A Non-Parametric Morphological Analysis of Hα Emission in Bright Dwarfs Using the Merian Survey

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Merian Survey

The Merian Survey is an optical medium-band survey designed to study the dark matter profiles and physical characteristics of star-forming bright dwarfs ($8 < \log(M_\star/M_\odot) < 9$) at $0.06 \lesssim z \lesssim 0.1$.

- Two new medium-band filters (N540, N708) installed on DECam capture [O III] and Hα emission to improve photo-z's.
- Merian footprint overlaps with HSC-SSP, providing a total of **seven photometric bands**.
- Subsample of over 2000 galaxies with available spectroscopy from SDSS, GAMA, and proprietary spectra taken for the Merian survey.

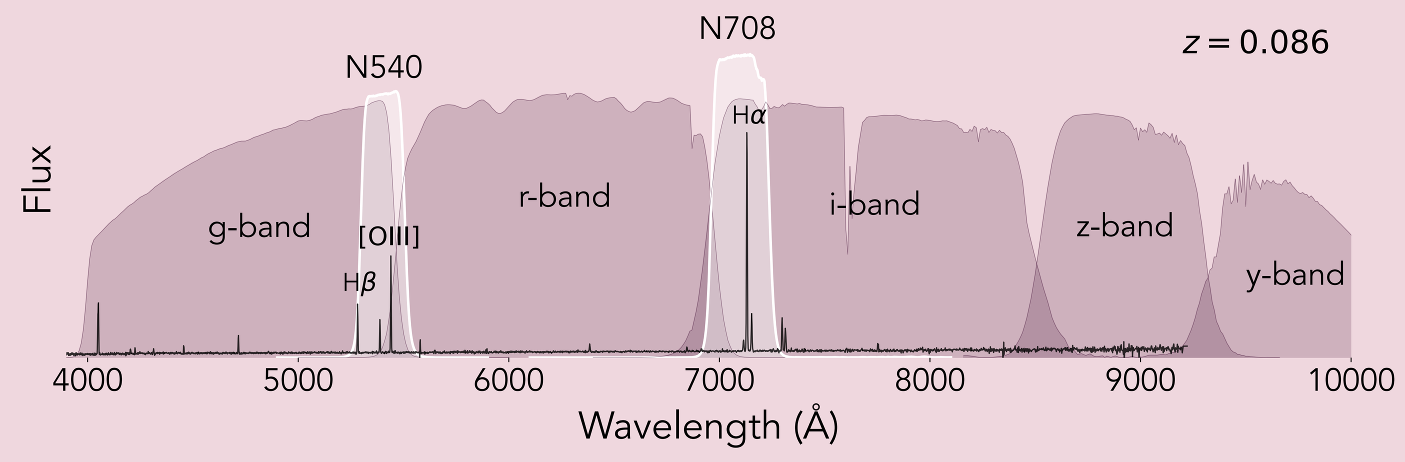


Figure 1. Merian medium-band filters (N540 and N708) and HSC broad-band *grizy* filters shown over a star-forming dwarf galaxy spectrum from SDSS with z = 0.086.

Measuring Hα emission and morphology

- We estimate the continuum emission in the N708 medium-band filter using a new semi-empirical model based on simulated photometry of dwarf galaxies. We measure photometric Hα EWs that agree with spectroscopic values to within ~30%.
- To create Hα maps, we scale the HSC z-band image (which is free of emission lines and representative of the stellar continuum) and subtract from the N708 image (see Fig. 4).
- We measure Hα luminosity and non-parametric morphological statistics of Hα and continuum maps: **asymmetry** index, **Gini** coefficient, and **M_{20}** statistic.

