

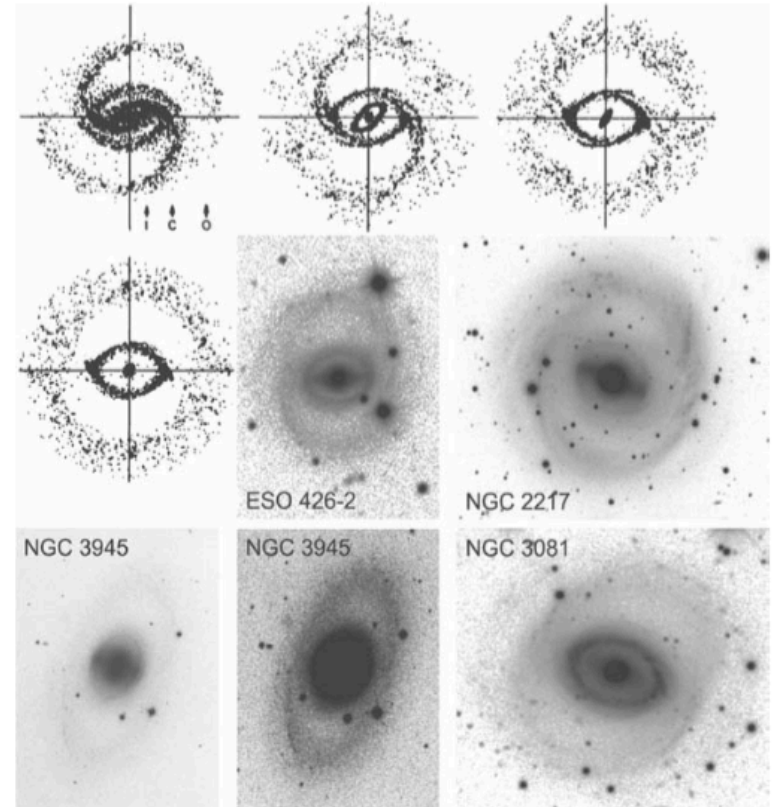


# Bar-induced central star formation enhancement

Lin Lin, Cheng Li, Ting Xiao, Lei Hao et al.  
Shanghai Astronomical Observatory

# Bulge growth: the role of bar

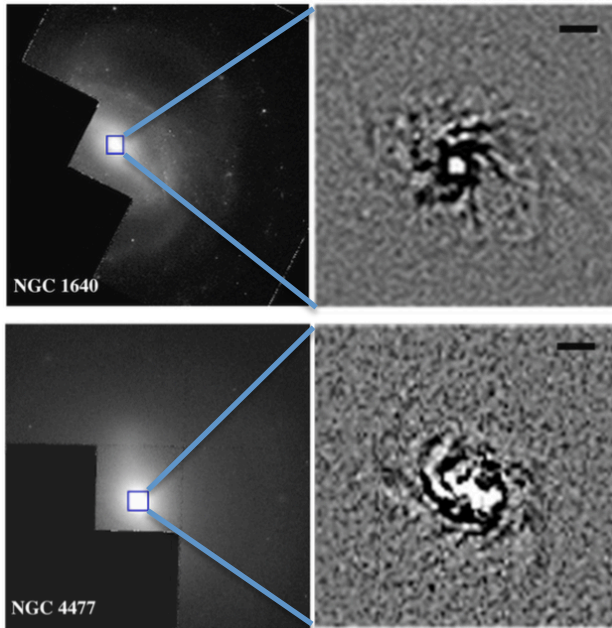
- Bar is a key driver for the formation of pseudobulges.
  - Transfer angular momentum to the outer disk (Athanasoula+92; Sellwood+93)
  - Bar-driven gas inflow is a natural consequence
  - Inflow rates and SFR are enough to build a pseudobulge in a few gigayears (Fisher+09; Haan+09)



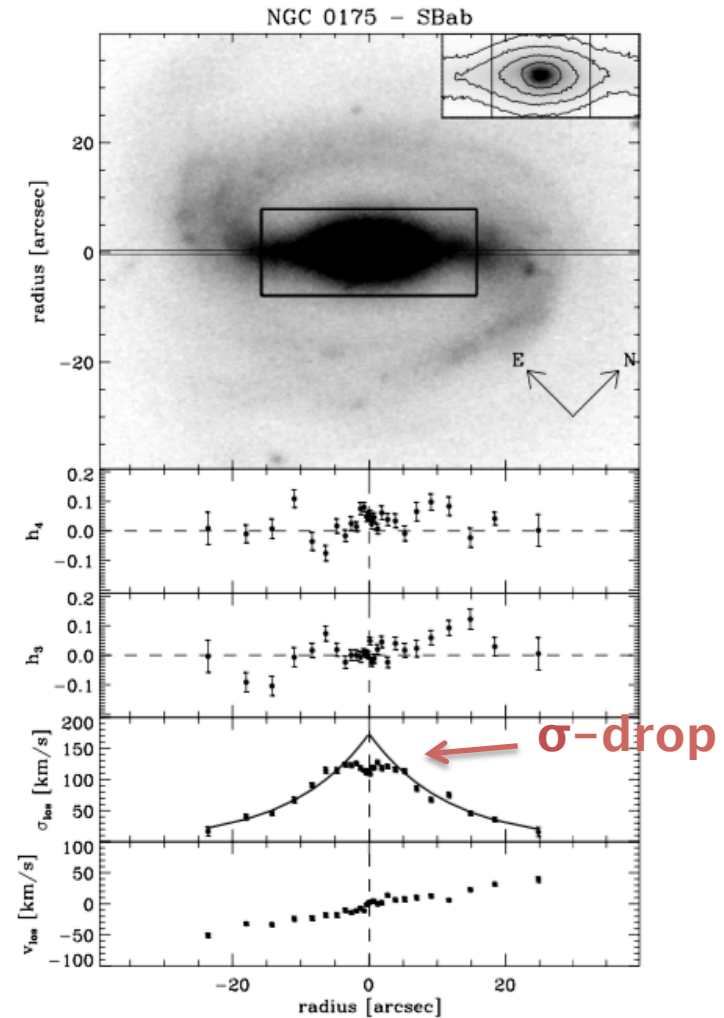
Simkin et al. 1980  
Kormendy & Kennicutt 2004

