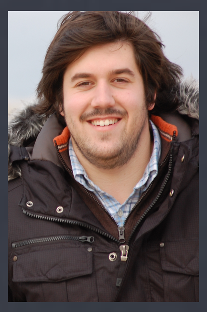

Galaxy morphology and spectrophotometric properties up to z∼6

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VIMOS Ultra Deep Survey

The VIMOS Ultra Deep Survey (VUDS) [1] is a spectroscopic redshift survey of 10.000 galaxies ($22.5 < I_{AB} < 25$) to study the major phase of galaxy assembly $2 < z \lesssim 6$. The survey covers 1 deg^2 in 3 separate fields: COSMOS, ECDFS and VVDS-02h, with targets selection based on an inclusive combination of photometric redshifts and color properties.

Morphology at high redshift

Locally, galaxy shapes are arranged in the well established Hubble Sequence. However, as we move towards the edge of the universe, galaxies have more and more irregular shapes [2].

Primary Class	Secondary Class
Compact	Compact
	Point-like
Extended	Round Shape
	Elliptical Shape
	2 centered components
Irregular	Elongated
	Cometary/Tadpole
	Multicore/Clumpy
Diffuse	Symmetric
	Asymmetric
Too Faint	

A sample of 297 galaxies with redshifts from VUDS and CANDELS data [3, 4] have been visually classified by 9 people, through a graphical interface.