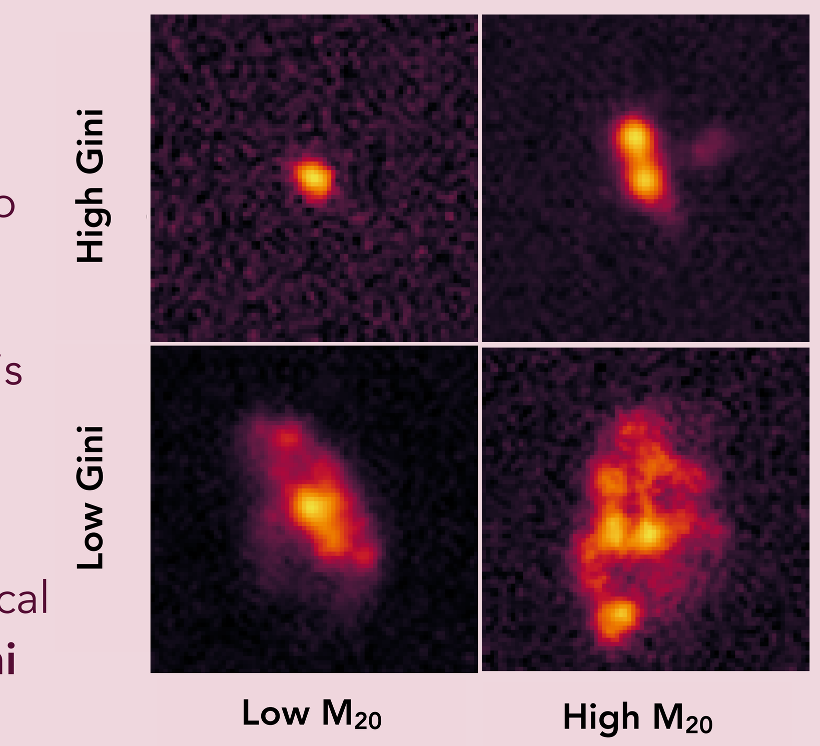


Figure 2. Hα maps with extreme values of G and M_{20}. Maps with low values of G have more homogeneous distributions and maps with low M_{20} have their brightest regions located near the galaxy's center.

Comparing Hα and continuum morphology

- Compared to the stellar continuum, Hα emission is **less symmetric, less homogenous,** and has its brightest regions **less centralized.** This hold for all mass and SSFR bins.
- The Hα maps are **more diverse** than the continua. The distribution of all parameters is broader for Hα than for the continuum.

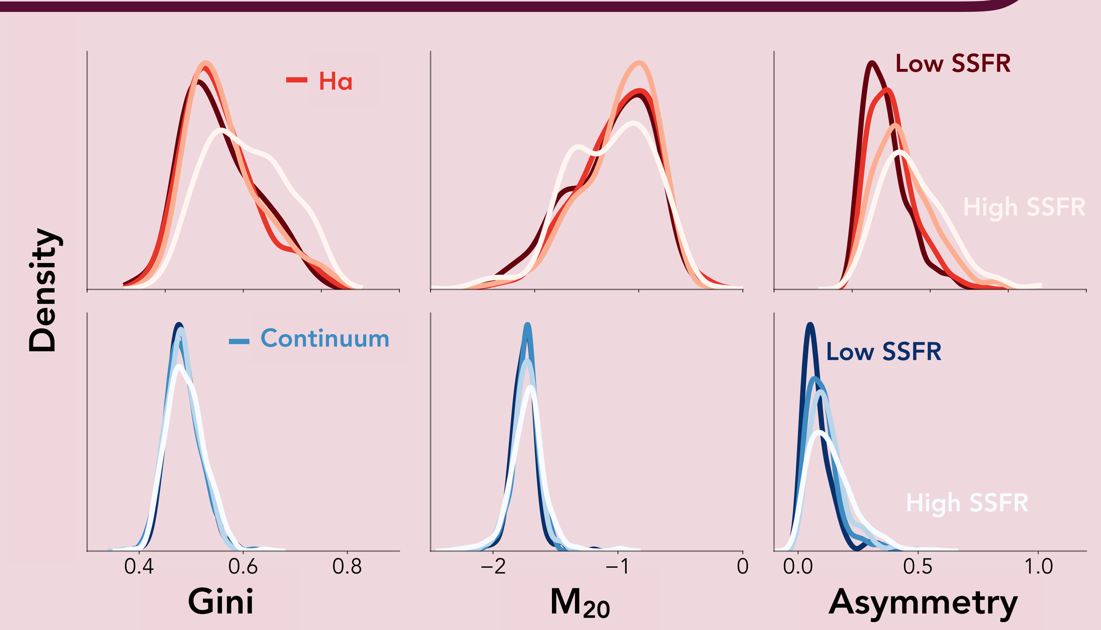


Figure 3. Distribution of morphological parameters binned by SSFR (lighter for higher SSFR) for the Hα maps (top, red) and continuum images (bottom, blue). The shading matches Figure 5.

