the galaxies were created by measuring the centroids of the Hα emission lines for each dithering with the low resolution spectra. The measurements for each dithering position were then interpolated down to a spatial resolution of 1 arcsec/pixel yielding a 60 × 60 pixel2 square grid.
The **velocity width maps** of the galaxies were derived from the [OIII]λ5007 emission lines for each dithering position with the high resolution spectra.

We classify the kinematics of these galaxies into three different classes:

Rotating disks (RD): The velocity map shows an ordered gradient, and the dynamical major axis is aligned with the morphological major axis. The velocity width map indicates a peak close to the dynamic center.

Perturbed rotation (PR): The kinematics show all the features of a RD, but the peak in the velocity width map is either absent or clearly shifted away from the dynamical center.

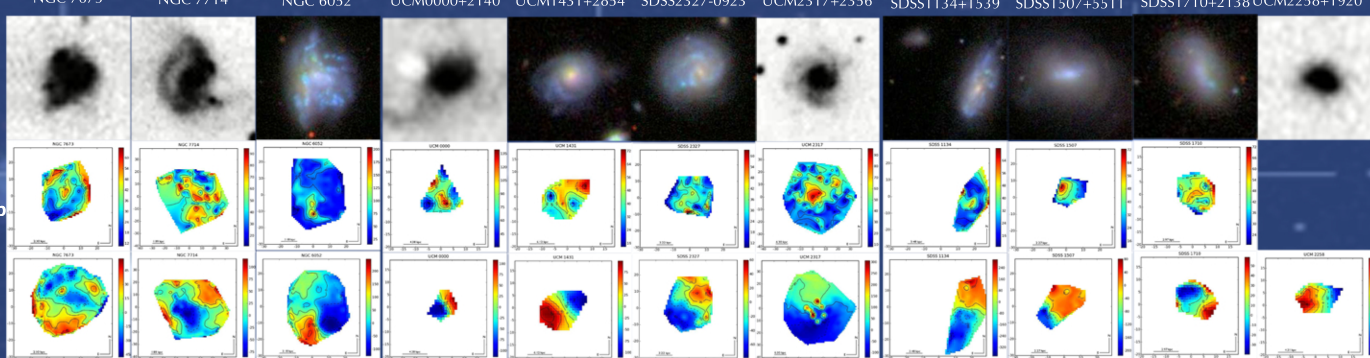
Complex kinematics (CK): Neither the velocity map nor the velocity width map are compatible with regular disk rotation, including the velocity maps that are misaligned with the morphological major axis.

Rotating disks

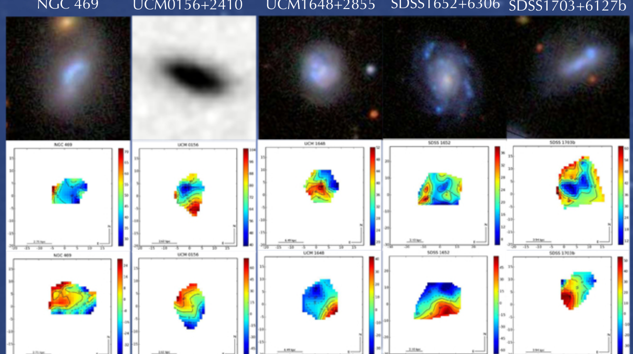
Continuum image

PPAK Velocity width map

PPAK Velocity map



Perturbed rotation

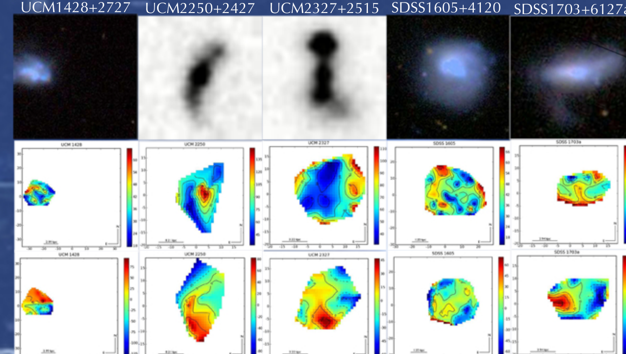


Continuum image

PPAK Velocity width map

PPAK Velocity map

Complex kinematics



Conclusions

We address the following two fundamental questions through the study of the kinematic maps:

(i) What processes are triggering the current starburst in LCBGs?

