

# sSFR Enhancement in Close Major-Merger Pairs --- Spitzer Observations

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# Spitzer Observations of Local Pairs

(Xu et al. 2010, ApJ, 713, 330)

## Sample:

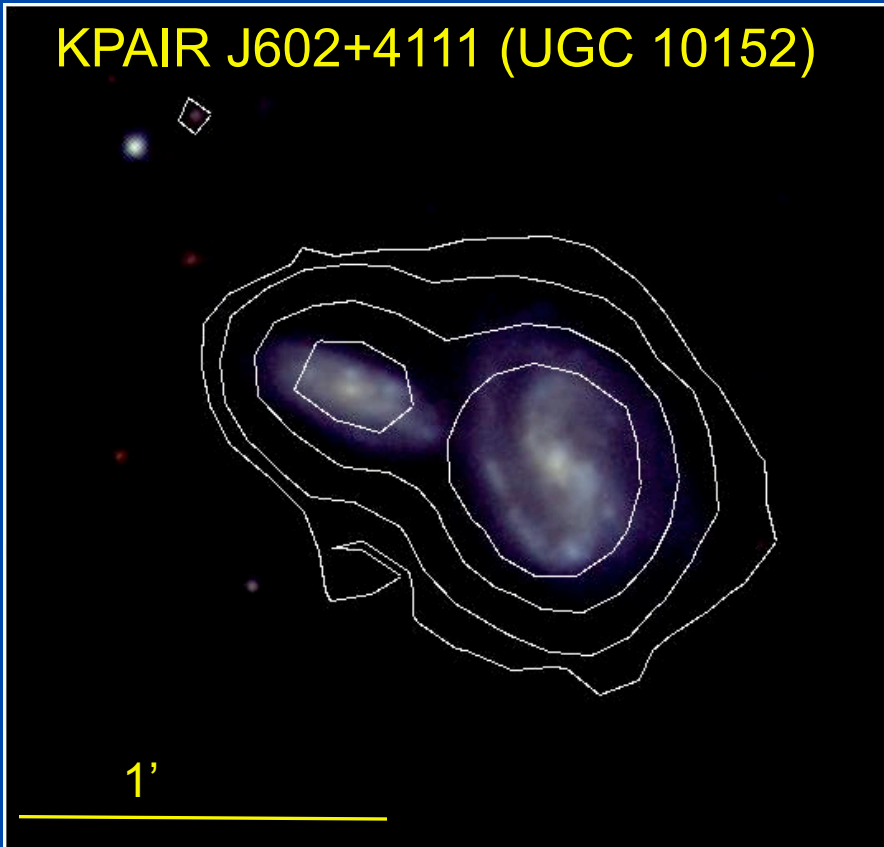
- 27 K-band selected  $z=0$  pairs (complete sample)
- all have measured redshifts for both components
- S+S and S+E pairs (E+E pairs excluded)

## Observations (37 hours, Spitzer GO2):

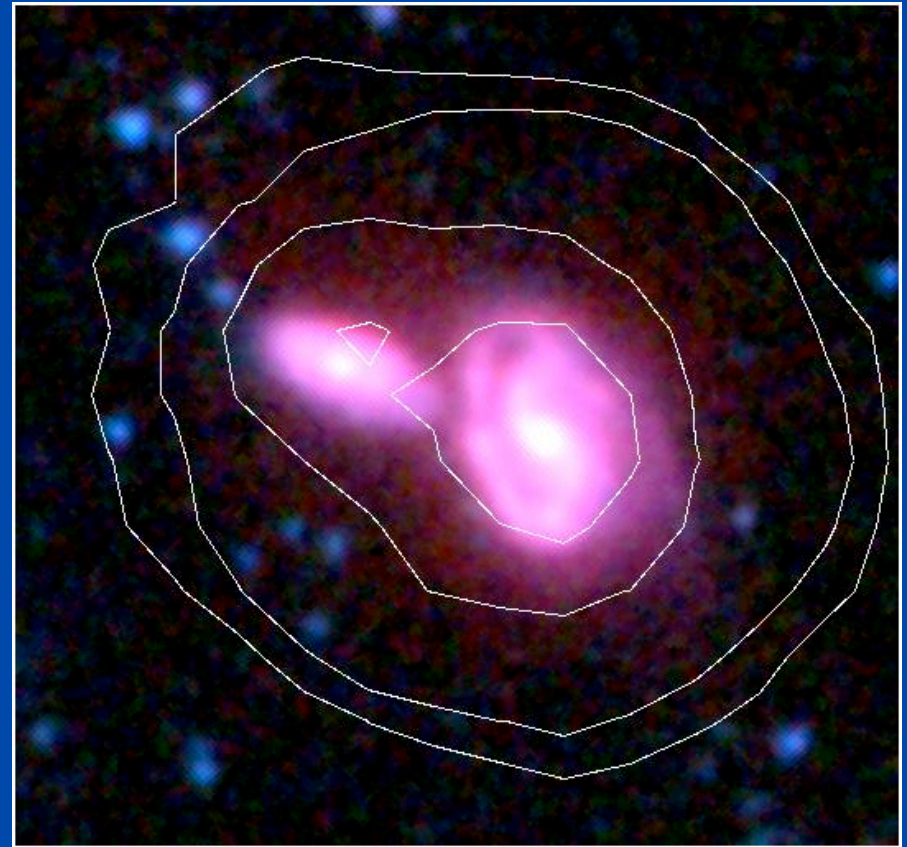
- images in 4 IRAC bands:
  - 3.6 and 4.5  $\mu\text{m}$  bands -- mainly from old star lights .
  - 5.8 and 8.0  $\mu\text{m}$  bands -- mainly from dust emission.
- maps in 3 MIPS bands (24, 70, 160  $\mu\text{m}$ ): most of dust emission, good star formation rate indicators.

