Optical spectroscopy of nearby LINERs

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Low-Ionization Nuclear Emission-line Regions (LINERs) are the least luminous and the most numerous among the local population of AGNs. They can be classified as type-1 or type-2 if their spectra show or do not show, respectively, a broad component which could be associated with the presence of a Broad Line Region (BLR). However, recent studies have proven that the classification of LINERs may be controversial for some objects, since space- and ground-based spectroscopy provide contradicting results on the presence of very broad components. We have studied the nuclear spectra of 9 type-2 and 21 type-1 LINERs with HST/STIS, Palomar and TWIN/CAHA data (Cazzoli et al. 2018; Hermosa-Muñoz et al. 2020). In this work we present the results of our analysis of the different spectral components, we discuss the eventual presence of BLR components in type-2s, together with the possible presence of outflows, both to be compared to type-1s.

Status of outflows in LINERs

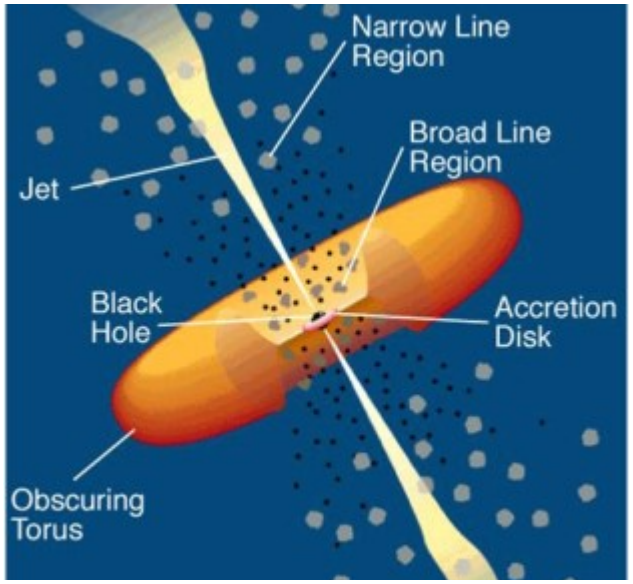
→ **LINERs** (Low-Ionisation Nuclear Emission-line Regions) are the low-luminosity end of Active Galactic Nuclei (AGN).

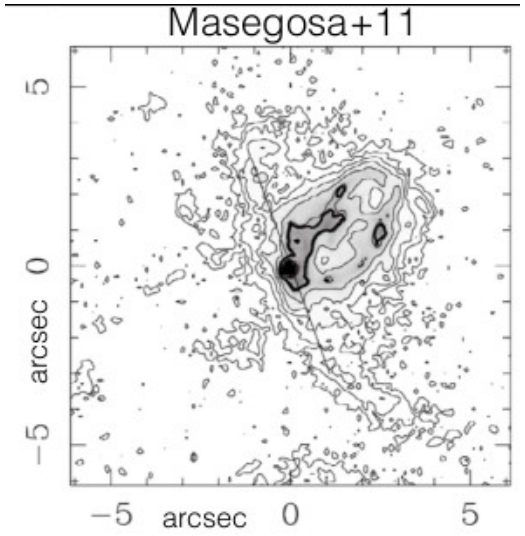
→ **Type-1 or 2** (L1 / L2) depending on if their optical spectra show a broad component in the Hα line or not (Ho et al. 1993), produced by the **Broad Line Region** (BLR) of the AGN, visible for type-1s.

→ **Outflows** are common in many galaxy types, including powerful AGNs. In LINERs they were studied only in Ho et al. (2003) and for some individual targets, but lacked from a complete sample and analysis until now (Cazzoli et al. 2018; Hermosa-Muñoz et al. 2020).

Our **main objectives** are to study:

1) the presence of different kinematic components, as outflows, in LINERs
2) the detectability of the BLR, in order to unveil their true nature.