# Bulge growth: the role of bar

- Composition bulges:
  - Secular-built
  - Classical-built



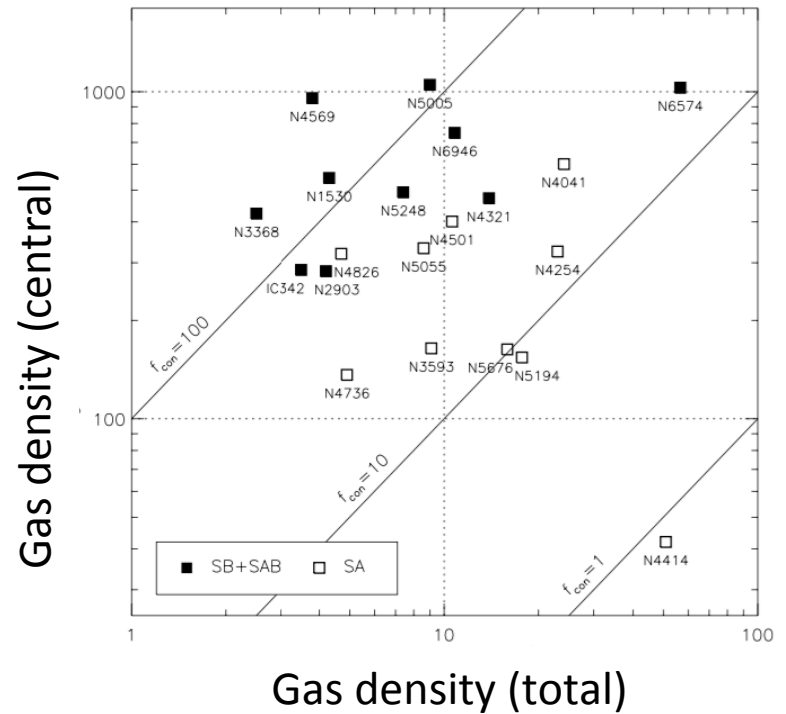
HST high resolution images



Mendez-Abreu et al. 2014

# Evidences: Bar-induced central SF

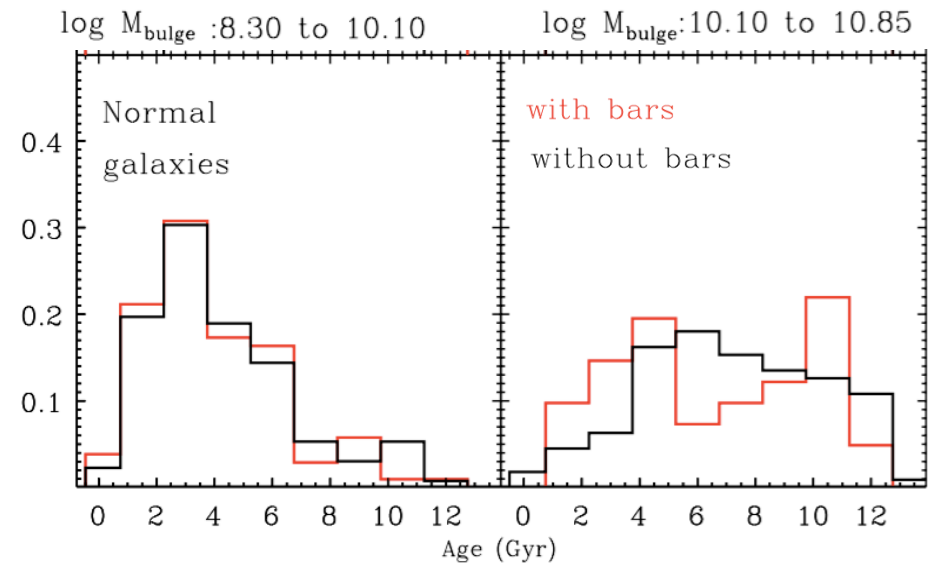
- Higher central concentration of gas (Sakamoto+99; Jogee+05; Regan+06)



Sakamoto+99

# Evidences: Bar-induced central SF

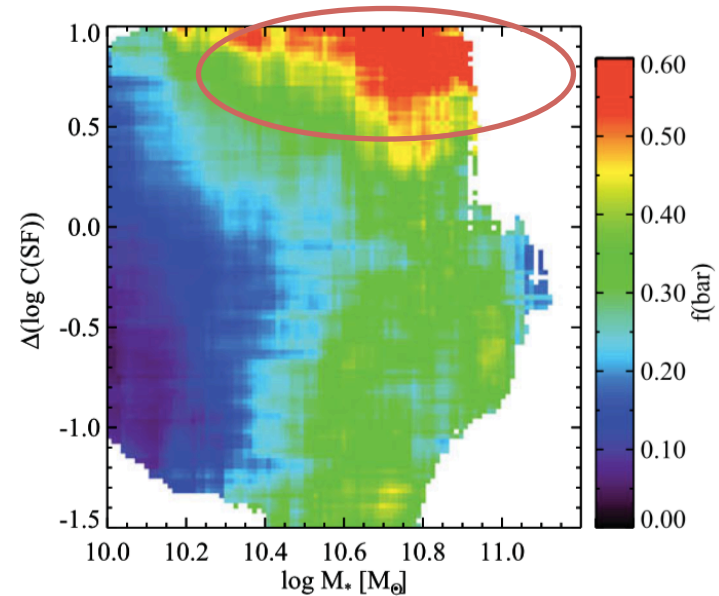
- Higher central concentration of gas (Sakamoto+99; Jogee+05; Regan+06)
- High frequency of young stellar population in bulges (Coelho+11; Mendez-Abreu+14)



Coelho+11

# Evidences: Bar-induced central SF

- Higher central concentration of gas (Sakamoto+99; Jogee+05; Regan+06)
- High frequency of young stellar population in bulges (Coelho+11; Mendez-Abreu+14)
- More than half of the galaxies with highly concentrated SFR are barred (Wang+12)