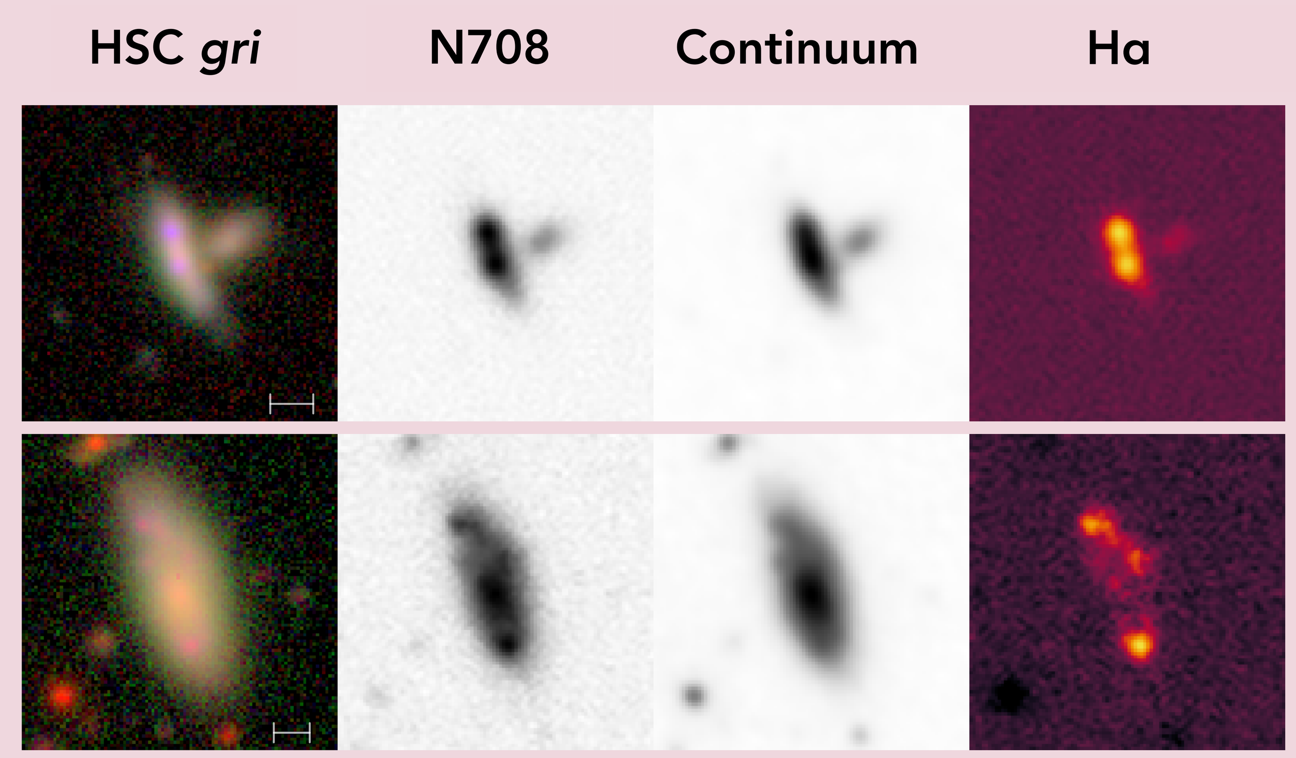


Figure 4. HSC-*gri* color image, Merian N708 cutout, scaled z-band image (estimate of stellar continuum), and Hα map for two example dwarf galaxies.

Asymmetry increases with SSFR

- **Asymmetry increases with SSFR** and distance above SFMS for continuum and Hα emission.
- Extends literature results to lower masses and Hα maps.
- **Mergers** and **accretion** increase both asymmetry and SSFR.