# 15 S+S pairs --- 56 % of the sample

KPAIR J602+4111 (UGC 10152)

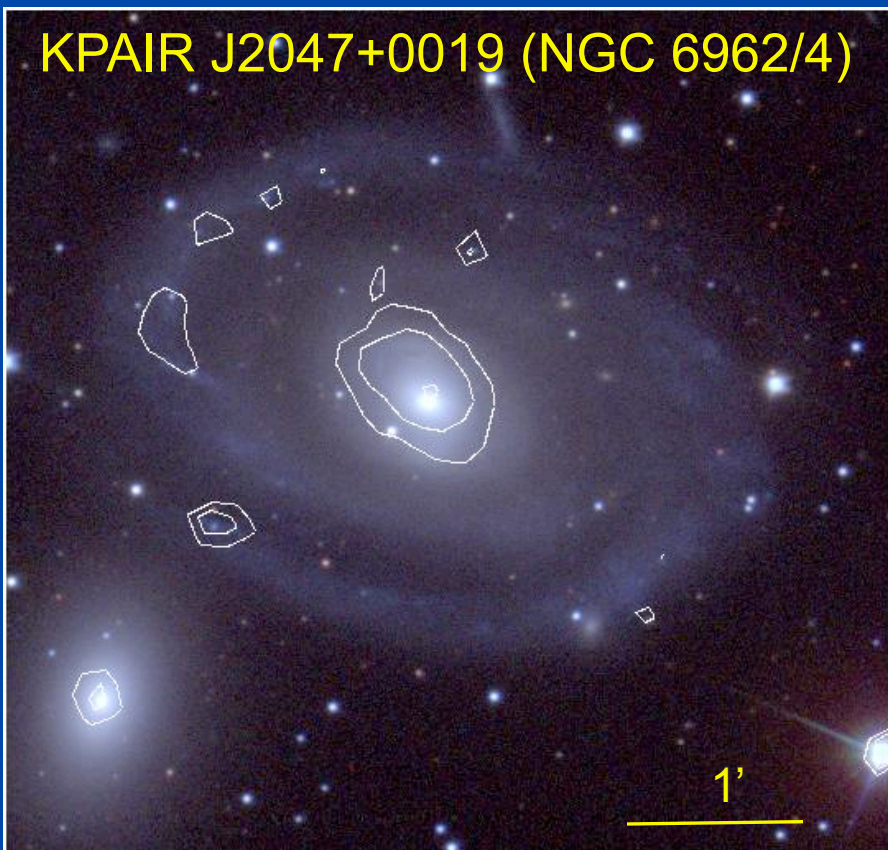


SDSS image + 24μm contours

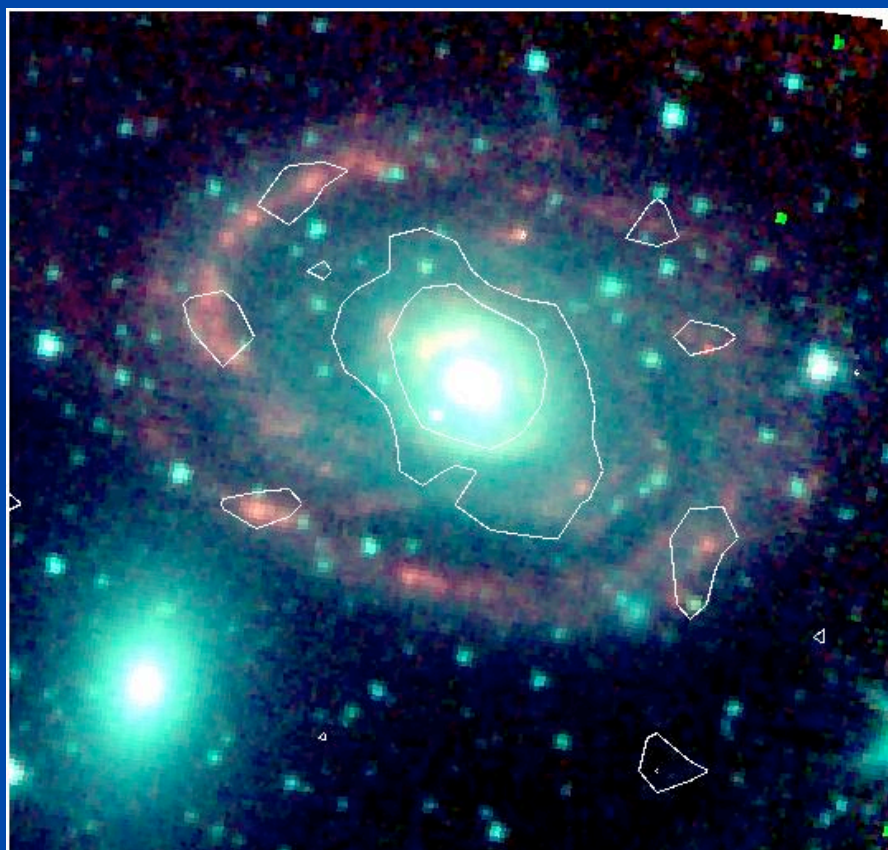


IRAC image + 70μm contours

# 12 S+E pairs --- 44 % of the sample



SDSS image + 24 $\mu$ m contours

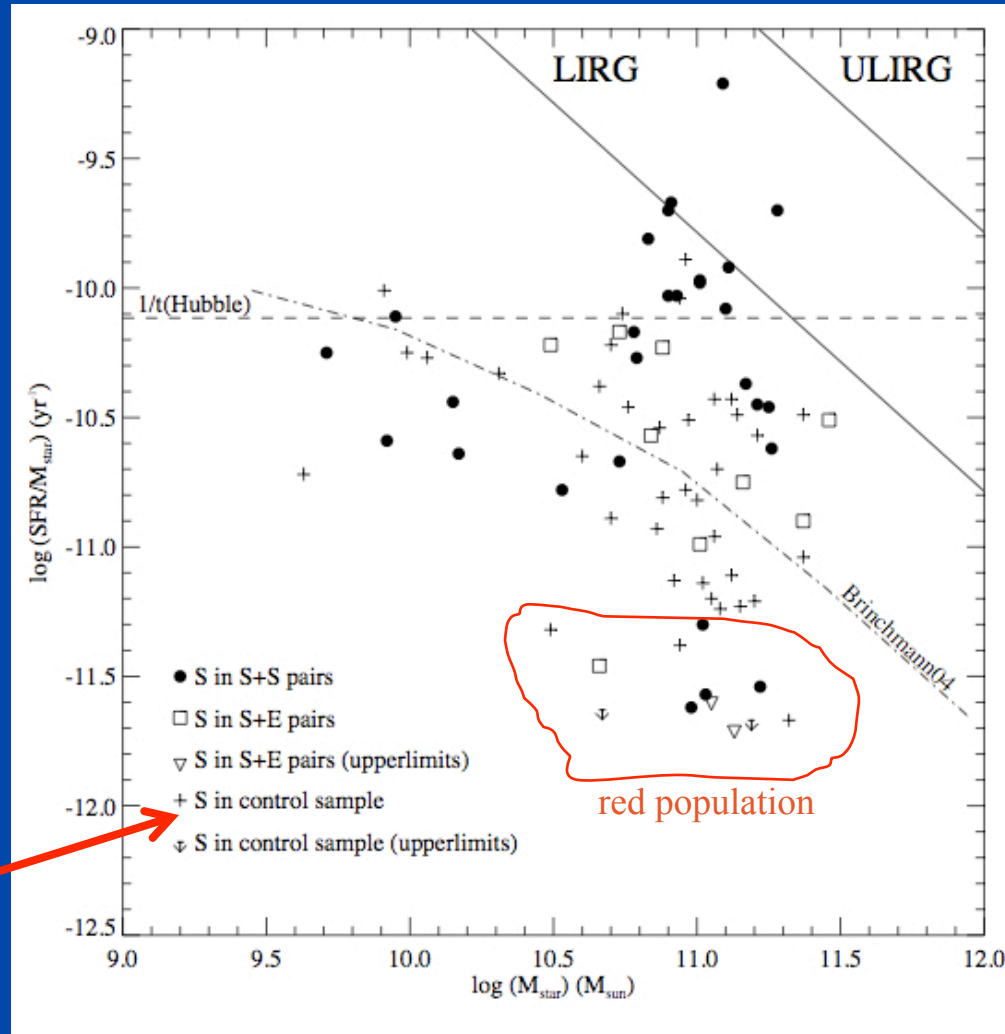


IRAC image + 70 $\mu$ m contours

# Specific SFR (SFR/M) of individual S galaxies

- S in S+E mixed with single spirals.