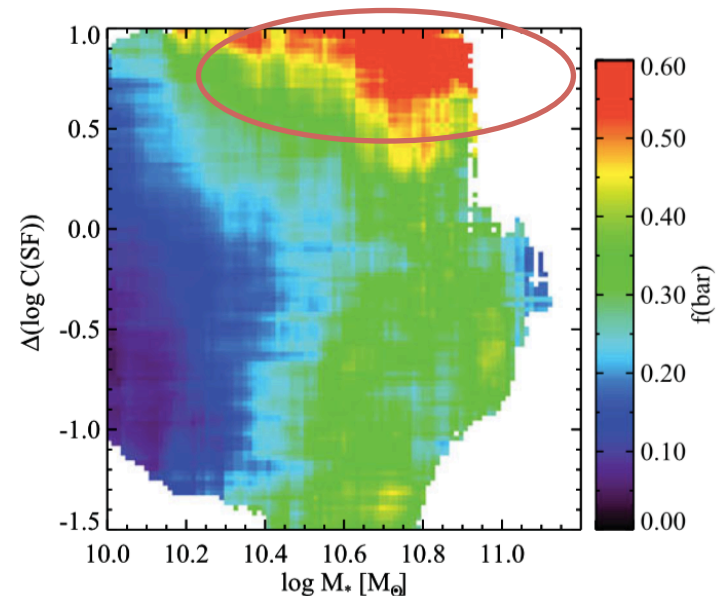


$$C(\text{SF}) = \text{sSFR}(\text{fiber}) / \text{sSFR}(\text{total})$$

Wang+12

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$$C(\text{SF}) = \text{sSFR}(\text{fiber}) / \text{sSFR}(\text{total})$$

Limited by sample size and spatial resolution!!

Wang+12

# CALIFA SURVEY

Calar Alto Legacy Integral Field spectroscopy Area survey

- We select a subsample of 57 face-on spiral galaxies from CALIFA DR2

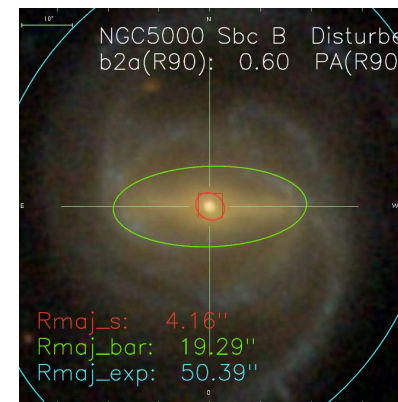
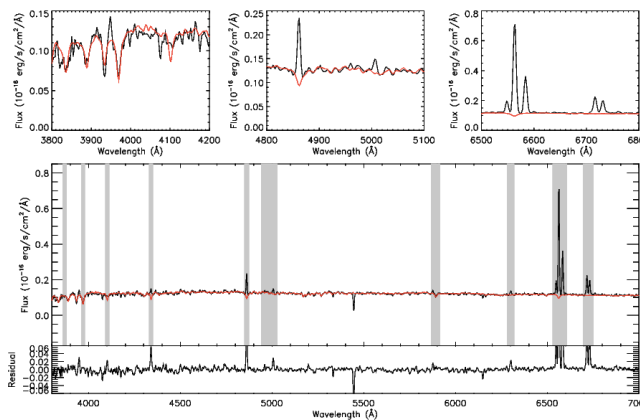
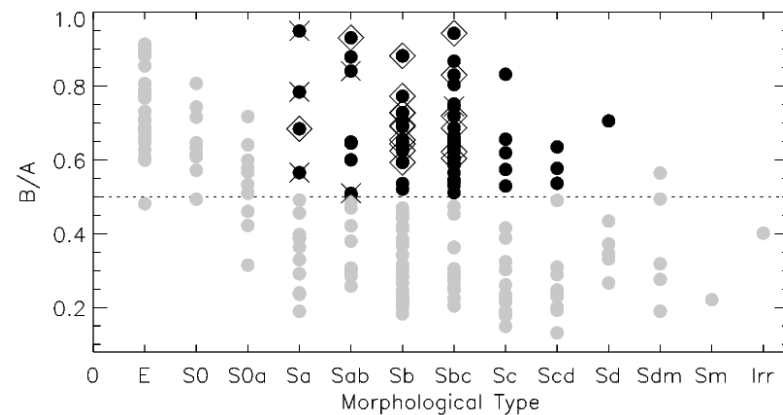
$b/a > 0.5$

Hubble type: Sa-Sd

excluded mergers & dust lanes

- Spectral Fitting and Measurement by STARLIGHT
- Photometry Decomposition by GALFIT

Barred: 31 unbarred: 26



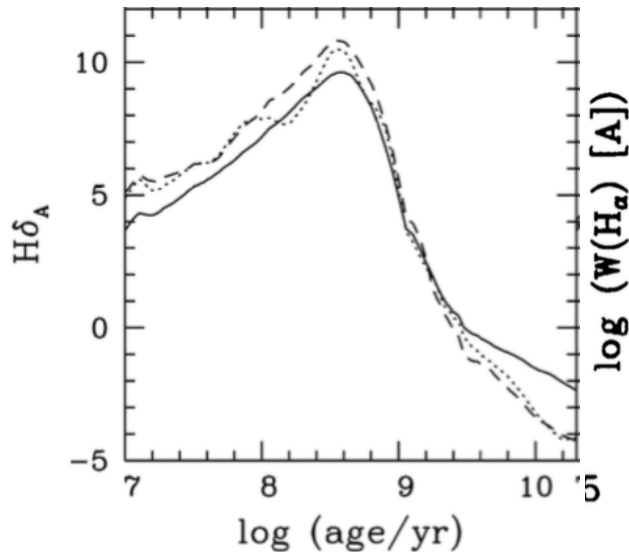
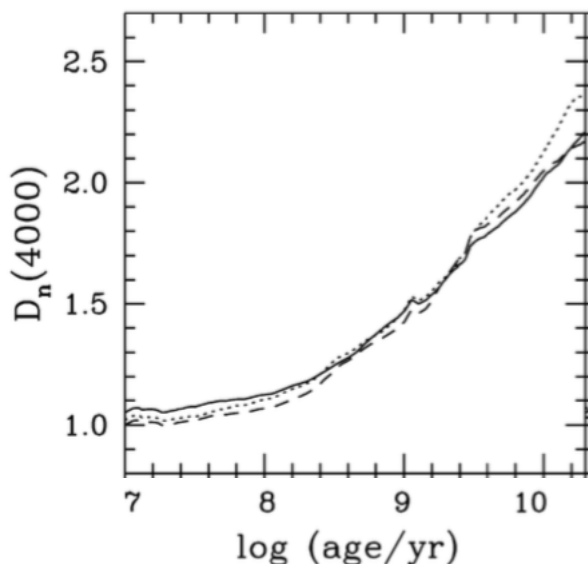


