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

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"Stormy Cosmos" in Pasadena
Spitzer Observations of Local Pairs

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 µm bands -- mainly from old star lights.
  - 5.8 and 8.0 µm bands -- mainly from dust emission.
- maps in 3 MIPS bands (24, 70, 160 µm): 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

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

1' SDSS image + 24µm contours

IRAC image + 70µm contours

KPAIR J2047+0019 (NGC 6962/4)

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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.

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sSFR enhancement

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

• 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:

![Neighbor Counts graph](image)
“Holmberg effect”

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

Hernandez-Toledo et al. (2001)

Kennicutt et al. (1987)

significance level of the correlation: 92%
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!

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

no diff. between SEP > 1 and SEP < 1

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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):

- Enhancement in 2nd only.
- No enhancement in 1st.

Major merger pairs (our result):

- 1st and 2nd are equally enhanced.

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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!

Woods & Geller 2007
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.