Sample and methodology

Sample: 22 L1 from the Palomar Survey, *Ho+97*

z ~ 0.006 and D ~ 30 Mpc

TWIN @ CAHA 3.5m
- 20 LINERs
- slit width 1.2" – 0.5 Å/pixel

ALFOSC @ NOT 2.5m
- 2 LINERs
- slit width 1.0" – 1.5 Å/pixel

HST / STIS *Balmaverde+14*
- 12 LINERs, only red bandpass
- slit width ≤0.2" – 0.6 Å/pixel

Sample: 9 L2 from the sample of *González-Martín+09*

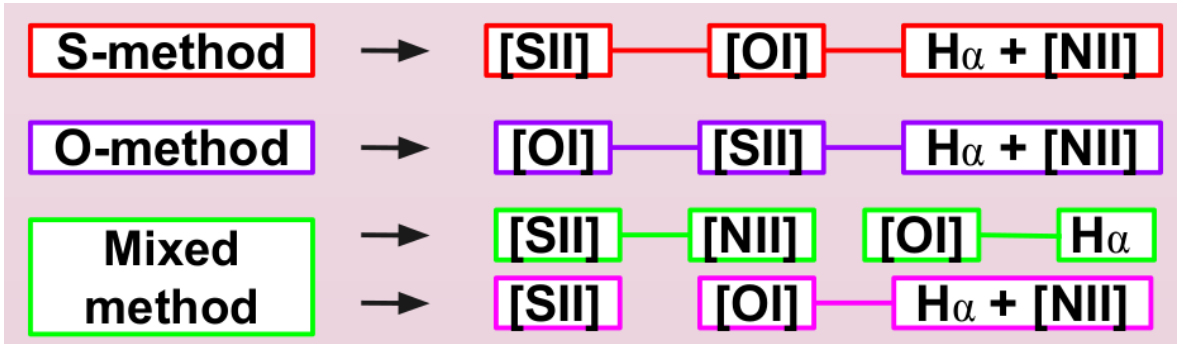
z ~ 0.005 and D ~ 27 Mpc

HST / STIS
- 9 LINERs, only red bandpass
- slit width 0.1"/0.2" – 0.6/1.1 Å/pixel

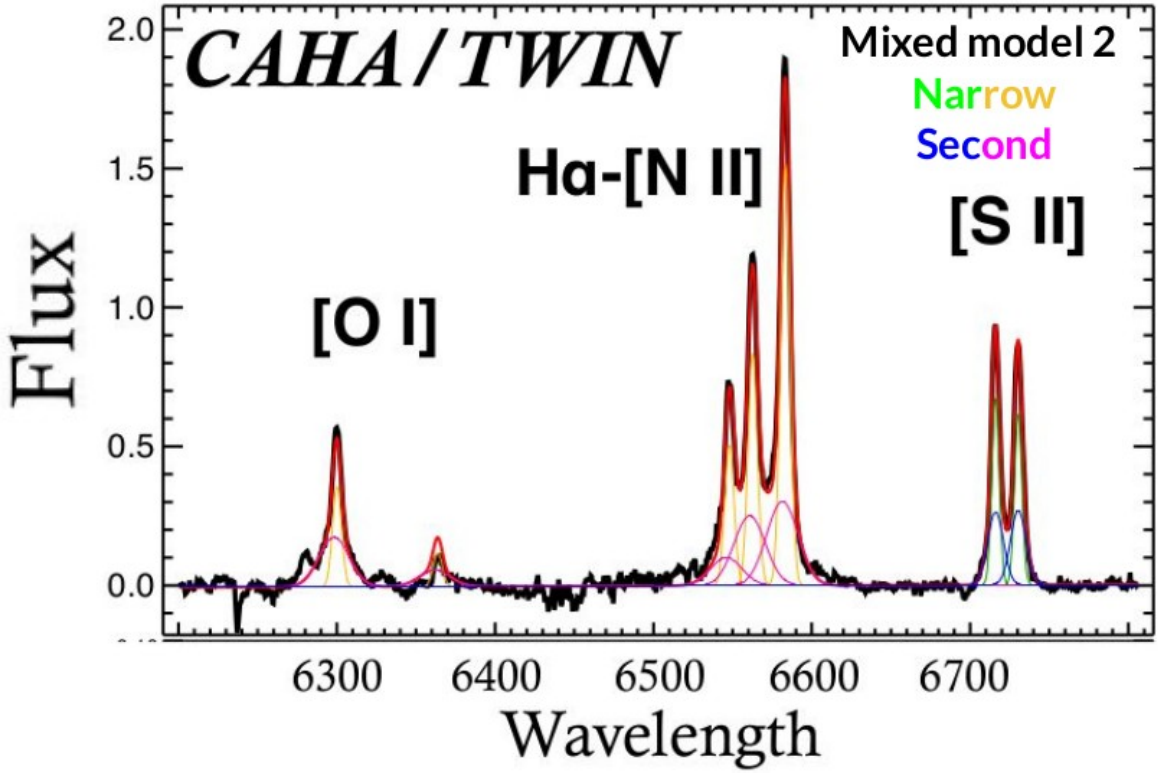
Hale / Palomar *Ho+95*
- 8 LINERs, only red bandpass
- slit width 2.0" – 2.5 Å/pixel

