The Nature of Star Formation within Bars using the CARS Sample

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Summary

Various authors have observed a lack of star formation within the bar region of some barred disc galaxies, while other galaxies show significant star formation in their bars (e.g. Phillips+1996). The absence of star formation can theoretically be explained by shear. Gas clouds that are travelling along the bar are subject to a velocity gradient perpendicular to the bar major axis. The resulting shear can disrupt the clouds and prevent them to collapse and form stars (Reynaud & Downes 1998, Emsellem+2015). In this work, we combine spectroscopic parameters with photometric properties in order to study how star formation can be inhibited in galaxy bars. We use spatially resolved Hα flux from VLT/MUSE observations of 16 nearby barred galaxies together with a detailed two-dimensional photometric image decomposition to explore how the absence and presence of star formation within the bar is connected to structural properties of the bar and the host galaxy.

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Motivation

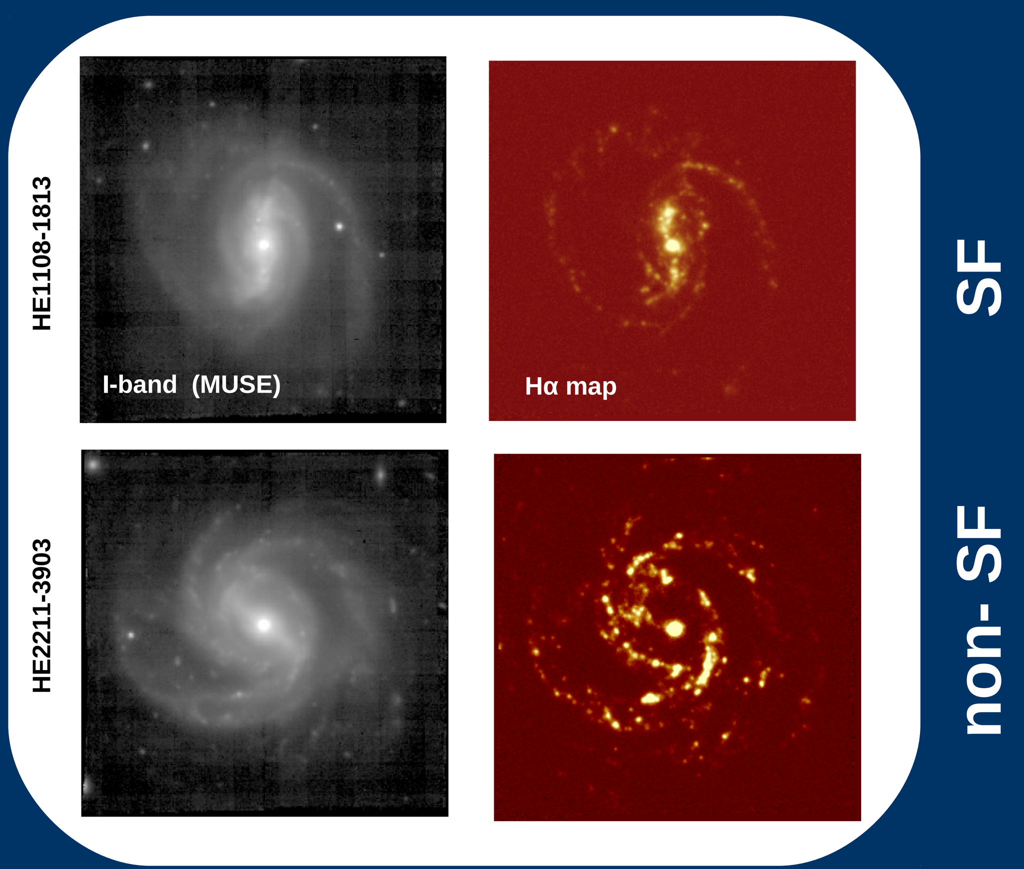

Fig. 1: MUSE pseudo i-band images (left) and Hα maps (right) for two different galaxies of the sample.

Both galaxies shown here are of similar morphological type and clearly strongly barred, yet excluding the central spot we only see Hα in one of the bars implying ongoing star formation along the bar. All 16 galaxies of our sample separate into these two groups of either star forming or quiescent bars. This raises the question: what is causing or inhibiting star formation in galaxy bars.

