Investigating the Star Formation - AGN Interplay Through the Lens of the Star Formation Reference Survey (SFRS)

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The Star Formation Reference Survey (SFRS)

Understanding the interplay between star formation (SF) and AGN activity is one of the most challenging subjects of modern Astrophysics, as both phenomena play crucial role in galaxy evolution. We probe the SF – AGN connection through the lens of Star Formation Reference Survey (SFRS; Ashby et al. 2011), a multi-wavelength project aiming to study the process of star formation in galaxies in the local Universe.

SFRS uses a sample of 369 IR-selected nearby galaxies, representative of the star formation rate (SFR), specific SFR (sSFR), and dust temperature distribution in the local Universe.. Therefore, it provides an ideal opportunity to explore the SFR – AGN connection in a variety of different galactic environments. The SFRS data are collected using the Spitzer, Green-Bank Telescope, CFHT, Tillinghast and PAIRITEL telescopes, as well as from the NVSS, 2MASS, SDSS and GALEX archives.

Goals

- Measure the AGN fraction across different galactic environments in the nearby Universe.
- Explore the distribution of the different galaxy activity types across the mass and sSFR range individually as well as on the sSFRS - mass plane of local star forming galaxies (Figures 1,2,4 respectively).
- Explore the AGN host galaxy locations on the main sequence plane.

Method

- The activity classification for the SFRS galaxies, was derived using standard optical emission line diagnostics (BPT diagrams). We obtained optical spectra for the sample with the 60-inch Tillinghast telescope and the FAST spectrograph, and from the SDSS archive. We removed the stellar continuum contribution from the spectra and measured the diagnostic emission lines. Our results show that SFRS consists of:

264 Starburst (71% of the total SFRS sample)
43 Seyfert (Sy) (12%)
25 LINER (7%)
37 Transition Objects (TO) (10%)

- We also derived the SFR of the sample galaxies using the total IR luminosity according to the calibration (Kennicutt & Evans, 2012; Murphy et al., 2011):

$$\mathbf{SFR\ (M_\odot/yr) = L_{TIR}\ (erg/sec) \times 10^{-43.41}}$$

where L_{TIR} is the total FIR luminosity (Dale & Helou 2002).

- The stellar masses were calculated following Bell et al. (2003).