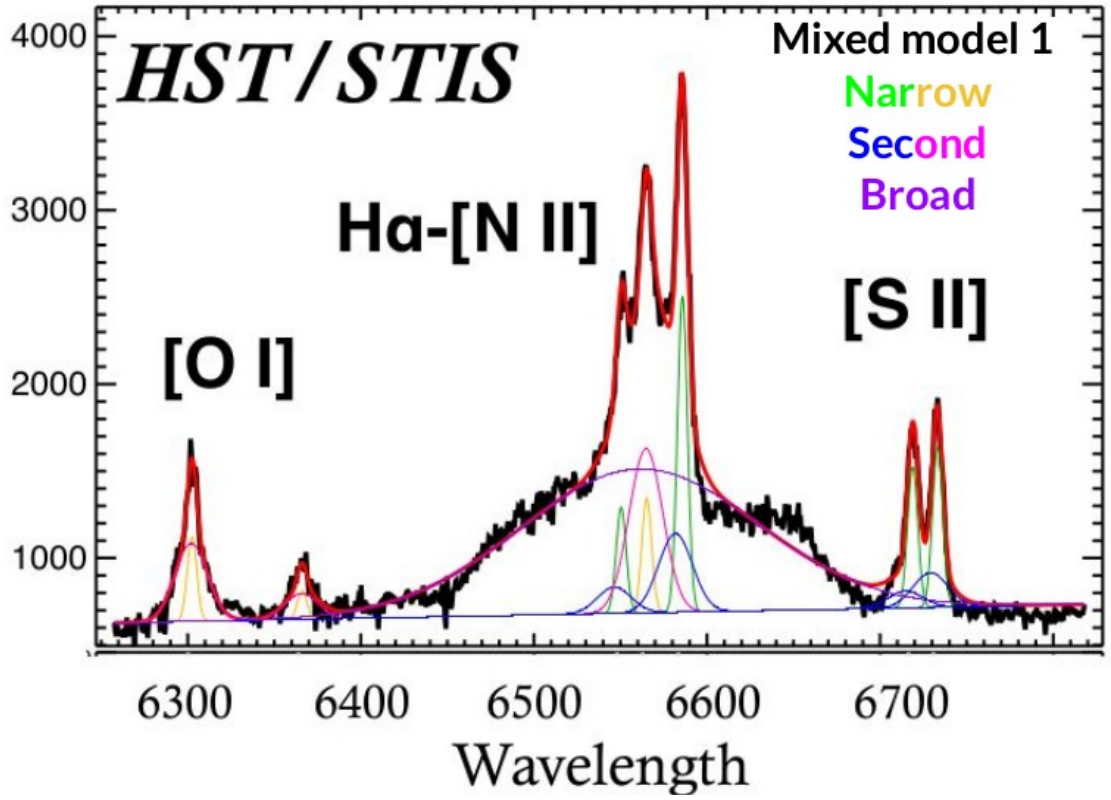
→ Multi-gaussian fitting, up to 2 components per forbidden line plus a very broad component for the BLR.

→ 3 different methods in order to account for the stratification of the Narrow Line Region.