- low mass S in S+S: no enhancement.
- massive S in S+S: in two groups:  
(1) red population  
(2) elevated SFR/M
- 3 LIRGs (all in S+S)
- no ULIRG

Control Sample:  
single spirals selected  
from SWIRE/SINGS;  
one-to-one mass-matched  
to paired spirals.



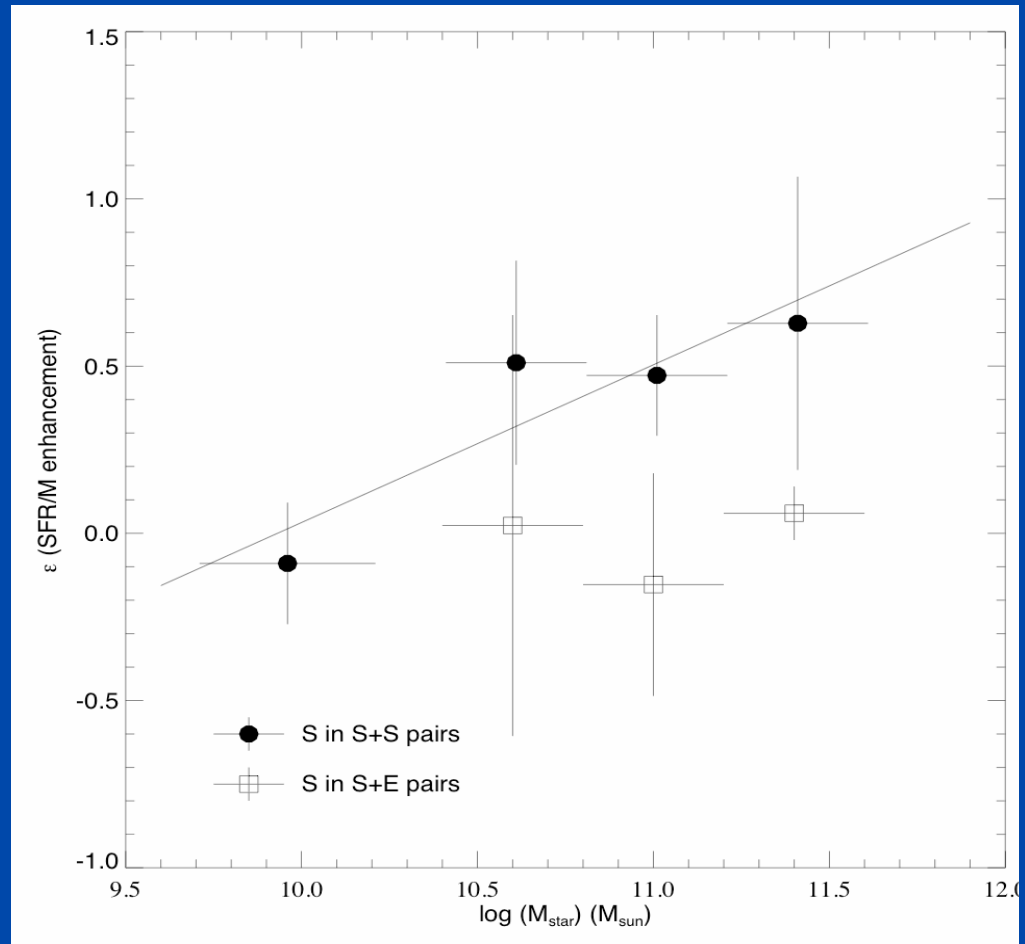
2010.11.03

"Stormy Cosmos" in Pasadena

# sSFR enhancement

Enhancement:  $\epsilon = \log(\text{SFR}/M)_{\text{KPAIR-S}} - \log(\text{SFR}/M)_{\text{control}}$