We search our maps of the galaxy velocity fields for signatures of recent interactions and close companions that may be responsible for the enhanced star formation in our sample.

We find 5% of objects show evidence of a recent major merger, 10% of a minor merger, and 45% of a companion. This argues in favor of ongoing interactions with close companions as a mechanism for the enhanced star formation activity in these galaxies.

(ii) What processes may eventually quench the current starburst in LCBGs?

Velocity and velocity width maps, together with emission line ratio maps, can reveal signatures of Active Galactic Nuclei (AGN) activity or supernova (SN) driven galactic winds that could halt the current burst.

We find only 5% of objects with clear evidence of AGN activity, and 27% with kinematics consistent with SN-driven galactic winds. Therefore, a different mechanism may be responsible for quenching the star formation in LCBGs.

We find **48% are RDs, 28% are PRs, and 24% are CKs**.
RDs show rotational velocities that range between 50 and 200 km/s, and dynamical masses that range between 1×10^{9} and 3×10^{10} Msolar.

Those objects in our representative sample of 22 LCBGs which show rotating natures can be compared with the spiral galaxies used to calibrate the Tully-Fisher relation (Tully & Pierce 2000). A dispersion five times higher than the one found for spiral galaxies implies that the velocity widths of those LCBGs that rotate, rather than accounting exclusively for this rotation, may also include other kinematic components.

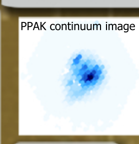
UCM2325+2318 (NGC 7673)

Results on the starburst origin

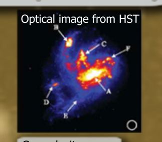
Our kinematic study shows an asymmetrical ionized gas velocity map, where a decoupled kinematic component is found at the position of clump B. This region results peculiar not only from the kinematic study but also from different physical properties. This region, with the highest Hα emission equivalent width and star formation surface density, is composed of young (we detect the presence of WR stellar population) and intermediate age clusters where the underlying stellar population shows the absence of strong absorption features. We find no evidence for neither AGN activity nor SNe galactic winds in this kinematically decoupled component, and from the derived metallicity and luminosity, clump B is in agreement with being an extremely giant HII region or an in-falling dwarf galaxy.
Between the possible mechanisms to explain the starburst activity in this galaxy, our 2D spectroscopic data support the scenario of an on-going interaction with the possibility for clump B to be the dwarf satellite galaxy.

Castillo-Morales et al. 2011
Pérez-Gallego etal. 2010

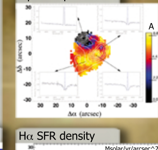
PPAK continuum image



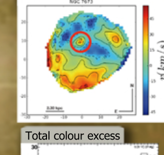
Optical image from HST



Hβ absorption EW

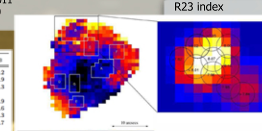


Gas velocity

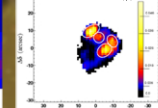


Region	R23	12+log(O/H)	M_B
NGC 7673	0.72	8.20±0.15	-20.2
Clump A	0.68	8.12±0.12	-17.9
Clump B	0.73	8.23±0.15	-17.3
B Surroundings	0.76	8.30±0.20	-
Clump C	0.73	8.21±0.16	-16.9
Clump D	0.69	8.14±0.12	-15.6
Clump E	0.69	8.15±0.14	-15.3
Clump F	0.73	8.21±0.16	-16.7
Region G	0.64	8.07±0.11	-

R23 index



Hα SFR density



Total colour excess