Main results: differences in the spectra

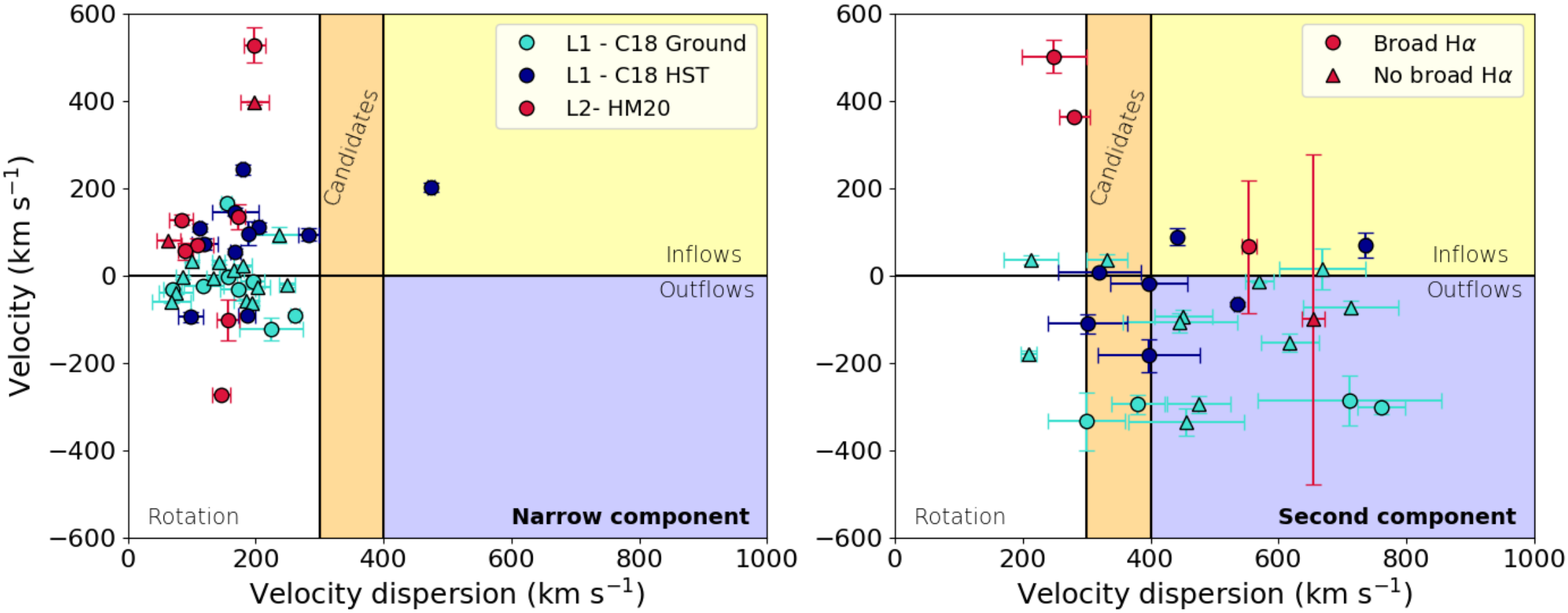




→ Large **differences between** the **ground**- and **space**-based spectra for some objects.

→ Unique works to systematically search for outflow signatures in LINERs, re-analysing HST data to unify the study (Cazzoli et al. 2018, Hermosa-Muñoz et al. 2020).

Main results: candidates to outflows



→ All **narrow** components are ascribed to **rotational** motions from the disc of the galaxies.

→ The **secondary** components fall in rotational and non-rotational motions, with **11 outflow candidates**.

Conclusions and future work

1) A **BLR** component is detected in **7/9 type-2 and 12/12 type-1** LINERs with the **HST** data. A secondary component compatible with **outflows** is detected in **2 type-2 and 9 type-1** LINERs.

2) **NGC 4594** is the only type-2 LINER with a broad detection in both ground- and space-based spectra. We propose its **reclassification as a type-1** LINER.

3) The broad component is (not) visible in some optically classified type-2 (type-1) LINERs, with differing results from space- to ground-based data. The detection of a broad component is favored with HST data due to their much better spatial resolution.

4) Further results, as the analysis of the NaI absorption doublet and line-ratios can be found in **Cazzoli et al. (2018) and Hermosa Muñoz et al. (2020)**.

5) We are now analysing **IFU** data for the outflow candidates to fully characterise them and confirm its presence in these LINERs with MEGARA@GTC and MUSE@VLT data.