Central Enhanced Star Formation: the role of bar and environment

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central SF -> bulge mass build-up

- Hubble type morphology
- global stellar mass and color
- BH mass, etc
Bulge plays an important role in galaxy evolution

How do bulges build-up?

Kormendy+04
CALIFA:
600 galaxies
D25 selected
spatial FWHM: 1 kpc
λ range: 3750-7500Å

MaNGA:
10000 galaxies
M* > 10^9 Msun
spatial FWHM: 1.5-4.5 kpc
λ range: 3600-10300Å
D4000, EW(Hd), EW(Ha) maps & profiles

typical spiral galaxy

Lin et al. (2017)
D4000, EW(Hd), EW(Ha) maps & profiles

typical spiral galaxy

Lin et al. (2017)
"turnover" galaxy

Lin et al. (2017)
Select turnover galaxies by fitting their profiles

Barred galaxies:
- $R_{in}$: $R_{bulge}$
- $R_{out}$: $R_{bar}$

un-Barred galaxies:
- $R_{in}$: 3” (PSF size)
- $R_{out}$: $R_{bulge}$

Lin et al. (2017)
Most turnover galaxies are barred galaxies, BUT only a fraction of barred galaxies show turnover.

- Discover 17 turnover galaxies from CALIFA DR2. ~88% (15/17) of them are barred galaxies. While only ~50% (15/31) barred galaxies show turnover profiles.

Lin et al. (2017)
Improvements based on MaNGA survey

- More general with a wide $M^*$ coverage
- larger sample size
  - statistical analysis
  - design control sample
Turnover Selection in MaNGA

• high-resolution galaxies in MPL-7 (2460 / 4672)
  - redshift < 0.05 (resolution ~1-2 kpc)
  - b/a > 0.5

• Bar identification by visual inspection

• Turnover detection
  - $\text{FWHM}_{\text{PSF}(1.5''}) < \text{break} < R_{50}$ or $R_{\text{bar}}$
  - date-driven automatically detect breaks along the profile
  - find out 134 turnovers (barred: 119, unbarred: 15)
Turnover galaxies from MaNGA

7962-12703
- $R_{50}$: 10.28"
- $R_{bar}$: 11.34"
- $R_{t}$: 4.52"
- Pair stage: --

8258-9101
- $R_{50}$: 7.14"
- $R_{bar}$: --
- $R_{t}$: 4.15"
- Pair stage: 2
Global properties of turnover galaxies

- Most of them are massive spiral galaxies, with $\log M^* \sim 10-11$, NUV-r $\sim 2-4.5$, with large fraction of barred.

- Few of them have $\log M^*$ less than 10, or global red color.

- The central emission can be SF or LINER-like galaxies.
Enhanced SFR within $R_{\text{turnover}}$

- Calculate SFR from dust-corrected Ha flux, then integrate the $\Sigma_{\text{SFR}}$ within $R_t$
- The $\Delta \log$ SFR have large spread. No obvious trend with stellar mass, color, or distance to SF sequence.
- The mean $\Delta \log$ SFR is about 1 dex (0.3 Msun/yr), could be up to 10 Msun/yr as the extreme case.
Most (119/134~88%) turnover galaxies have bars, but only (119/325~36%) bar galaxies show turnovers.

If turnovers are caused by bar-induced gas inflow, can we see larger SFR enhancement in stronger bars?

No obvious correlation between bar and environment in the literature

Any environmental effects to trigger turnover feature?
Bar effects: I.

- Both turnover radius and SFR enhancement have good correlation with bar length
- Turnover radius show a weak correlation with bar ellipticities
- Do not find obvious trend between SFR enhancement vs. bar ellipticities

— measure $L_{\text{bar}}$ and $b/a_{\text{bar}}$ using ellipse@IRAF
Bar effects: II.

Comparison with control sample ($M^*$, NUV-r, $T_{\text{bar}}$ matched):

- No obvious differences in bar length and bar ellipticity

$\Rightarrow$ Bar-induced gas inflow happens periodically?
Environmental effects

Comparison with control sample (M*, NUV-r, T\textsubscript{bar} matched):

- In 2 Mpc scale, no significant difference.
- In 4 Mpc scale, turnover galaxies tend to locate in higher density than control sample (KS test $p<0.05$)

local density catalog from H. Wang+16
Summary

• We look for turnover feature in EW(Ha), EW(Hd) and D4000 profiles, which indicates recent star formation.

• We confirm that turnover galaxies are massive spirals, with a large fraction of barred galaxies, BUT only a fraction of barred galaxies will show central turnover.

• The enhanced SFRs have a large variety. The typical $\Delta \log \text{SFR}$ is $\sim 1$ dex, could be up to 10 Msun/yr.

• Both turnover radius and SFR enhancement have clear correlation with bar length. Turnover radius have a typical value of $1/3$ bar length.

• Turnover galaxies tend to locate in higher density environment than control sample.
The central observed and extrapolated log EW(Ha) have large spread.

The mean $\Delta$ log EW(Ha) do not have obvious trend with stellar mass, color, or distance to SF sequence.