The L-σ relation for HII galaxies

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INTRODUCTION

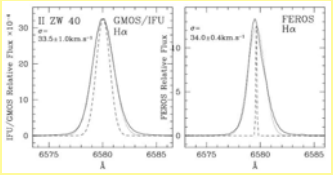
HII galaxies are low-mass metal-poor galaxies in the local universe whose properties (small sizes, irregular, blobby morphology, low mass, low metallicity, enhanced star formation activity) are expected to mimic young galaxies at high redshift that possibly represent the primordial building blocks of galaxy formation according to the hierarchical scenario of structure evolution.

One particular property regards the existence of a correlation of the integrated emission line Luminosity L(Hβ) with the observed line width σ (Terlevich & Melnick 1981, Melnick et al. 1988, Telles & Terlevich 1993). Once calibrated this relation is a powerful tool to be used as a cosmological distance indicator or probe of dynamical masses in galaxies (Melnick, Terlevich & Terlevich 2000).

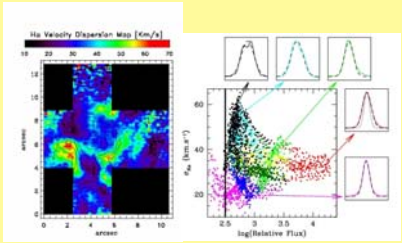
The validity of this application to high redshift has not yet been tested. We, however, have investigated the [L-σ] relation for a homogeneous sample of about one hundred local HII galaxies (z < 0.1), using accurate line widths from high resolution spectra from FEROS on the 1.52m ESO at La Silla, and spectrophotometry from our uniform observations given by Kehrig, Telles & Cuisinier (2004).

THE ORIGIN OF THE SUPERSONIC LINE WIDTHS: Stellar Winds & Supernova or gravity?

We (Bordalo, Plana & Telles 2008) have used GEMINI-IFU for a kinematic study of the prototype HII Galaxy **II Zw40**, in order to decouple the effects of stellar evolution, affecting the broad components of the integrated profiles, with the narrow component associated with random motions . It is this narrow component which is responsible for the existence of the L-σ relation.



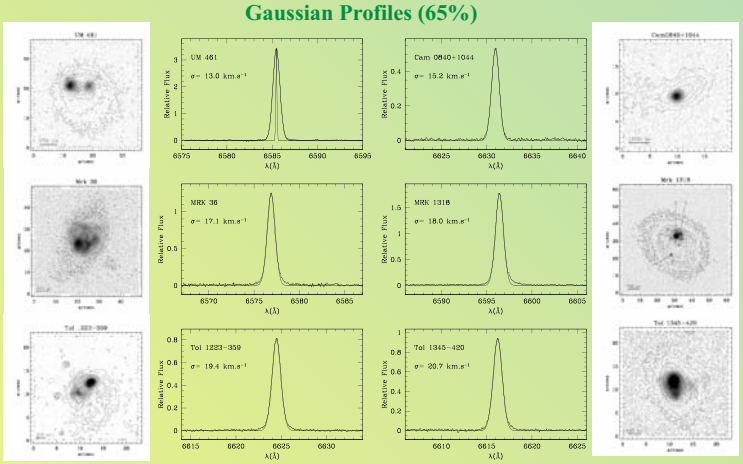
Left: Integrated GMOS-IFU Hα line.
Right: Core FEROS Hα line of II Zw 40.
The core line width measures the integrated overall dispersion of the starburst region (see also Telles etal 2001).



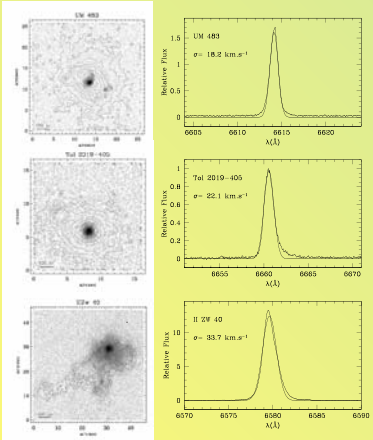
Left: Gemini IFU Velocity Dispersion map of IIZw40.
Right: Kinematic Diagnostic Diagram (Muñoz-Tuñón etal 1996). High dispersion points at low intensities are likely associated with expanding shells and stellar winds (no SN yet). The high intensity core dominates the integrated line width, and is due to random motions, possibly probing the gravitational potential.

Hα FEROS LINE PROFILE TYPE vs. Morphology NTT Hβ images (Lagos, Telles & Melnick 2007)

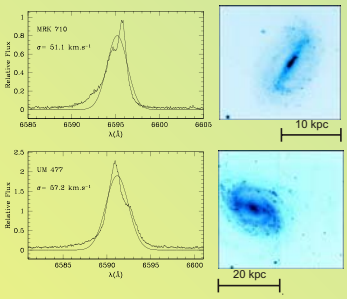
Gaussian Profiles (65%)



Irregular Profiles (20%)

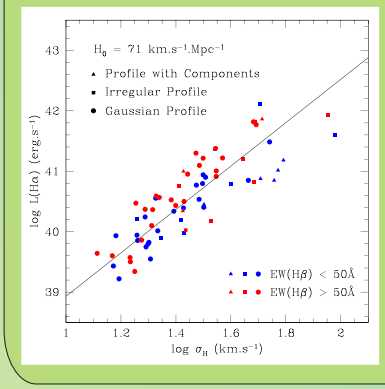


Profiles with components (15%)



$L(H\beta) \propto \sigma^4$

Correlation or Upper Envelope?
Fundamental Plane?



Left graph shows the [L – σ] relation for 70 galaxies for which we have fluxes and equivalent width Hβ from kehrig et al. spectrophotometry. The solid line represents the bi-variate fit linear fit.
logL(Hα) = (3.59±0.27)logσ +(35.34±0.38)
RMS = 0.38

PCA results:

We used the PCA technique to identify a second parameter in [L- σ] relation. Here EW(Hβ) appears to be a possible second parameter in [L- σ] relation, representing 33.6% of the variability as a second principal component.

CONCLUSIONS

- HII galaxies show a [L – σ] relation that can be calibrated and used as cosmological distance indicator and probe galactic masses
- Line profiles indicate morphological features due to massive stellar evolution
- Core line width measurement dominates the integrated profile
- Narrow line component probes random motions, likely to be associated with the gravitational potential.
- EW(Hβ) is a possible second parameter in [L – σ] relation

We must further investigate how these derived motions precisely relate to the underlying mass distribution, the possible evolutionary effects of the starburst on the observed Luminosity-σ relation and how they can be parametrized, and the proper application to high redshift galaxies (galaxy families).

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ET acknowledges his US GEMINI Fellowship by