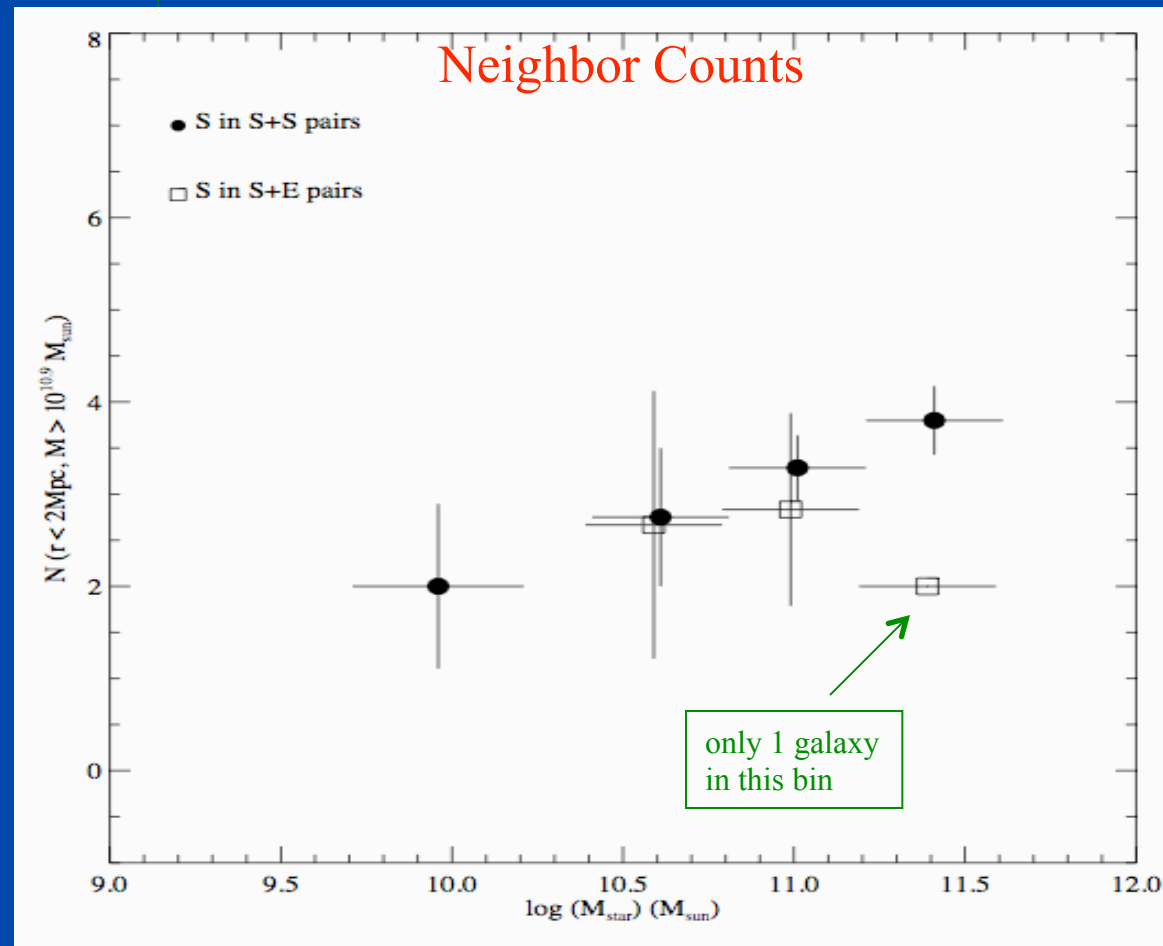
- Only massive S in S+S pairs show sSFR enhancement
- No sSFR enhancement for low mass S in S+S pairs
- No sSFR enhancement for S in S+E pairs, either.



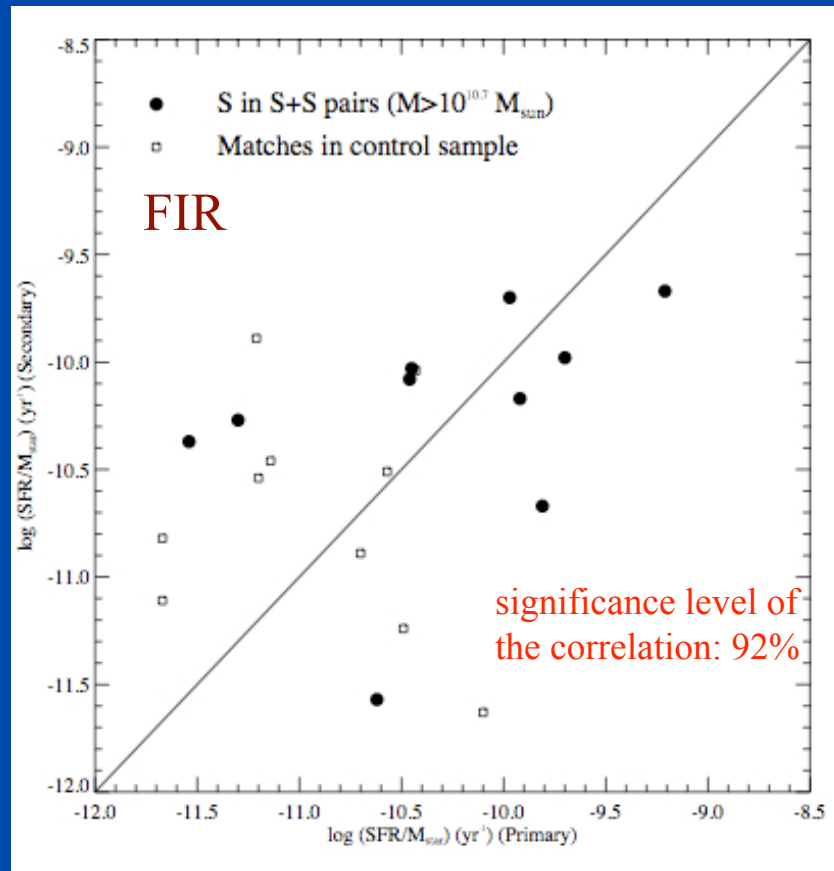
- Why are S in S+E pairs behave differently from those in S+S pairs ???

