Galaxy mergers at $z < 1.5$ from VVDS and MASSIV

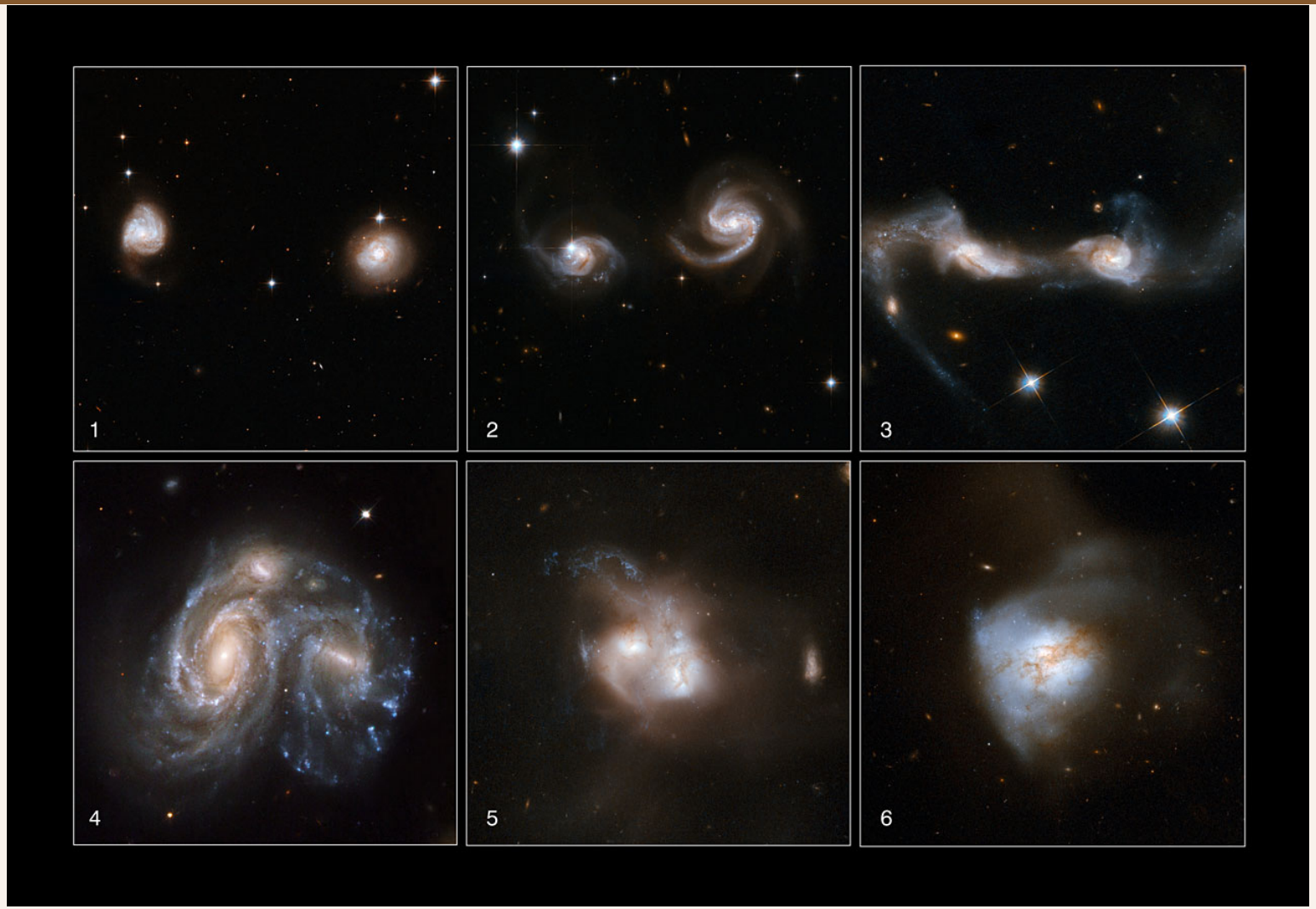
C. López-Sanjuan, O. Le Fèvre,
L. Tresse, L. Tasca, O. Cucciati, P. Cassata, O. Ilbert,
B. Epinat, T. Contini, B. Garilli, D. Vergani,
the VVDS + MASSIV collaborations