# Recent SFH indicators: D4000, EW(H $\delta$ ), EW(H $\alpha$ )

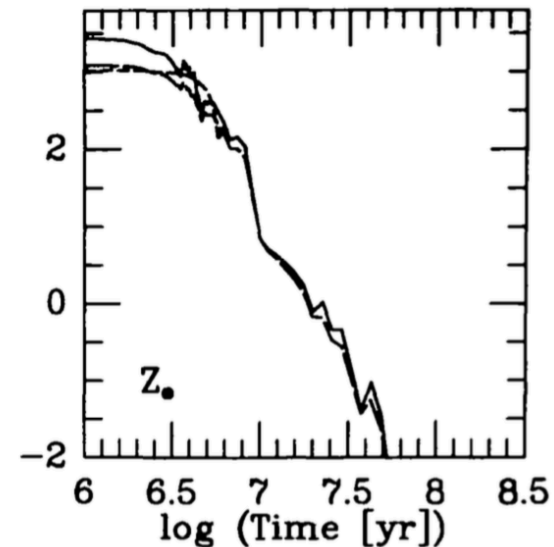
D4000: SF happened 2-3Gyr before

EW(H $\delta$ ): SF around 1Gyr

EW(H $\alpha$ ): SF < 10-50Myr



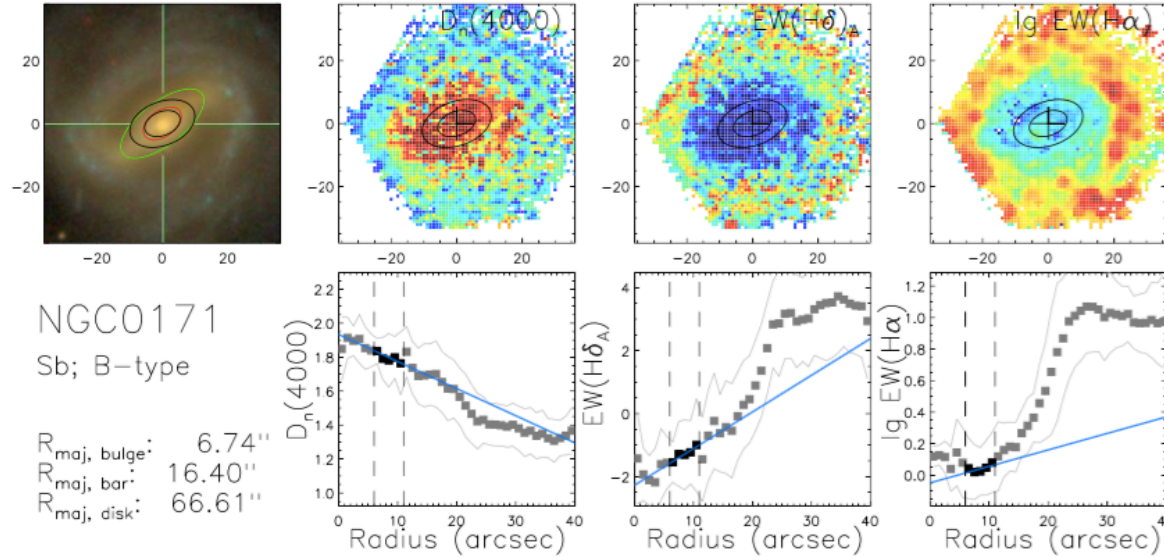
Kauffmann+03:  
e-folding model



Leitherer95:Starburst99  
Single burst model

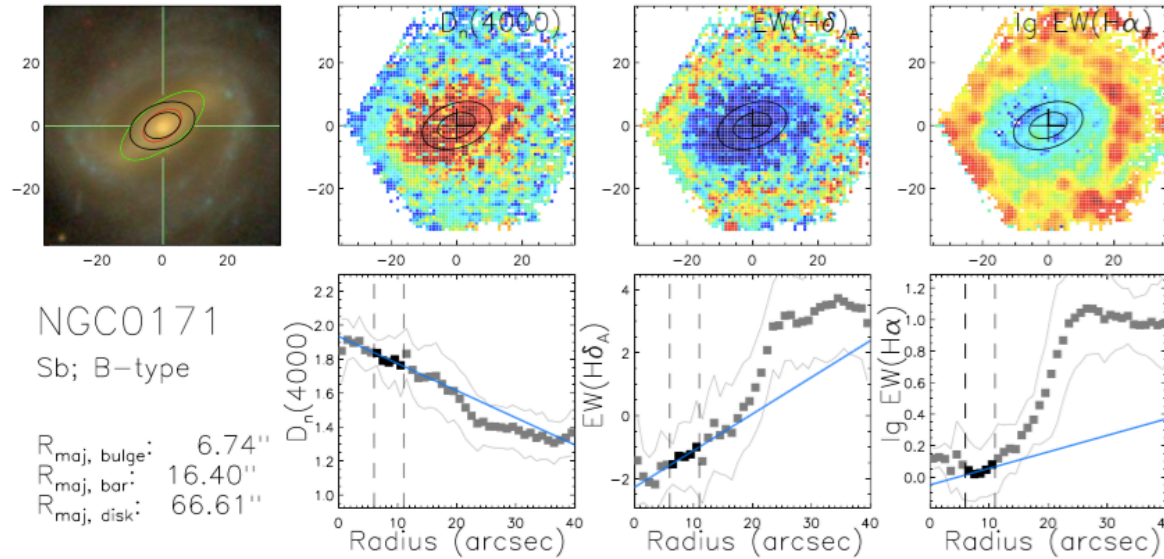
# D4000, EW(H $\delta$ ), EW(H $\alpha$ ) maps & profiles

A typical  
Spiral:

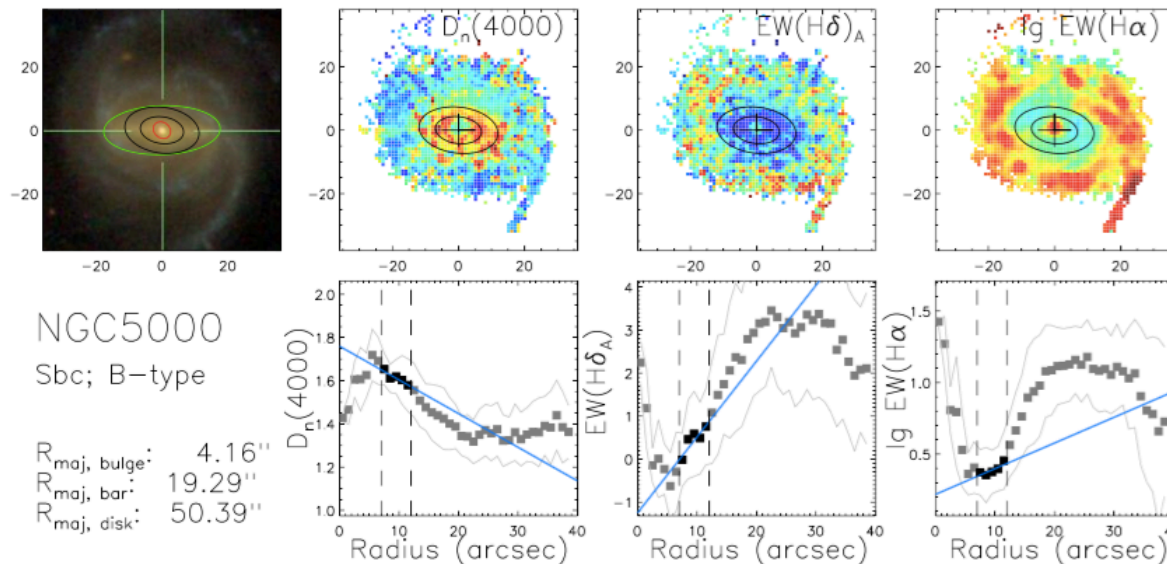


# D4000, EW(H $\delta$ ), EW(H $\alpha$ ) maps & profiles

A typical  
Spiral:



An example  
which shows  
“turnover”:

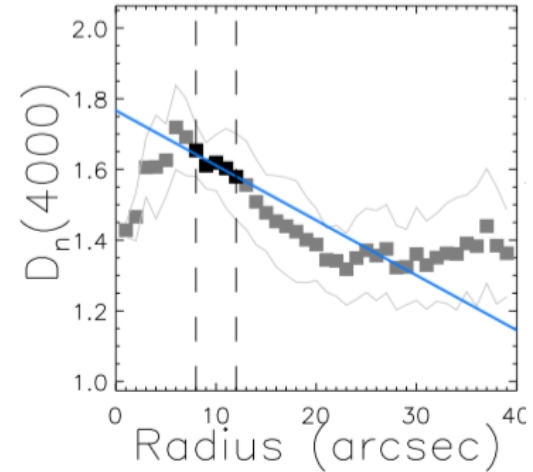
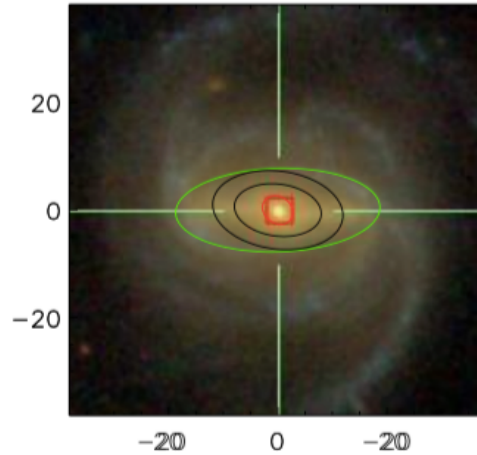


# Identify D4000-turnover galaxies

Barred galaxies:

$$R_{in}: R_{bulge}$$

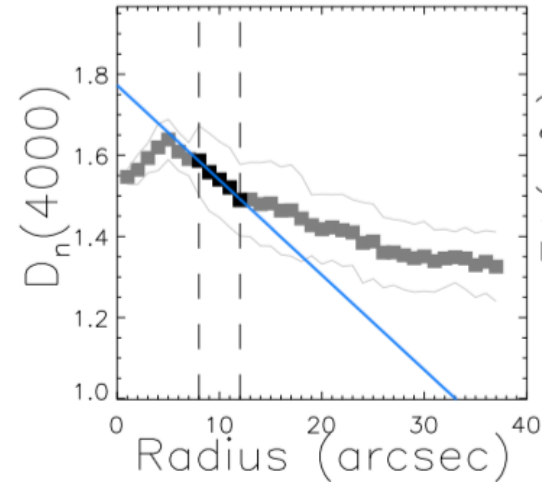
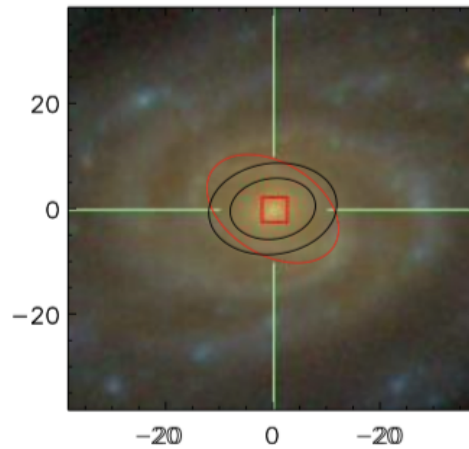
$$R_{out}: R_{bar}$$



non-Barred galaxies:

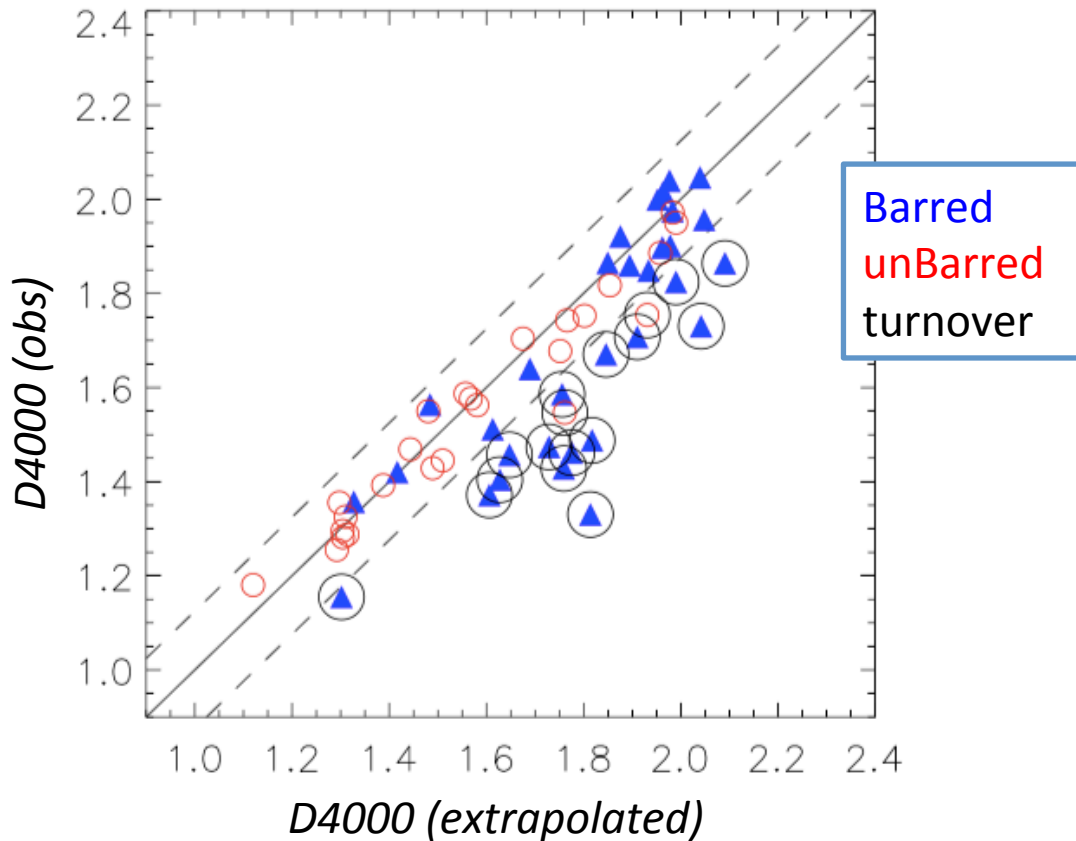
$$R_{in}: 3'' \text{ (PSF size)}$$

$$R_{out}: R_{bulge}$$



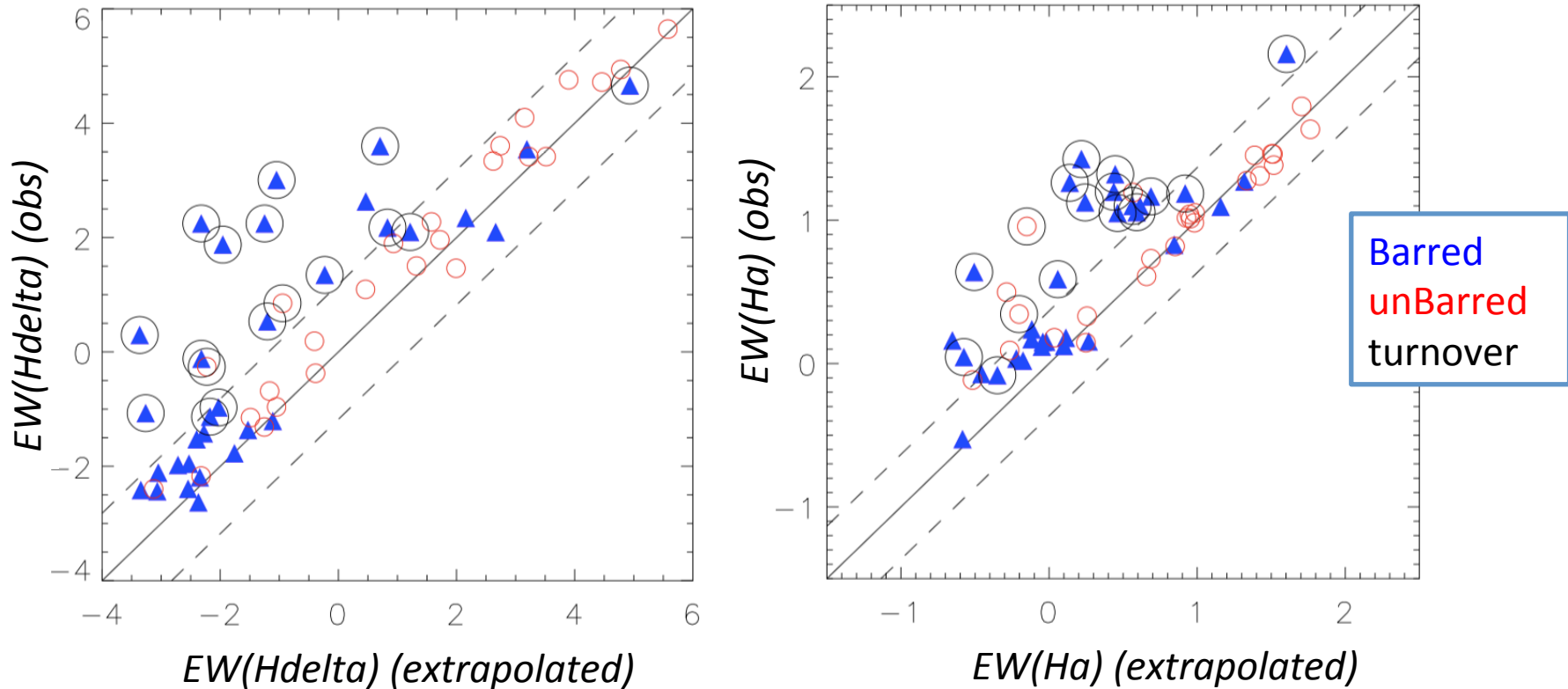
Lin et al. 2017

# Identify D4000-turnover galaxies



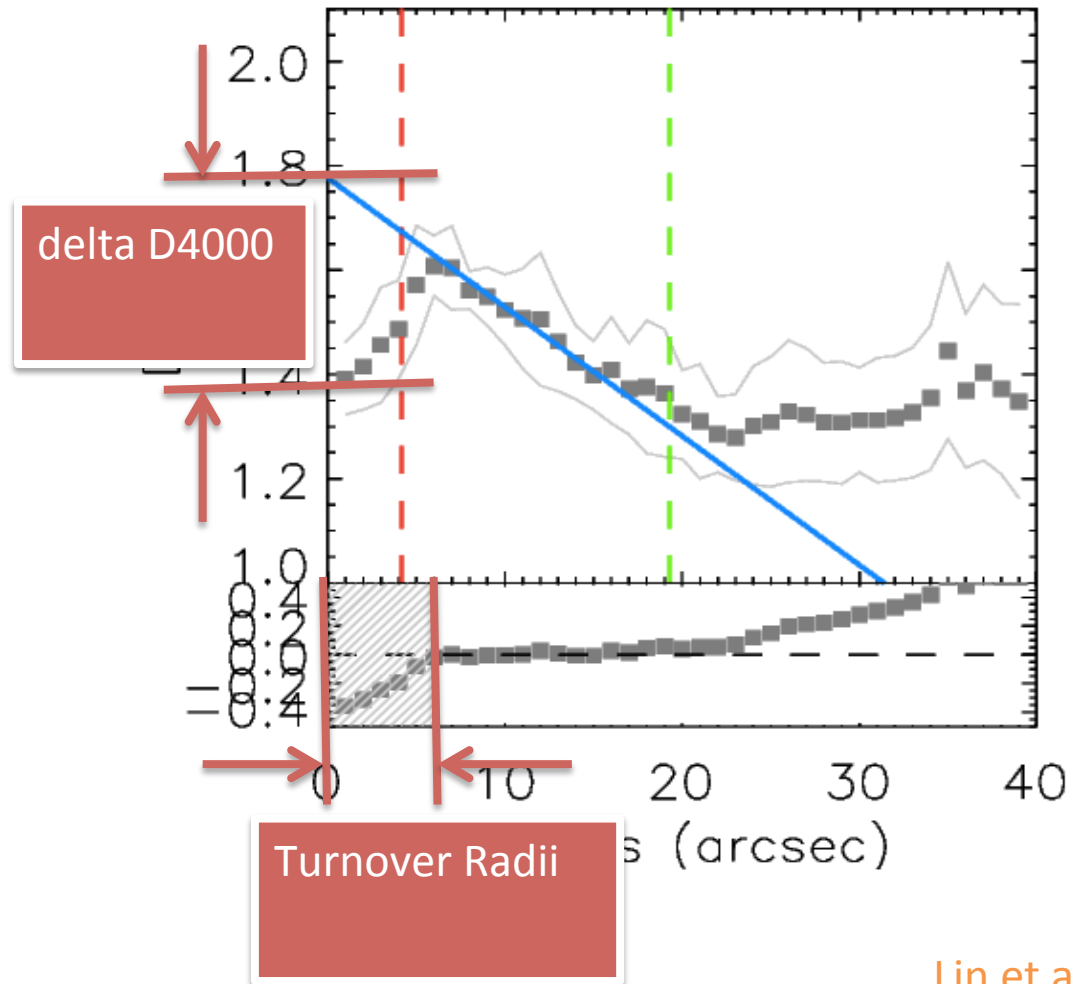
- Most (15/17) turnover galaxies are barred galaxies.
