Connecting Star formation in the outer regions of galaxies to the ISM: Story of the Extended Disk of NGC 3344[1]

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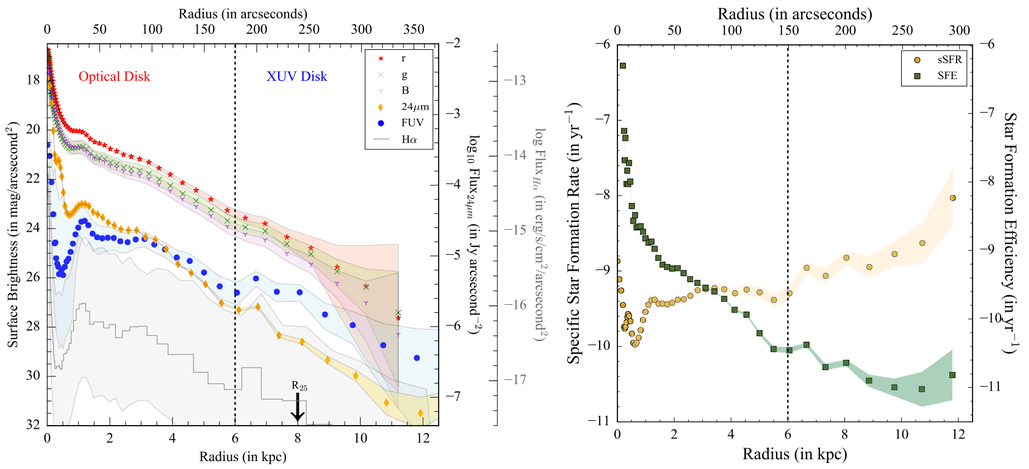
OBJECTIVE

Investigate properties of young stellar associations in the Extended Ultraviolet[2,3] (XUV) disk galaxy, NGC 3344 to understand the connection between star formation and interstellar medium (ISM) in the low-density outer regions of nearby galaxies.

MOTIVATION

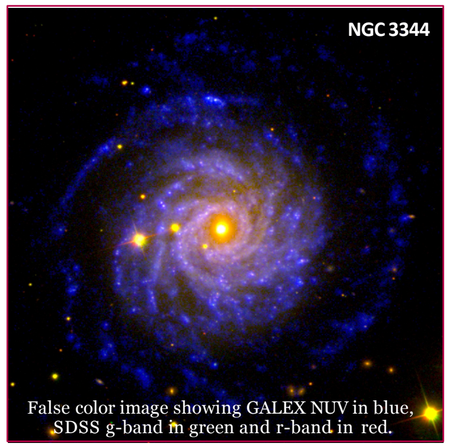
Star formation occurring in the outer regions of spiral galaxies is a puzzle. Conditions in the outer regions are sub-critical compared to the traditional inner star-forming disk and have a HI-dominated ISM, low gas column densities, molecular gas content, metallicities, and dust abundances. These regions, somehow, still support star formation and understanding how stars form in the outer regions can give deep insight into galaxy evolution.

INSIDE OUT DISK GROWTH VIA STAR FORMATION



Radial profiles of panchromatic emissions and derived galaxy properties of NGC 3344 show that

1. FUV emission shows larger scale length indicating young stars have extended distribution.
2. FUV is a better indicator of star formation in the outer disk.
3. Increase in specific star formation rates in the XUV disk of the galaxy provides evidence for inside-out growth.



False color image showing GALEX NUV in blue, SDSS g-band in green and r-band in red.