Centro de Estudios de Física del Cosmos de Aragón
CEFCA

From galaxies to cosmology with deep spectroscopic surveys
A tribute to Olivier Le Fèvre // 5th July 2022

Funding agencies : FONDO DE INVERSIONES DE TERUEL · GOBIERNO DE ESPAÑA · MINISTERIO DE CIENCIA E INNOVACIÓN · GOBIERNO DE ARAGON · FEDER

Galaxy mergers

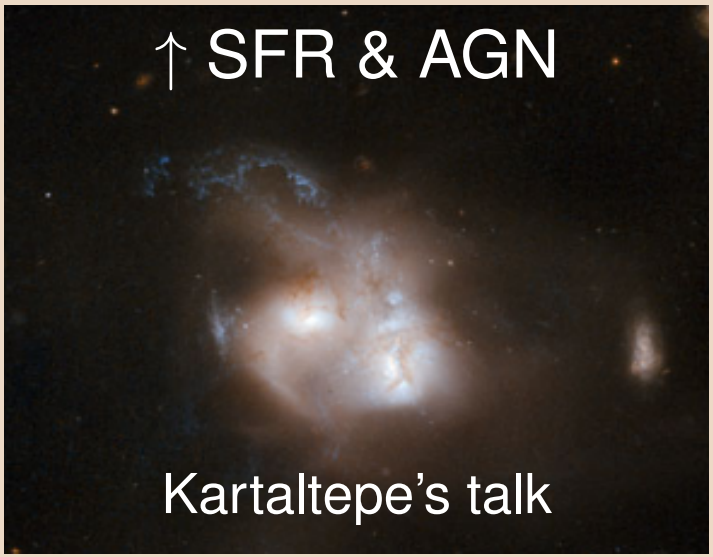


We live in an hierarchical Universe,
plenty of galaxy mergers.

Galaxy mergers

What is the role of mergers in galaxy evolution?

Understand the impact of mergers in galaxy properties (SFR, metallicity, AGN, size, morphology, mass assembly, etc.)



Measure the merger rate and its evolution with redshift looking for distorted galaxies or kinematically close pairs.

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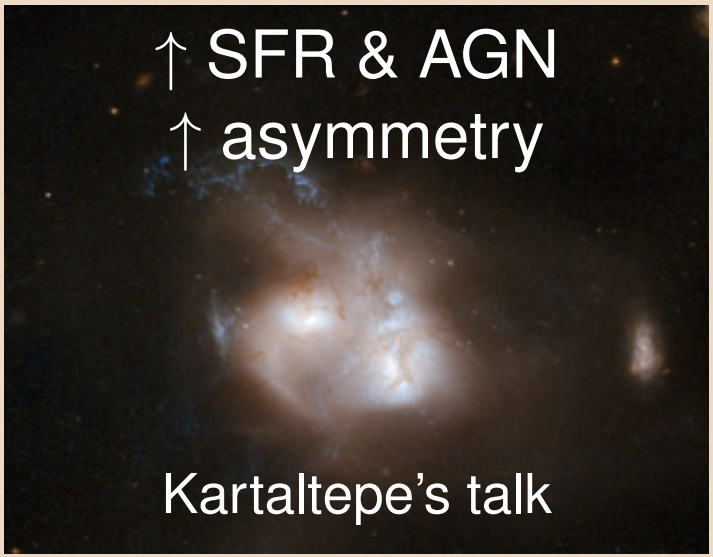

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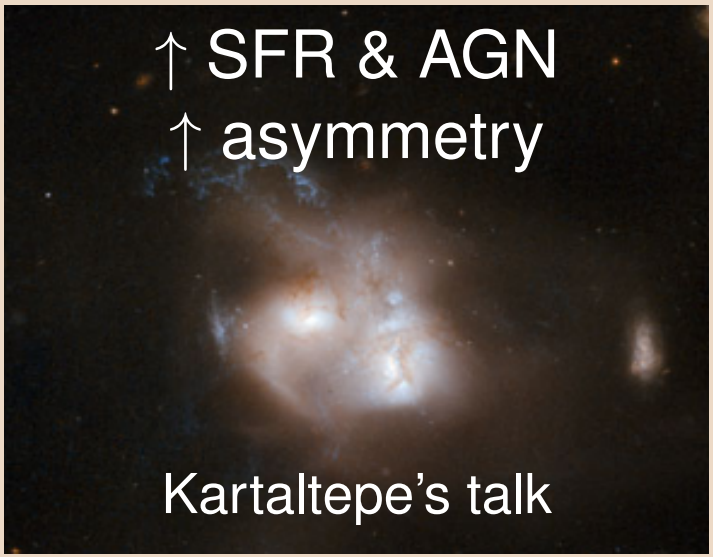