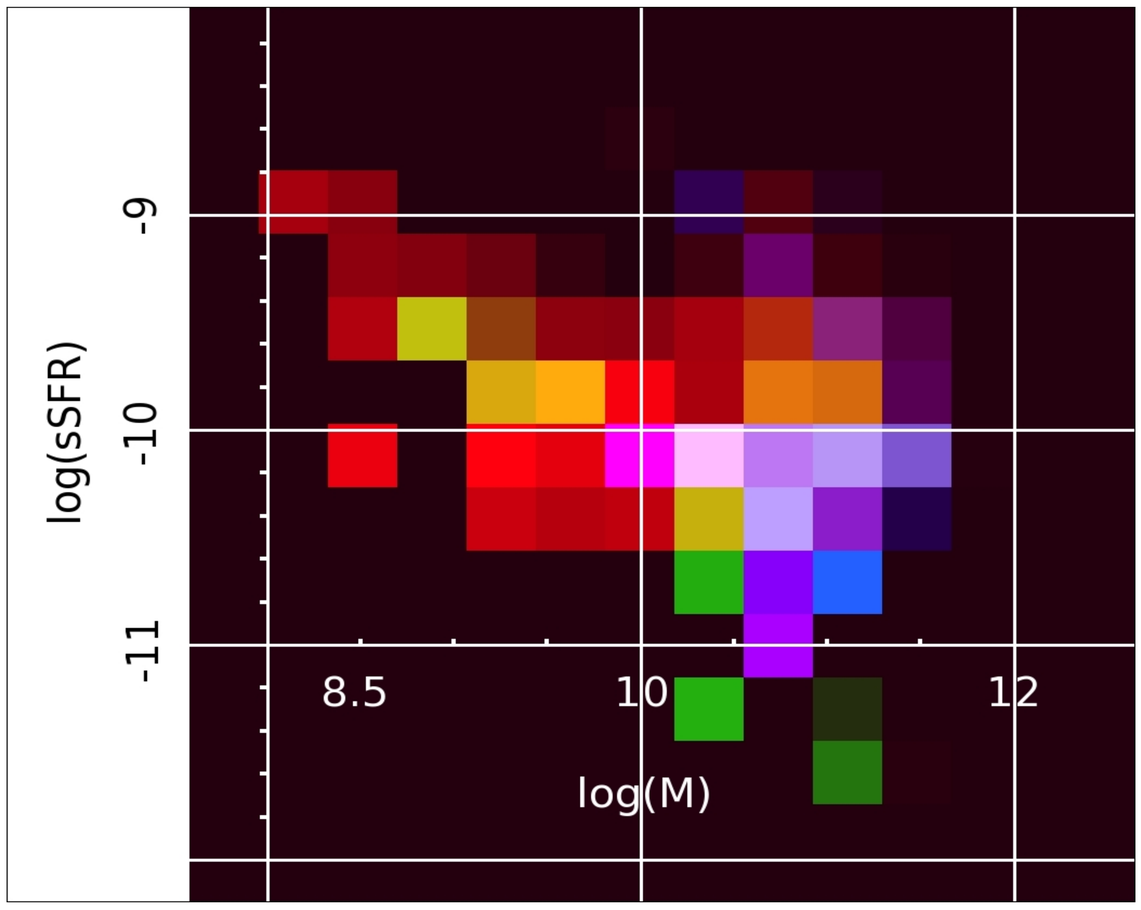

Figure4: The bivariate (M, sSFR) function of the three different activity types, binned in 0.4 x 0.3 dex bins. The color representation is: red for the star forming galaxies, where we see the signature of the well-known galaxy main sequence, green for the Sy and TO and blue for the LINERs.

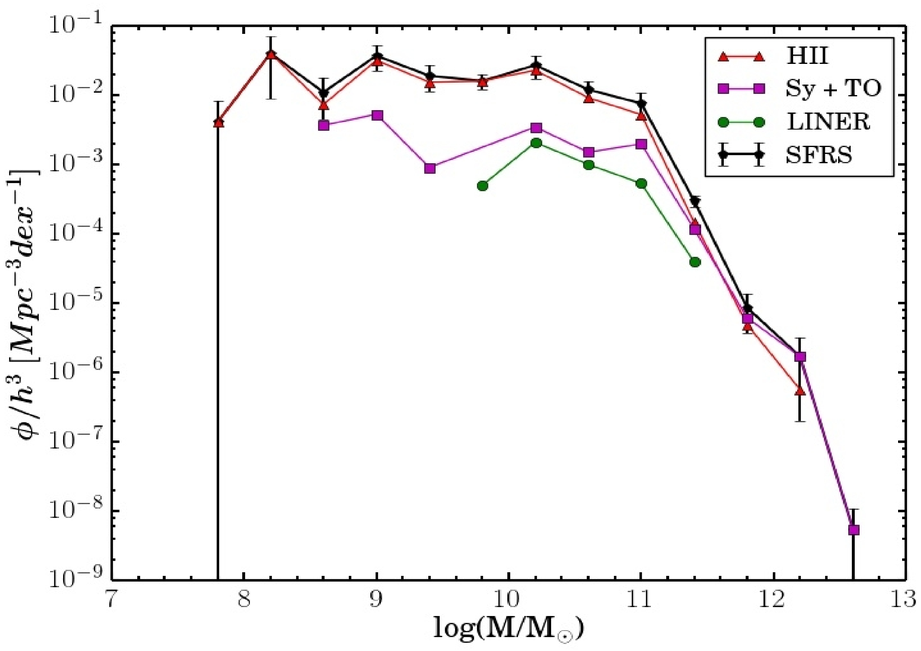

Figure1: Stellar mass function of the entire SFRS sample (black line) along with the contribution of the different activity subclasses, binned in 0.4 dex bins. We see that AGN host galaxies (magenta) cover the same mass range as the star forming galaxies (red).