- Only half (15/31) of barred galaxies are turnover galaxies.

# Turnovers in EW(Hd) and EW(Ha) profiles



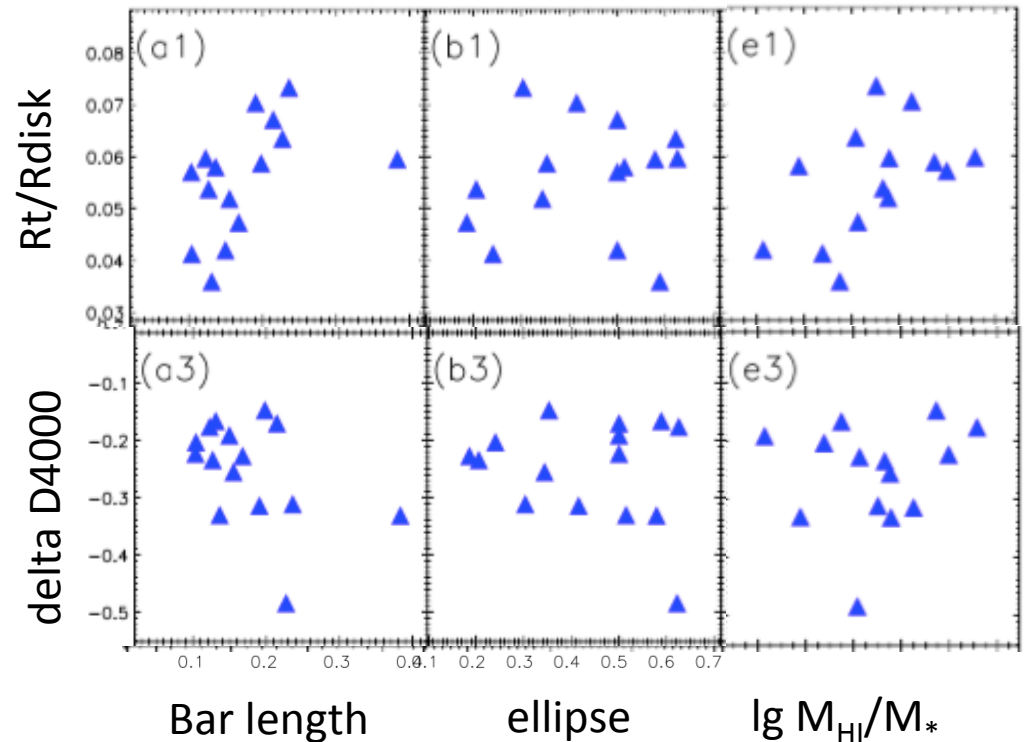
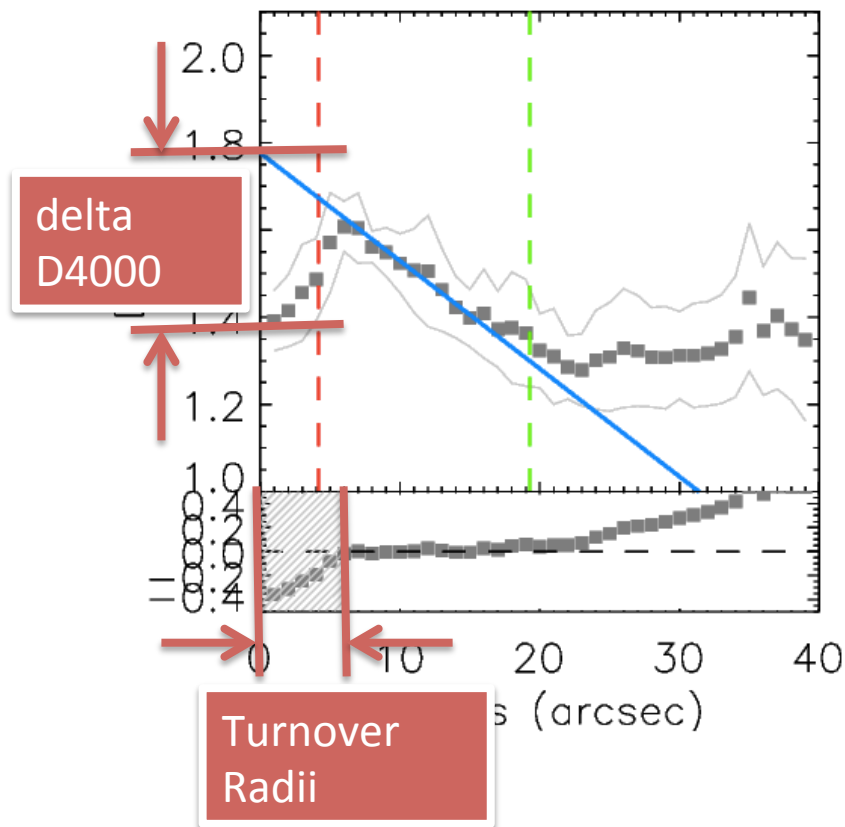
- Most of the turnover galaxies defined by the D4000 also show turnover feature in the other two parameters.