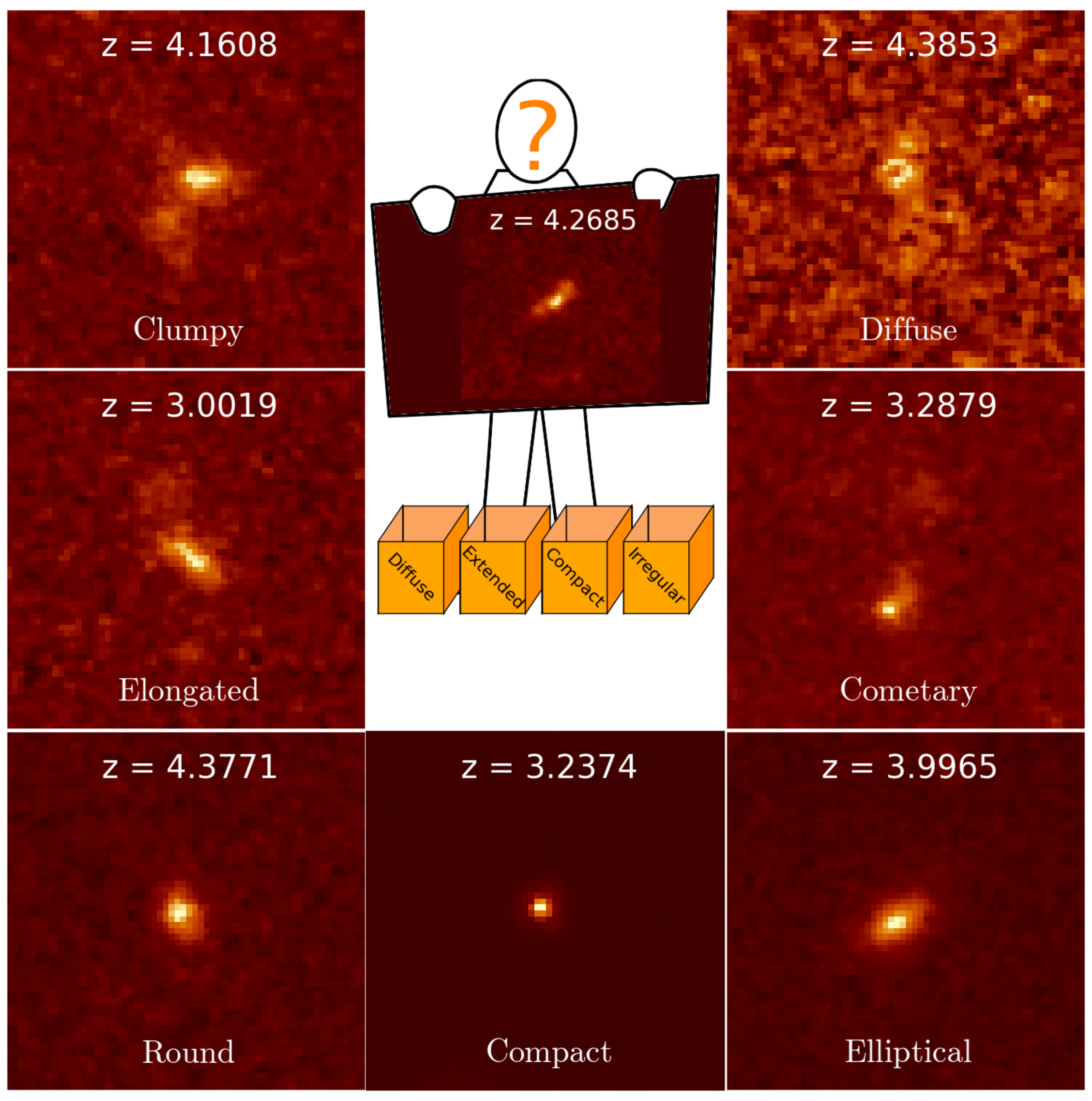

Figure 1a) The most common classes of galaxies portrayed in 3.72″ × 3.72″ F160W band cutouts.

Morphology and Ly-α

With our classification we investigate the evolution of different morphological classes over ∼2 Gyr from $z \sim 5$ to $z \sim 2$ (Figure 3a), and the connexion between Lyman-α emission and morphology (Figure 3b).