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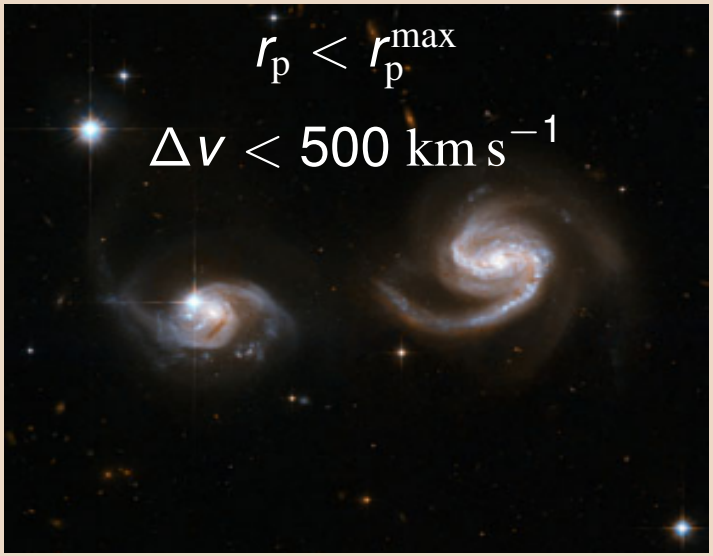


At the biginning of the PhD...

NEW TECHNIQUES FOR RELATING DYNAMICALLY CLOSE GALAXY PAIRS TO MERGER AND ACCRETION RATES: APPLICATION TO THE SECOND SOUTHERN SKY REDSHIFT SURVEY

D. R. Patton,[1,2,3] R. G. Carlberg,[3] R. O. Marzke,[4] C. J. Pritchet,[1] L. N. da Costa,[5] and P. S. Pellegrini[6]

Received 1999 July 1; accepted 2000 January 26

Hubble Space Telescope imaging of the CFRS and LDSS redshift surveys – IV. Influence of mergers in the evolution of faint field galaxies from $z \sim 1$

O. Le Fèvre,[1]★ R. Abraham,[2] S. J. Lilly,[3] R. S. Ellis,[2] J. Brinchmann,[2] D. Schade,[6] L. Tresse,[1,4] M. Colless,[5] D. Crampton,[6] K. Glazebrook,[7] F. Hammer[8] and T. Broadhurst[9]