# S+E pairs have higher local density than S+S?

- Answer is No :



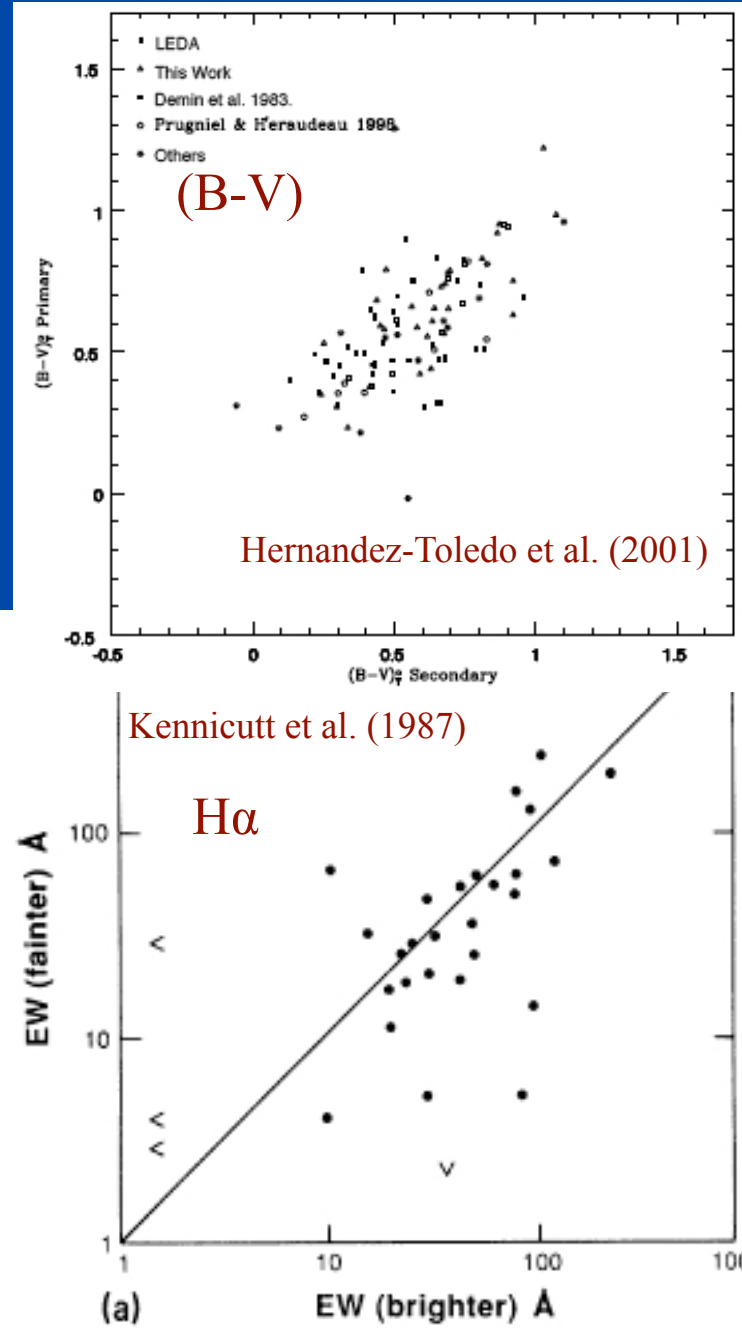
# “Holmberg effect”



- Concordant global SFR between two galaxies in massive S+S pairs.
- But not for nuclear SFR (Joseph et al. 1984).