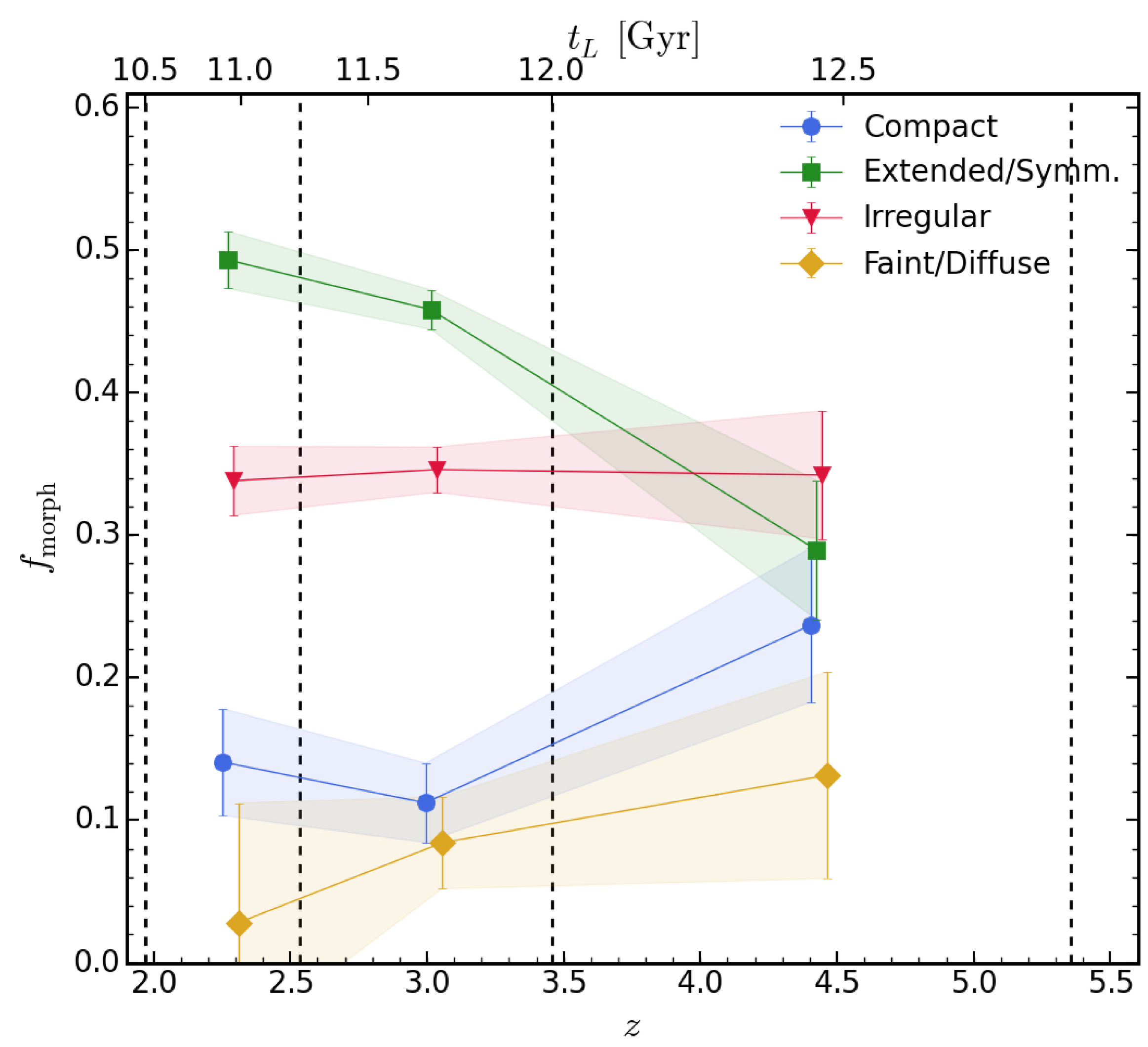

Figure 3a) evolution of the fraction of galaxies of different morphology classes from $z \sim 5$ to $z \sim 2$ as seen from F160W. These fractions are not corrected for surface brightness dimming nor resolution effects.. The vertical dashed lines delimit the redshift bins considered.