Results

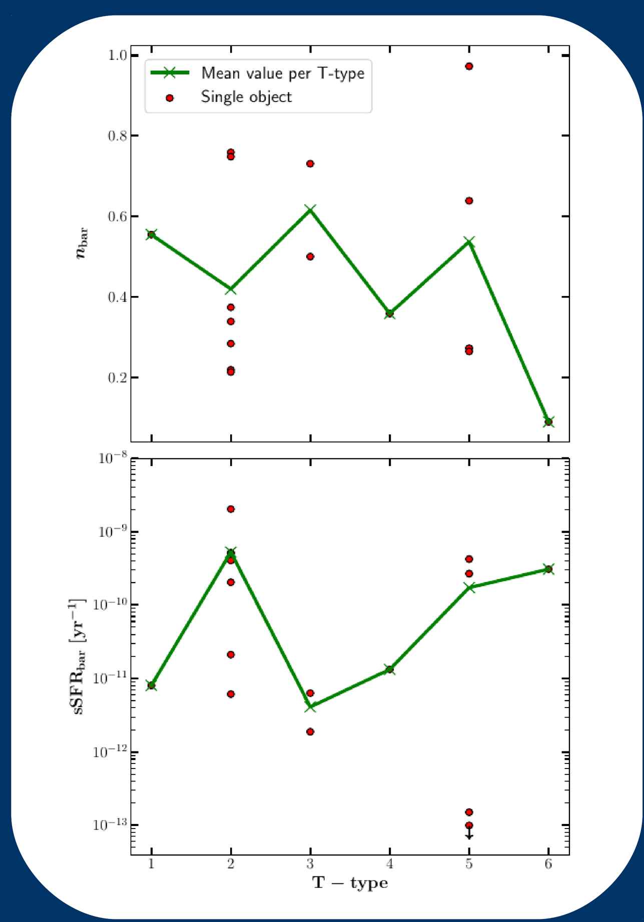

Fig. 5: Bar Sérsic index (n_bar) and specific star formation rate (sSFR) versus Hubble type T. There is NO CORRELATION between flatness of the bar or star formation within the bar with Hubble type.

Understanding these results in the context of previous work (Elmegreen & Elmegreen 1985, Elmegreen+1996, Ohta 1996, Phillips 1996) is in order. **Come to discuss with us!**

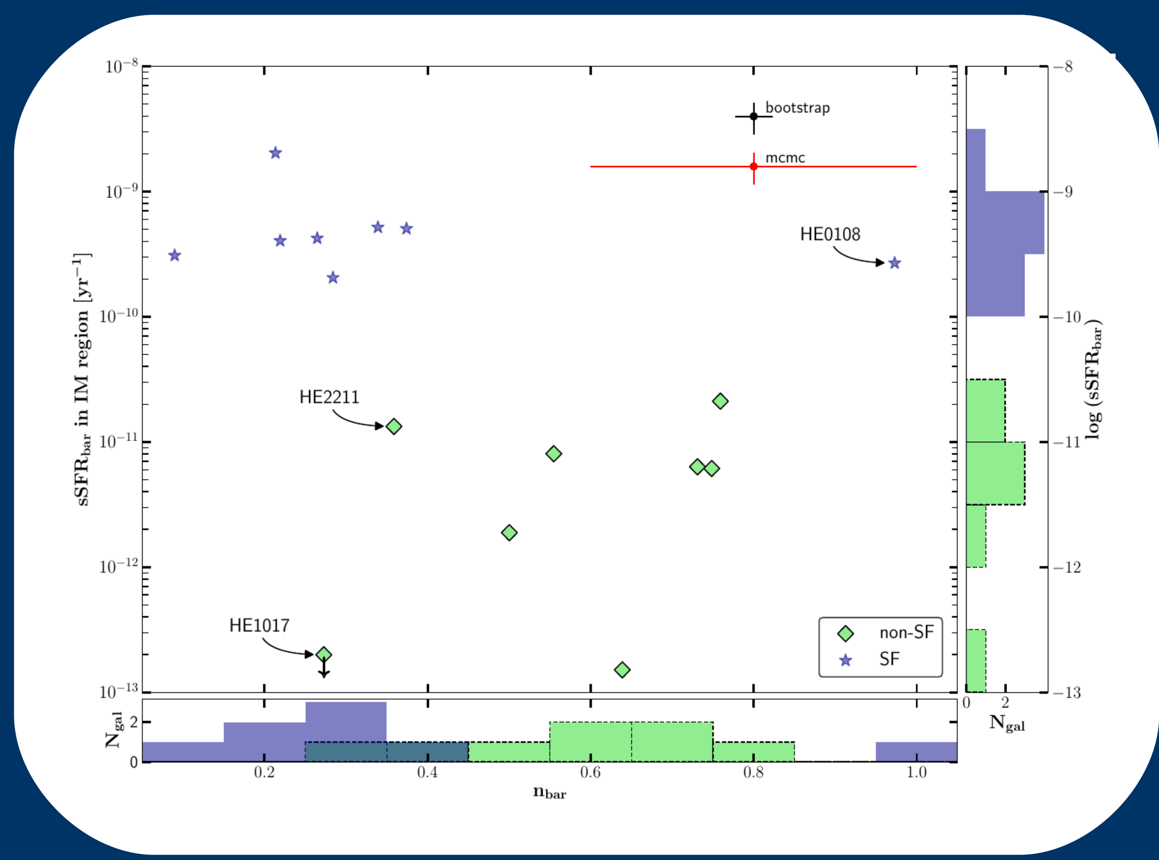

Fig. 4: Specific star formation rate (sSFR) versus bar Sérsic index (n_bar). Star forming (SF) bars clearly cluster at very low Sérsic indices whereas non-SF bars tend to have higher values.