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"Stormy Cosmos" in P

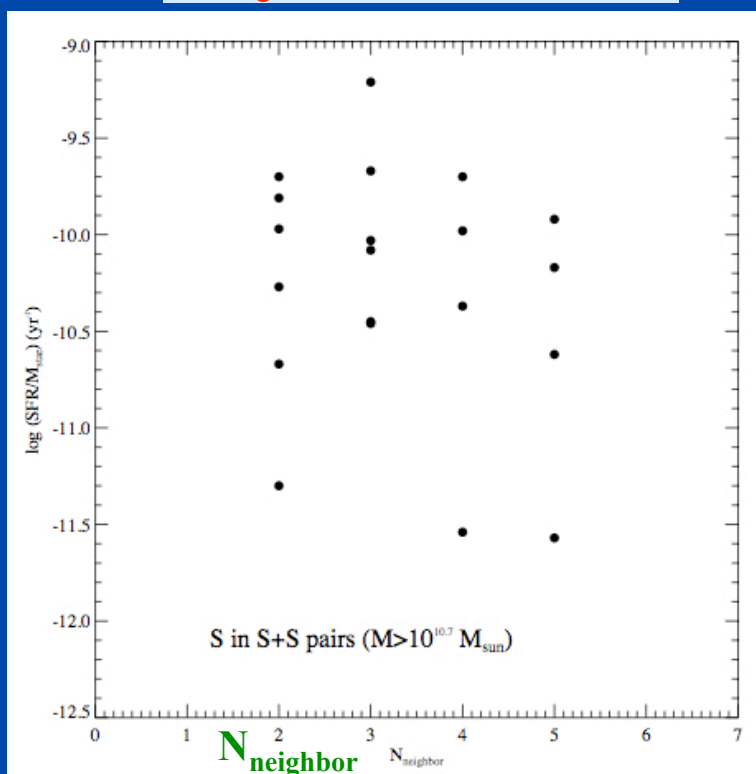




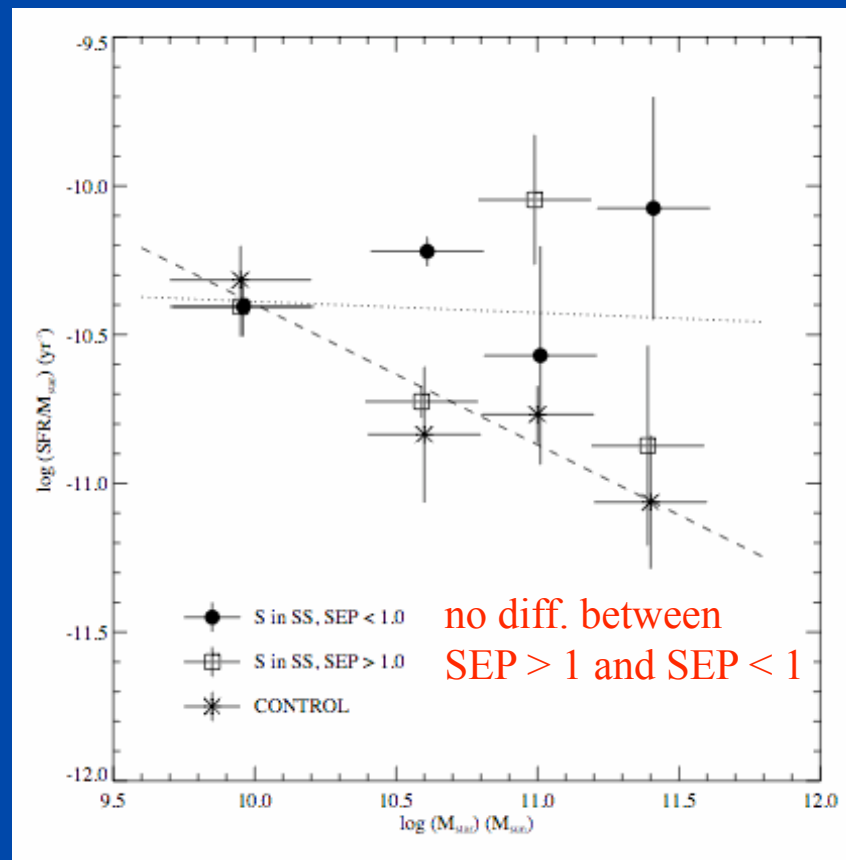
Can “Holmberg effect” be due to the sSFR dependence on local density?

No!

no sSFR dependence on  $N_{\text{neighbor}}$  for S+S pairs:



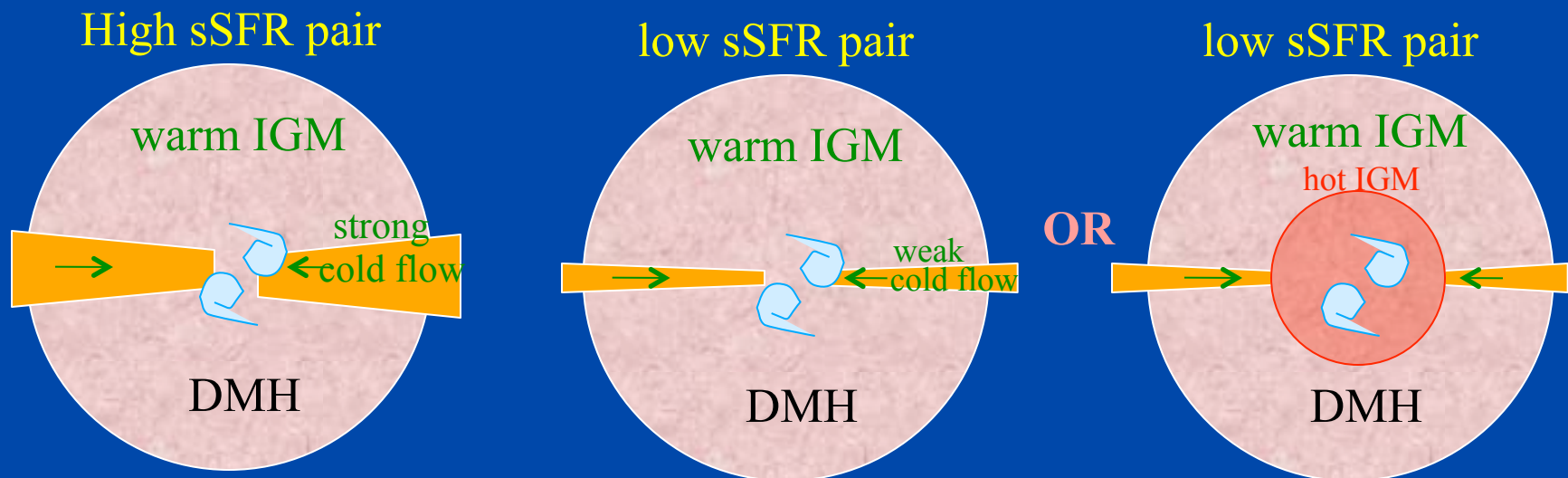
Or is it due to the sSFR dependence on pair separation? No!