A DIRECT MEASUREMENT OF MAJOR GALAXY MERGERS AT $z \lesssim 3$

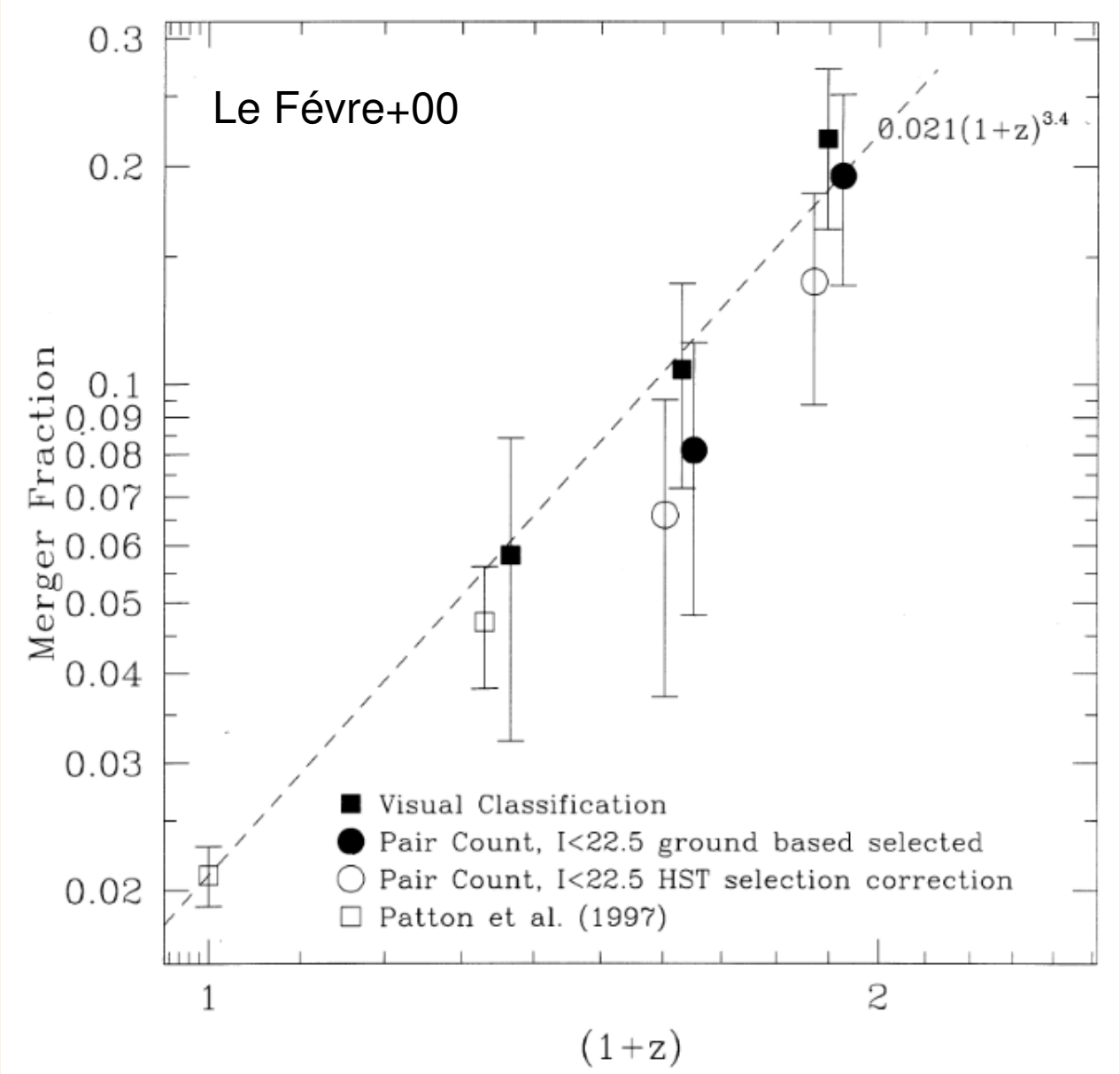
Christopher J. Conselice,[1,2] Matthew A. Bershady,[3] Mark Dickinson,[4] and Casey Papovich[5]

Received 2003 April 14; accepted 2003 May 28

THE DEEP2 GALAXY REDSHIFT SURVEY: EVOLUTION OF CLOSE GALAXY PAIRS AND MAJOR-MERGER RATES UP TO $z \sim 1.2$[1]

Lihwai Lin,[2,3] David C. Koo,[3] Christopher N. A. Willmer,[3,4] David R. Patton,[5] Christopher J. Conselice,[6] Renbin Yan,[7] Alison L. Coil,[7] Michael C. Cooper,[7] Marc Davis,[7,8] S. M. Faber,[3] Brian F. Gerke,[8] Puragra Guhathakurta,[3] and Jeffrey A. Newman[9]

Received 2004 August 21; accepted 2004 November 3; published 2004 November 17



First measurement of the merger fraction evolution up to $z = 1$

During the PhD...

THE EVOLUTION OF GALAXY MERGERS AND MORPHOLOGY AT $z < 1.2$
IN THE EXTENDED GROTH STRIP

Jennifer M. Lotz,[1,2] M. Davis,[3] S. M. Faber,[4] P. Guhathakurta,[4] S. Gwyn,[5] J. Huang,[6] D. C. Koo,[4]
E. Le Floc'h,[7,8,9] Lihwai Lin,[4] J. Newman,[10,11] K. Noeske,[4] C. Papovich,[9,12] C. N. A. Willmer,[12]
A. Coil,[11,12] C. J. Conselice,[13] M. Cooper,[3] A. M. Hopkins,[14] A. Metevier,[4,15]
J. Primack,[16] G. Rieke,[12] and B. J. Weiner[12]