The Sérsic index of a bar describes the flatness of its surface brightness profile. The smaller the Sérsic index, the flatter the profile.

The galaxy HE0108-4743 shows strong Hα emission everywhere in the galaxy. The high sSFR within the bar is thus probably unrelated to bar properties.

In this work we find a new correlation between star formation activity within the bar region and flatness of the surface brightness profile.

Analysis

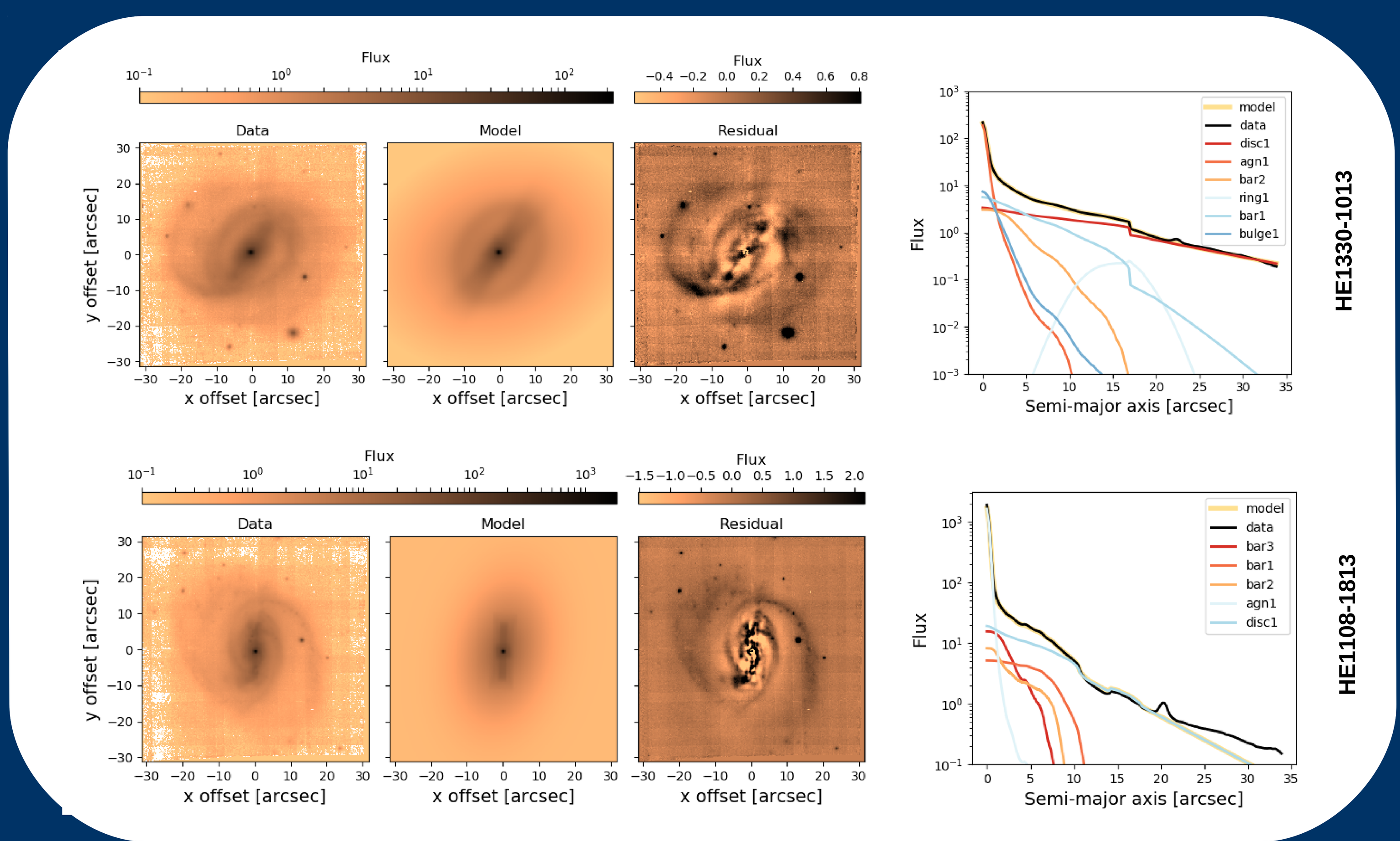

Fig. 2: Photometric 2D image decomposition with *IMFIT* (Erwin 2015) on collapsed MUSE pseudo "i-band" images including up to 7 different components.