•  $\text{SEP} = s_{\text{projected}} / (r_{\text{primary}} + r_{\text{secondary}})$

# Can sSFR of galaxies be modulated by IGM in DMH?

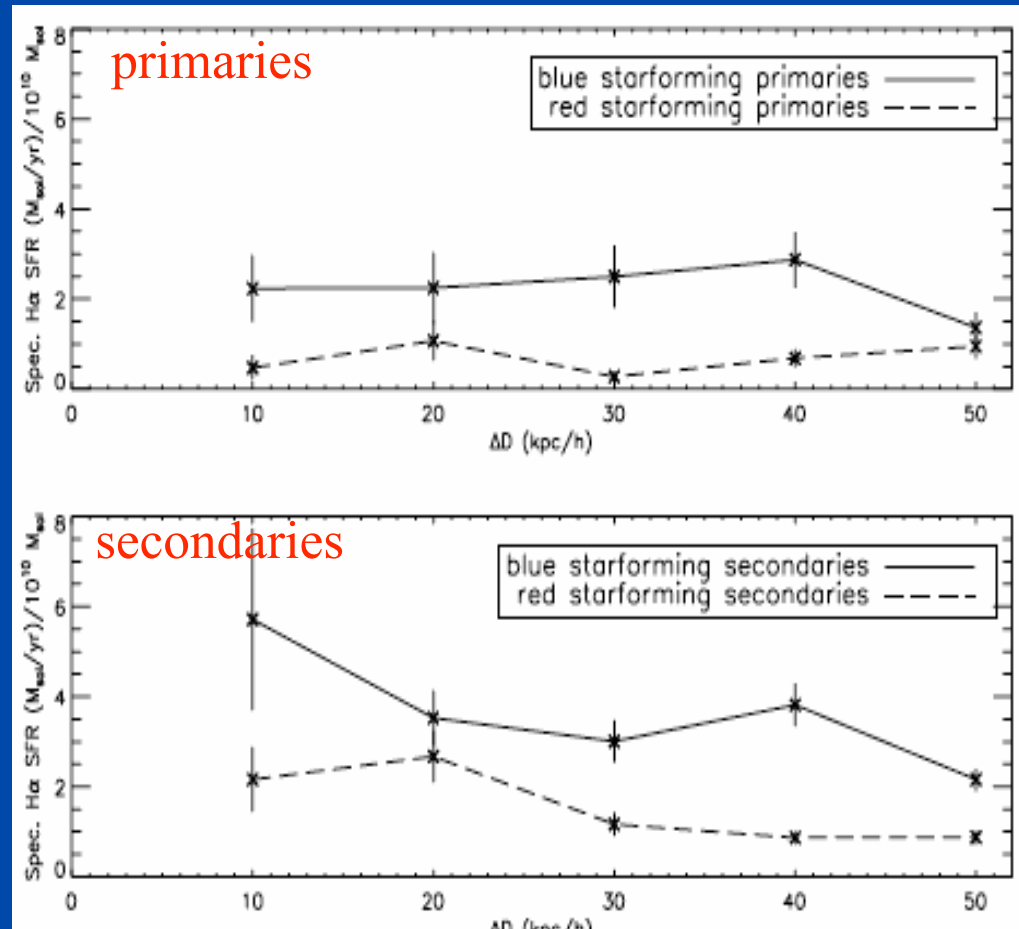
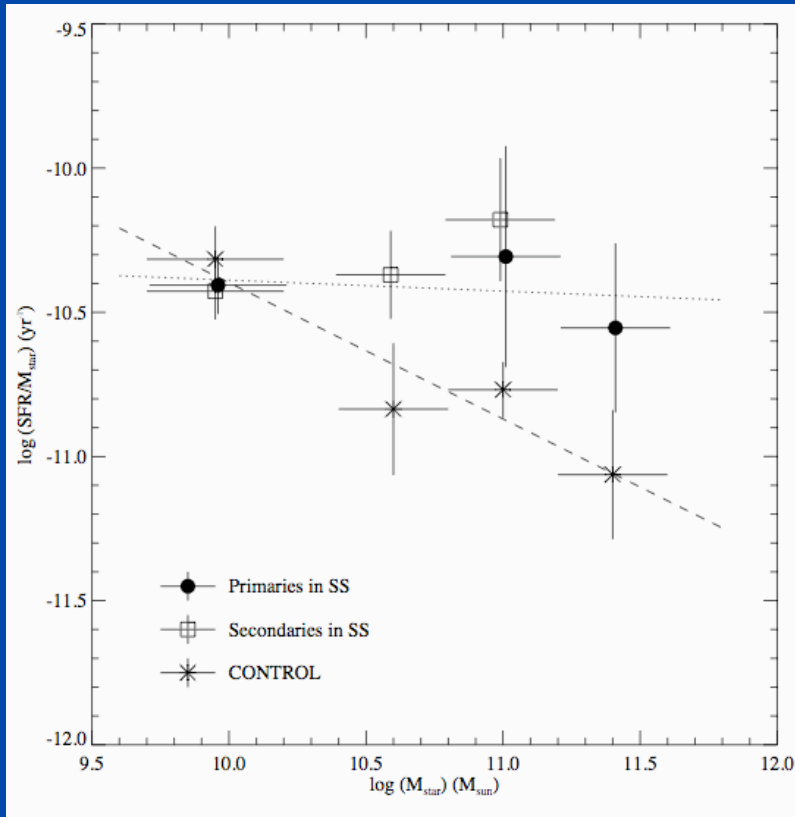
- The “Holmberg effect” in S+S pairs and the non-enhancement of S galaxies with E companions reveal a link between the sSFR of two galaxies in a pair.
- Our conjuncture: **the correlation is due to the modulation of the sSFR by the IGM in the dark matter halo (DMH) that the two galaxies share.**



# SFR/M enhancement: Primaries and Secondaries

Minor merger pairs (Woods & Geller 2007):

Major merger pairs (our result):



- 1<sup>st</sup> and 2<sup>nd</sup> are equally enhanced.

- Enhancement in 2<sup>nd</sup> only.
- No enhancement in 1<sup>st</sup>.