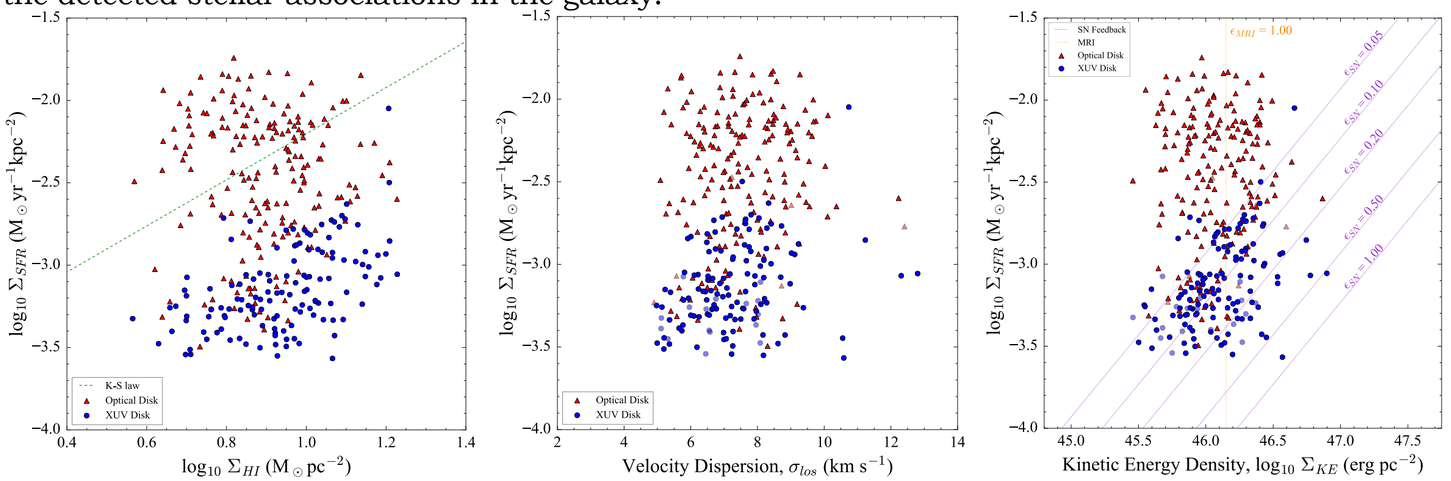
CONCLUSION

- Star formation occurring in the outer suggest growth of the galaxy disk via inside-out mechanism.
- Star formation in the outer region is limited by the formation of molecular clouds. Turbulence can trigger star formation on a small scale.

Future work will involve studying the underlying stellar populations in the outer regions by comparing them to stellar evolutionary models and elucidate the fate of stars in outer environments

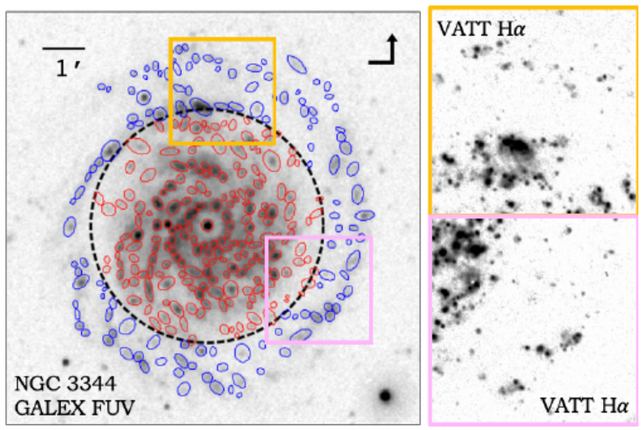
CONNECTING STAR FORMATION & ISM KINEMATICS OF YOUNG STELLAR ASSOCIATIONS

In the ISM, the cold HI reservoir converts to cold molecular (H_2) form, which further collapses to form stars. The far outer regions (blue) of galaxies are HI-dominated as opposed to the H_2-dominated inner regions (red). The following plots show star formation & ISM properties traced by HI-21 cm imaging of the detected stellar associations in the galaxy.



1. Stellar associations in the outer disk have high-HI mass density and low-SFR density showing longer HI depletion time (τ_{dep}) of ~10 Gyrs. Given a H_2 τ_{dep} of ~2 Gyrs, the longer HI τ_{dep} implies that star formation in the outer disk is only limited by the formation of molecular clouds [4,5,6].
2. No correlation observed between star formation rate and turbulence traced by velocity dispersion of the atomic HI gas implies that turbulence-triggered star formation dominates over a small scale. Supernova feedback with energy efficiency of $\lesssim$ 20% would be sufficient to support the ISM[7].

YOUNG STELLAR ASSOCIATIONS IN NGC 3344



1. We detect 320 UV-bright young stellar associations in the galaxy out of which 132 are in the outer XUV disk (blue regions). These show star formation on ~100 Myrs timescale.
2. In addition, majority of these regions show detection in Hα that traces OB stars, hence implying active star formation (~10 Myrs old) occurring in the outer disk.
3. Hα, however, is weaker in these due to stochasticities in the formation of massive stars and/or variation in the upper end of the IMF.

REFERENCES

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