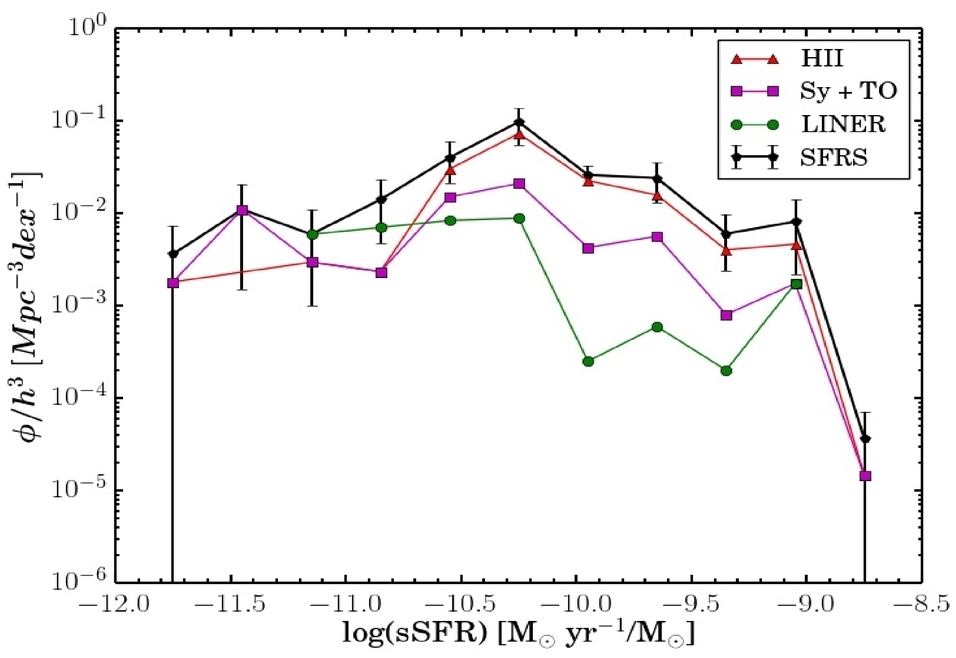

Figure2: The sSFR function for the entire SFRS sample (black line) and the different galaxy activity types, binned in 0.3 dex bins.

Results

Based on the activity classification derived above, we present the univariate sSFR and stellar mass function for each activity class, based on the same functions calculated for the entire sample (Bonfini et al. in prep.). We also present their relative contribution in the bivariate M – sSFR function (Bonfini et al. in prep.). Additionally, we study the distribution of the SFRS galaxies on the FIR color space which is indicative of dust temperature.

- **We find that both star forming and AGN host galaxies span the same mass range** (Figure 1). Seyfert and TO classes peak around 10^{11} M$_\odot$, but Sy galaxies also extend to lower masses, consistent with the view that AGN can be found in the 'blue cloud' region on the Color-Magnitude diagram of galaxies.

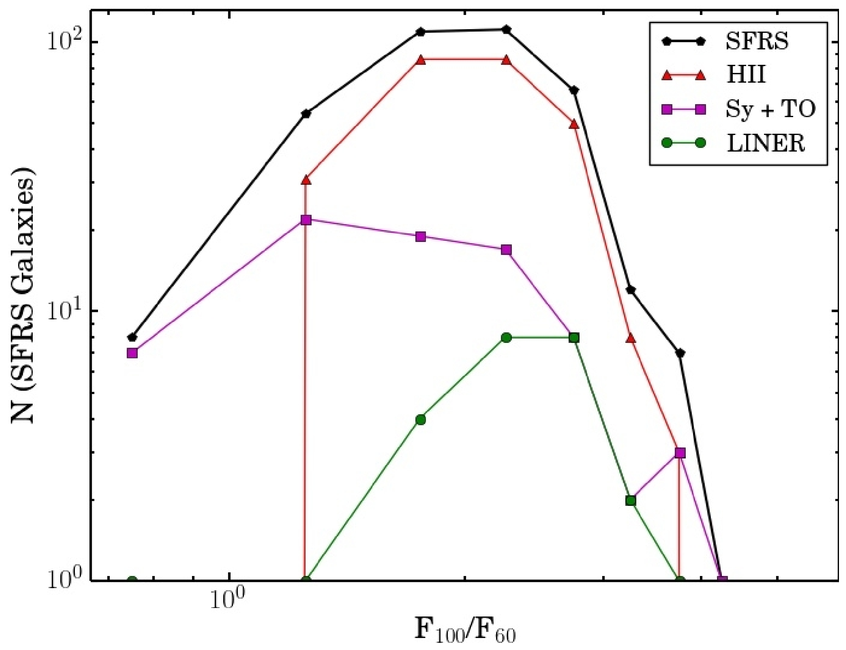

Figure3: The distribution of the SFRS galaxies (black line) and individual galaxy activity types, according to their FIR colors (a dust temperature proxy).

- **LINERs are observed towards intermediate to higher galaxy masses.** They cover a broad range of sSFR but with higher contribution at lower sSFR, consistent with previous studies showing that they are found preferably in more massive and passive galaxies (e.g. Ho et al. 1997).
- **AGN appear as expected to peak at low F100/F60 ratios** (high dust color temperature), while star forming galaxies are evenly distributed. **LINERs peak at colder dust temperatures**, which is consistent with early – type galaxies.
- **Seyfert and TO appear to follow a similar trend with the star forming galaxies on the M, sSFR plane**, although they extend to higher masses and lower sSFR.
- LINERs lie towards the lower right region of the (M – sSFR) plane, consistent with their respective univariate distributions.

Future Work

Cross calibrate and combine the different multi-wavelength SFR tracers to improve our SFR estimations, and use SED fitting techniques to disentangle the AGN from the stellar contribution in the SED, to make a direct comparison with the previous indicators and methods.

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