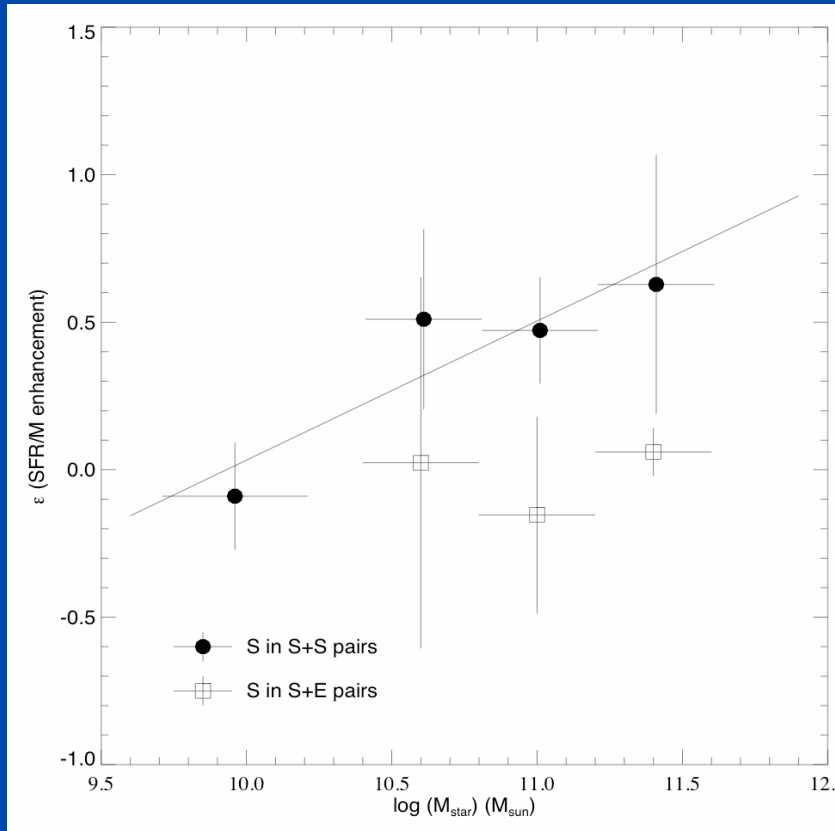
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"Stormy Cosmos" in Pasadena

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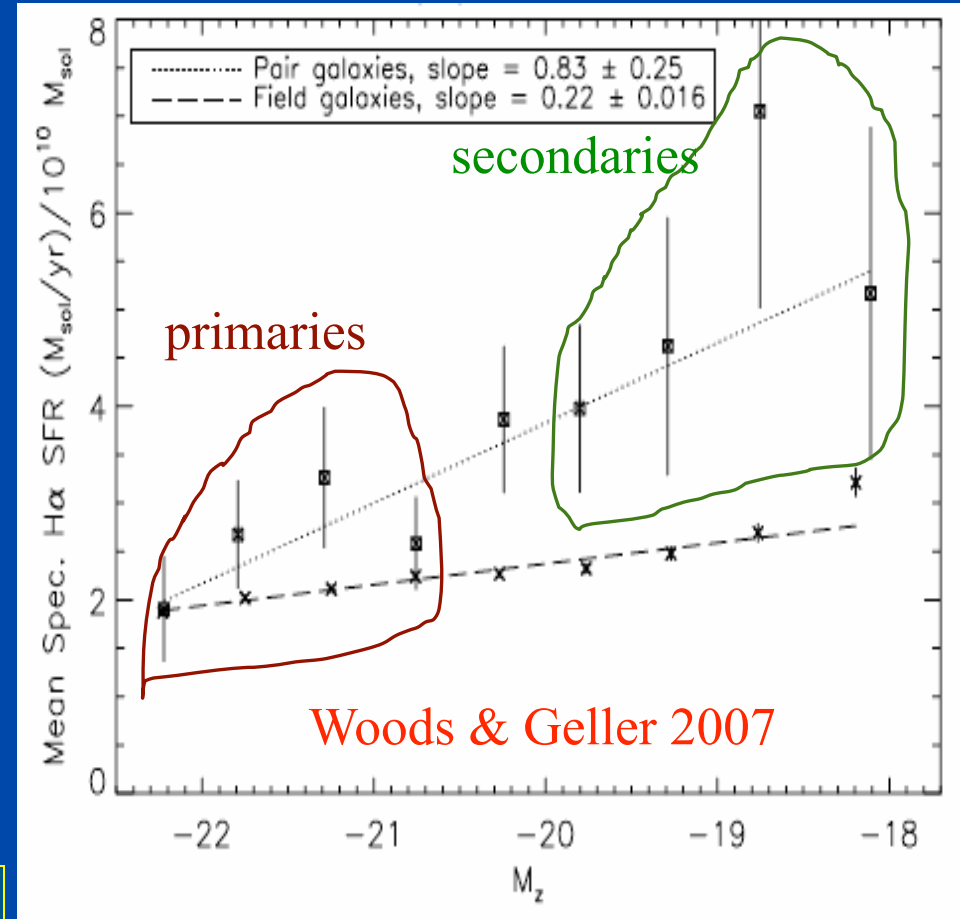
# Mass Dependence of SFR/M enhancement

Major merger pairs (our result):



- no enhancement in low galaxies
- strong enhancement in massive galaxies.

Pairs including minor mergers:



- minor-merges: Completely opposite!

# Summary

- 1) Spitzer observations of a subsample of 27 S+S and S+E pairs show diversified star formation activities (from very active LIRGs to very quiescent galaxies).
- 2) Compared to a control sample of single normal spiral galaxies, only massive spirals in S+S pairs show significant sSFR (SFR/M) enhancement.
- 3) No sSFR enhancement is found in spirals in S+E pairs.
- 4) sSFR's of the primaries and secondaries are correlated (Holmberg effect).  
The correlation may indicate modulations of sSFR by the IGM in the dark matter halo (DMH) surrounding the pair.
- 5) sSFR enhancement of spiral galaxies in major-merger S+S pairs behaves very differently from that of S in minor-merger S+S pairs: no enhancement in low mass spirals, and equal enhancement for primaries and secondaries in massive pairs.