We fit a selection of the following galaxy components, while we only include a component if we have a clear indication of its presence:
- Point source, bulge, disc, bar1, bar2, bar3, ring

All 3 bar components are part of one single bar: bar1 is the main long part of the bar, bar2 is the broadened inner part which is also called barlens (Athanassoula+2015), and bar3 is the very thin and long part. They come from different families of orbits with different elongations.

The main parameters we are interested in are the **length and ellipticity of the bar,** the **bar Sérsic index**, the **bar-to-total light ratio**, the **bulge-to-total light ratio**, the **bulge Sérsic index** and the **disc scale length.**

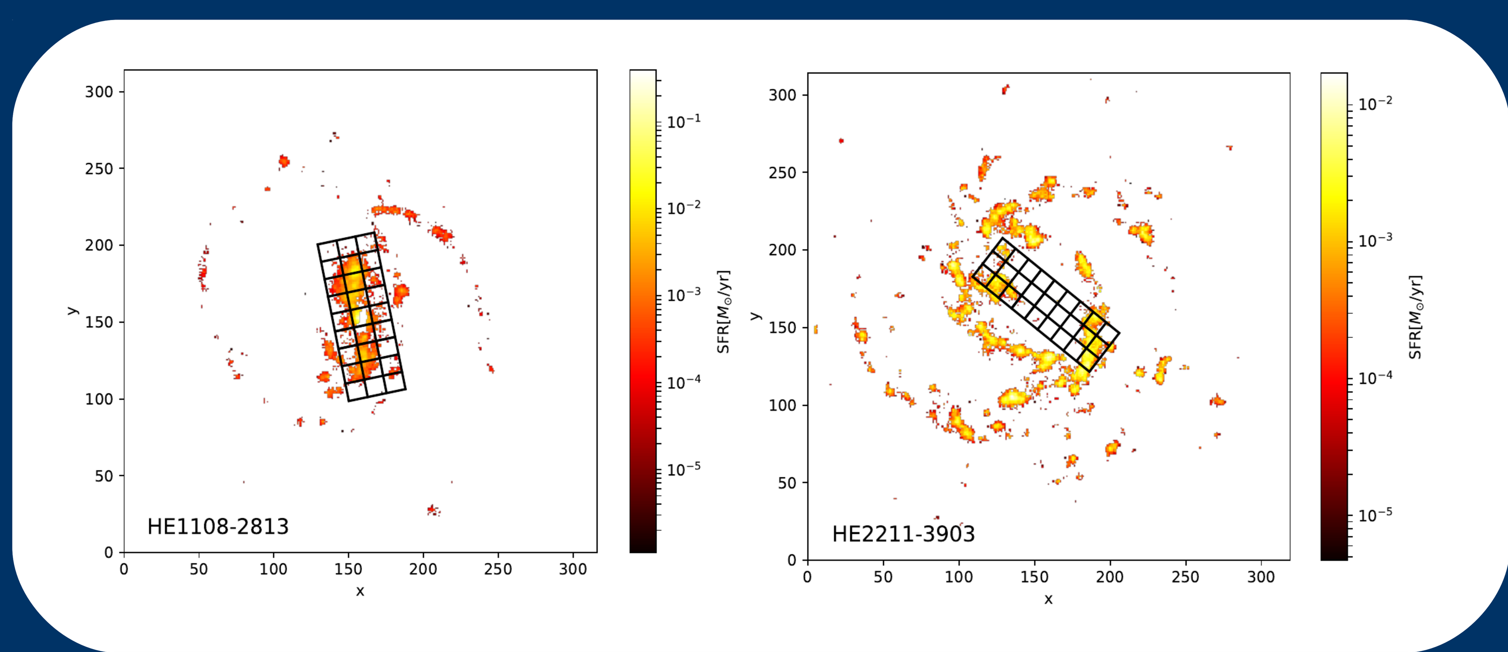

Fig. 3: Spatially resolved star formation rates (SFR) from dust corrected Hα flux for two different galaxies in the sample. The maps are overplotted with a black grid covering the region of the bar and splitting it into 3 x 9 sub-regions.

In the presence of an active galactic nucleus (AGN), star formation is no longer the only source of photoionisation triggering Hα emission. Since it is extremely difficult to separate in a single spectrum the amount of Hα that was caused by one or the other mechanism, we identified for each spaxel the predominant source of ionisation by means of its location in the "Baldwin, Phillips & Terlevich" (BPT) diagram and removed all AGN dominated-spaxels from the subsequent analysis.

The total specific SFR (sSFR) as shown in Fig. 4 was integrated within carefully selected regions of the bar to omit contamination from spiral arms at the tips of the bar or residual contamination from the AGN in the center.

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