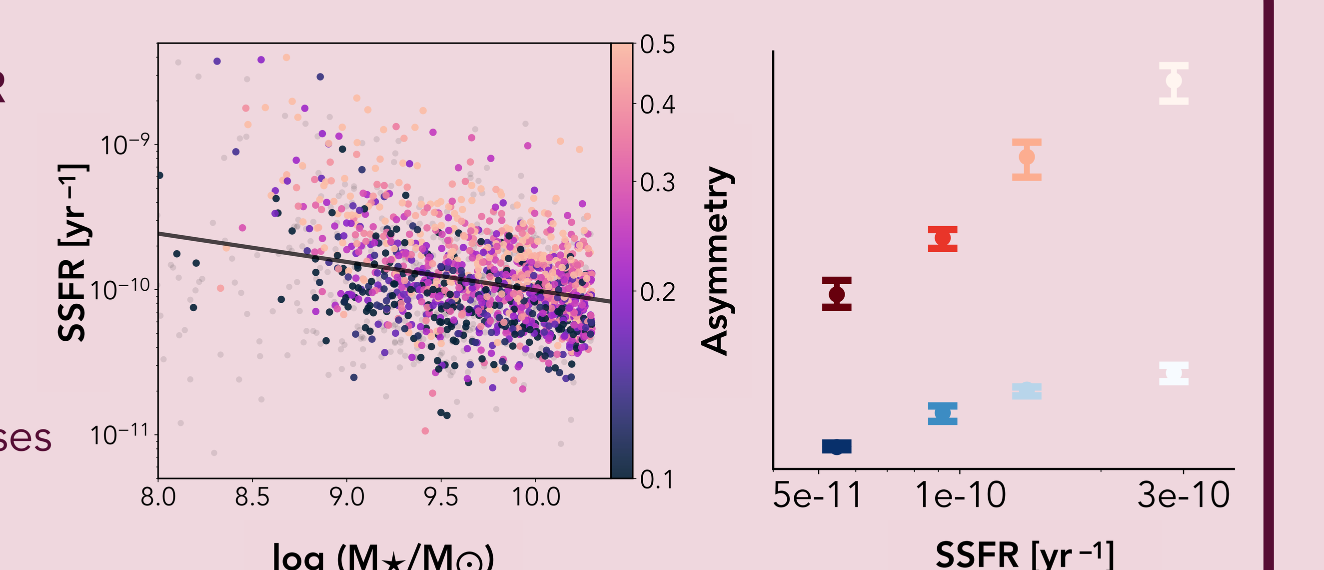
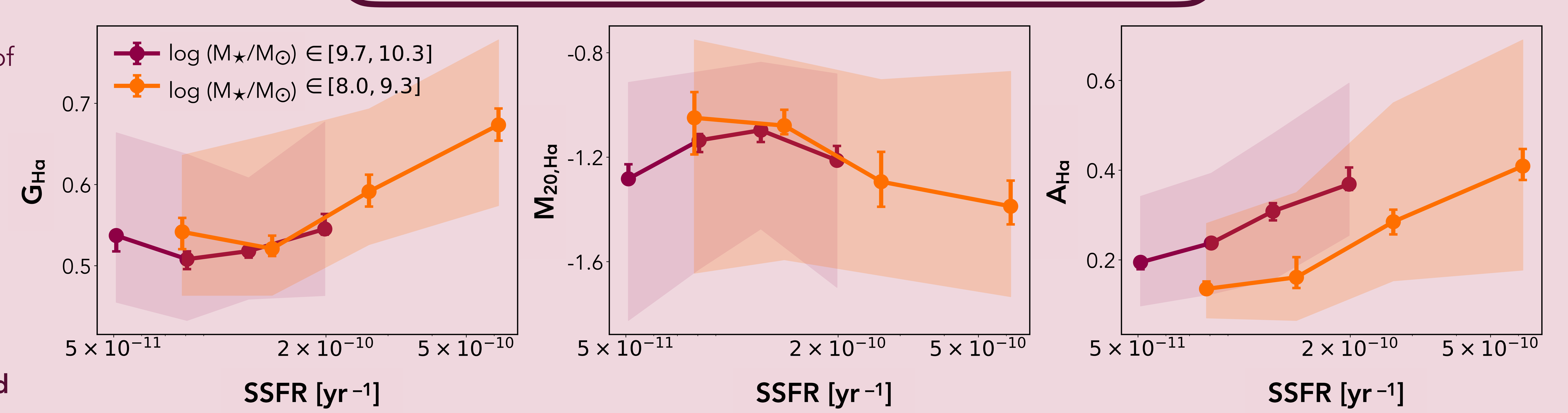


Figure 5. (Left) SSFR versus stellar mass colored by Hα asymmetry. (Right) Asymmetry versus SSFR for Hα (red) and continuum (blue). The shading matches that of Figure 3.