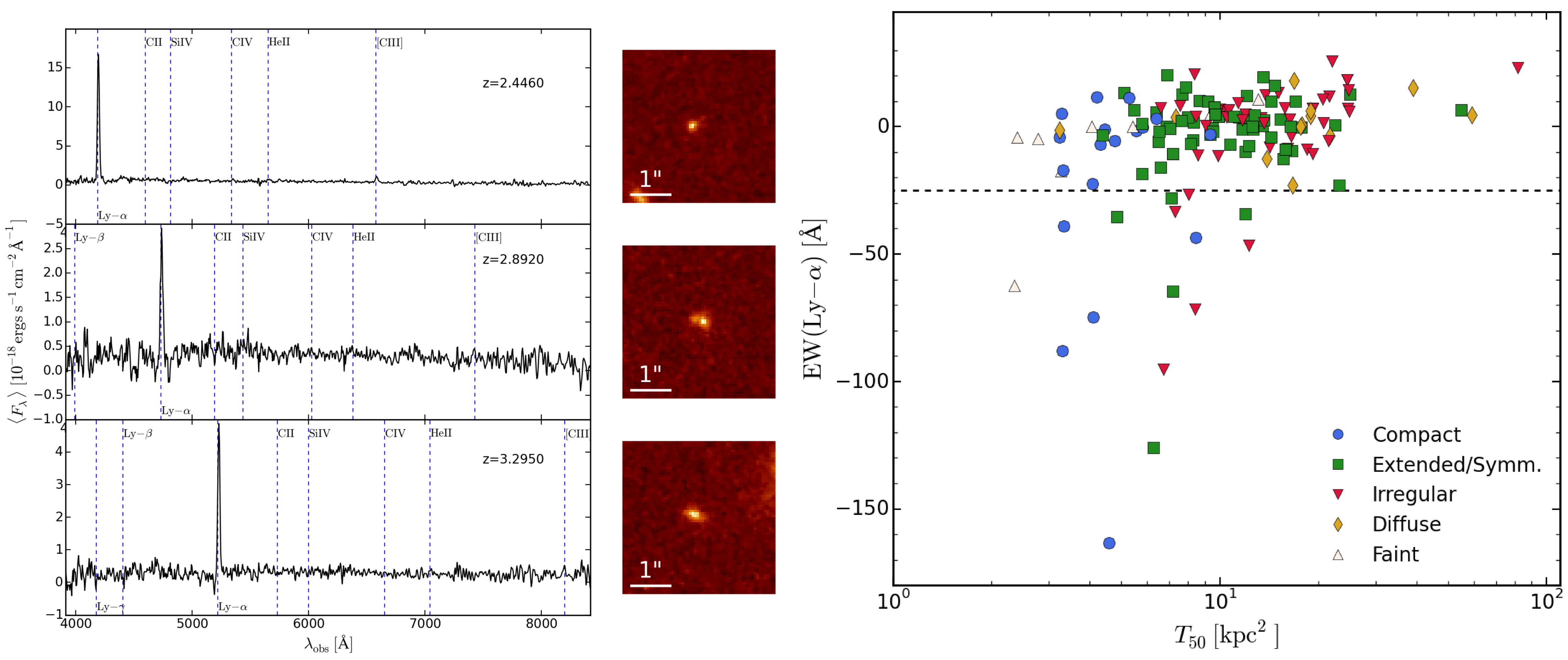

Figure 3b) Three strong LAE examples and Ly-α equivalent width (EW) vs. galaxy size T_{50}. The morphology class of galaxies is indicated by the different symbols. The EW(Ly-α) is measured directly on VUDS spectra [6]. LAE with EW<-25 show irregular, compact and extended/symmetrical morphologies in the F160W band in similar fractions. These LAE are more common in smaller galaxies.

Morphological Classes

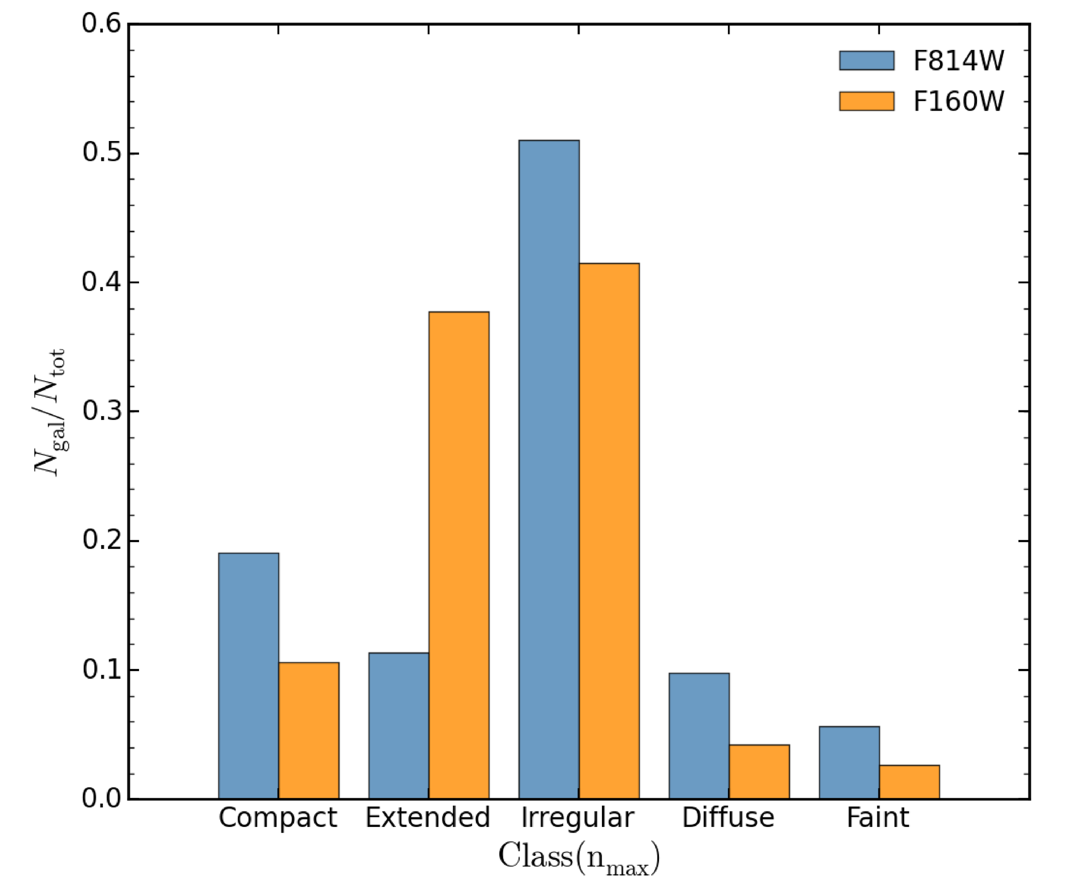

Figure 2a) Primary class distribution in different bands.