# Quantify turnover strength



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# turnovers vs. bar & gas properties

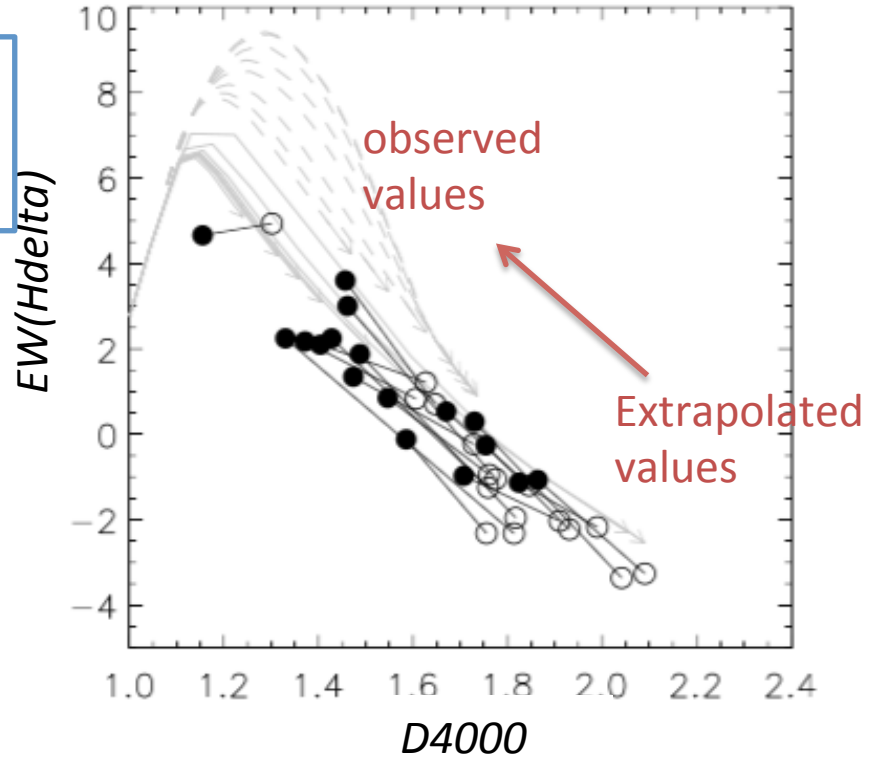
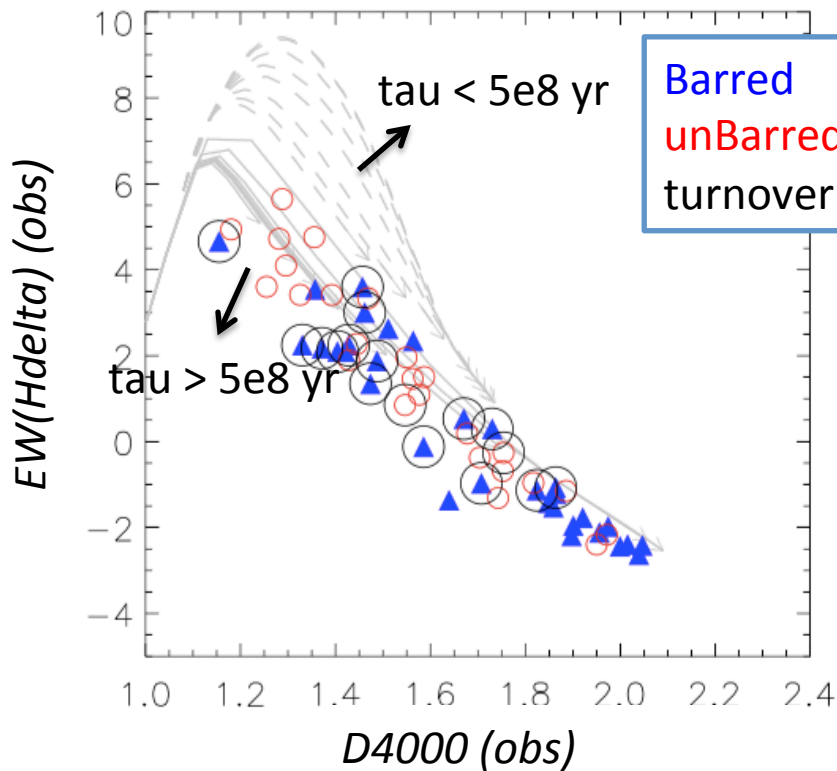


- Only found weak correlation between bar length and turnover size.

Lin et al. 2017



# Recent SFH of turnovers



- Both observed and extrapolated values are consistent with e-folding models, suggesting the central regions have been forming stars continuously in the past 1-2 Gyr.

Lin et al. 2017

# Summary

- We analysis maps and profiles of D4000, EW(H $\delta$ ) and EW(H $\alpha$ ) for galaxies from CALIFA survey.
  - We identify a class of “turnover” galaxies which indicates recent star formation in the inner region.
  - We find strong link between “turnover” feature with the bar structure. While only half of barred galaxies present central turnover.
  - Turnovers in D4000 also present corresponding turnover features in the profiles of EW(H $\alpha$ ) and EW(H $\delta$ ).
  - The size of the bar is the only galaxy property that is found to correlate with the turnover feature.
  - Need to extend our analysis to the larger MaNGA sample.



# Global properties of D4000-turnovers