Dwarfs with high SSFR have compact Hα

- Hα maps of galaxies with the highest SSFRs have high values of G (are clumpy - see top left panel of Fig. 3). This trend is driven by the lowest mass galaxies ($\log(M_\star/M_\odot) < 9.3$, see Fig. 6). We find no trends in G for higher mass sources over the range of SSFR covered by the sample.
- Compact Hα distribution in high SSFR dwarfs implies that bursts of star formation are likely triggered by dynamical instabilities resulting from a combination of **mini-mergers, interactions, and accretion**. Based on their masses, SSFRs, and sizes, improbably high molecular surface densities would be required to sustain a quasi-steady state.



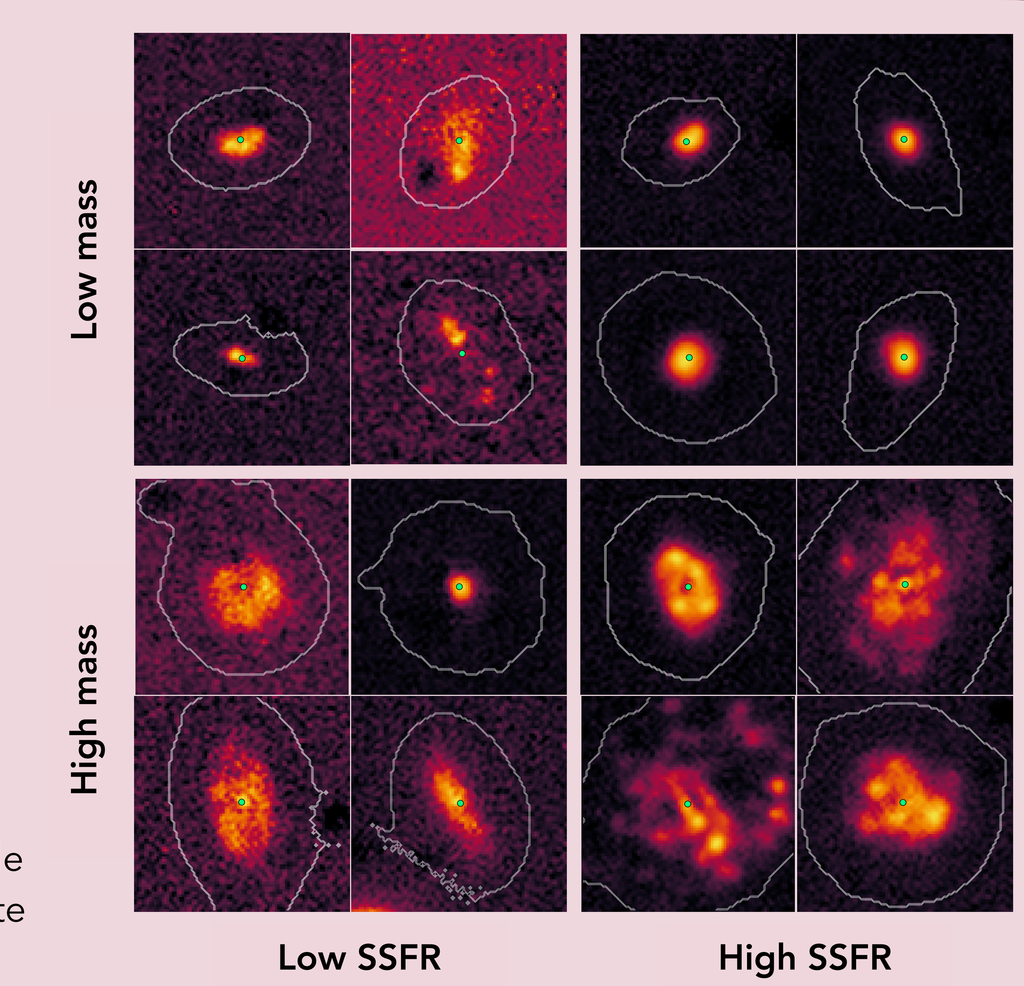


Figure 6. (Top) Median values of Hα morphological parameters plotted as a function of SSFR for two mass bins. The error bars show the 16%-84% confidence interval for the median and the shaded regions represent the the central 68% of points in each bin. For the lower mass bin, $G_{H\alpha}$ and $A_{H\alpha}$ increase with SSFR while $M_{20,H\alpha}$ decreases. (Right) Examples of Hα maps for low and high mass sources with extreme SSFRs. The green dot indicates the center of the galaxy and the white contours show the extent of the stellar continuum. **The lower mass galaxies with high SSFR have Hα emission that is compact and slightly off center.**

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