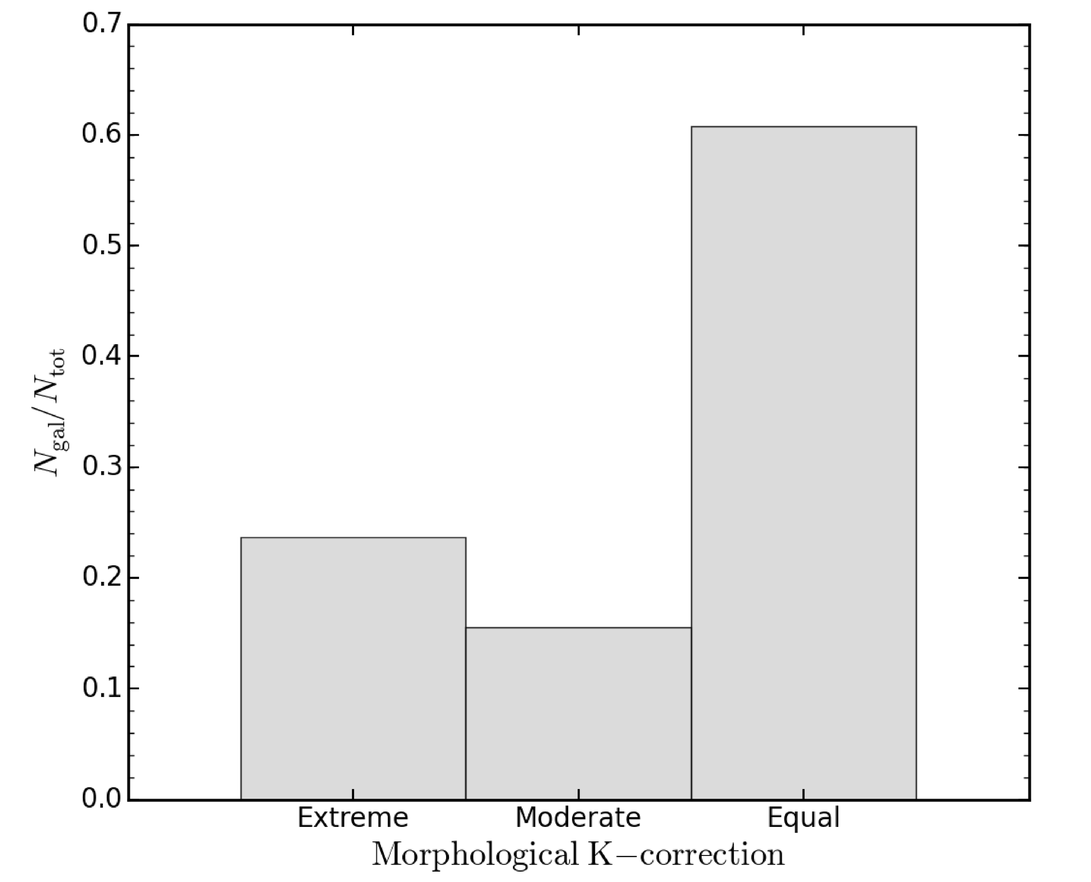

Figure 2b) Differences between observed bands. **Extreme**: ≠ primary; **Moderate**: = primary, ≠ secondary. **Equal**: = primary, = secondary.

Size Estimates

To measure the size of one galaxy, there are two main methods. Either one parameterizes the galaxy profile to obtain a size parameter, or we measure it directly. The second approach has the advantage of being independent of any asymmetries that the galaxy may have. And since most of the galaxies of our sample show clear irregular morphology we opted for the second method to infer the physical size which is given by [5],

$$T_\alpha = N_\alpha L^2 \left(2 \times 10^{-11} \frac{\text{ster}}{\text{arcsec}^2}\right) D_A^2.$$

where N_α is the number of pixels of size L (in arcsec/pixel) that sum up to α% of the galaxy measured flux and D_A is the angular diameter distance from cosmological models.

Summary

- **Irregular galaxies are predominant on the highest redshifts $z \sim 3.5 - 5$**
- **Extended/Symm. galaxies are the most common at $z \sim 2 - 3.5$**
- **No preferred morphology class for LAEs**
- **LAEs are more common in smaller galaxies**

References

[1] Le Fèvre, O. et al. 2015 A&A, 576
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[5] Law, D. et al. 2007, ApJ, 656, 1
[6] Cassata, P. et al. 2015, A&A 573, 24