The structures of distant galaxies – III. The merger history of over 20 000 massive galaxies at $z < 1.2$

Christopher J. Conselice,* Cui Yang and Asa F. L. Bluck

The VIMOS VLT Deep Survey

Evolution of the major merger rate since $z \sim 1$ from spectroscopically confirmed galaxy pairs*

L. de Ravel[1], O. Le Fèvre[1], L. Tresse[1], D. Bottini[2], B. Garilli[2], V. Le Brun[1], D. Maccagni[2], R. Scaramella[4,13],
M. Scodeggio[2], G. Vettolani[4], A. Zanichelli[4], C. Adami[1], S. Arnouts[23,1], S. Bardelli[3], M. Bolzonella[3], A. Cappi[3],

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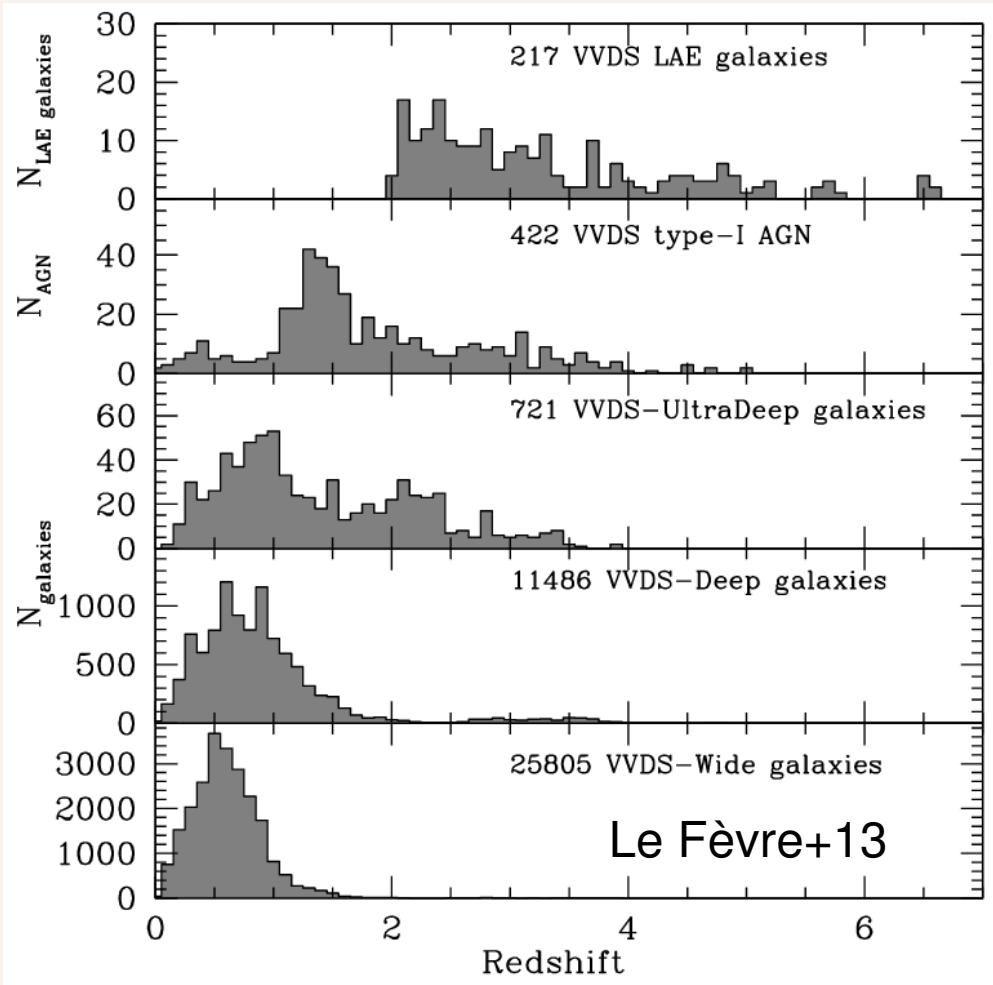
Major mergers in VVDS (de Ravel, Le Fèvre+09)



Main survey conducted with VIMOS.

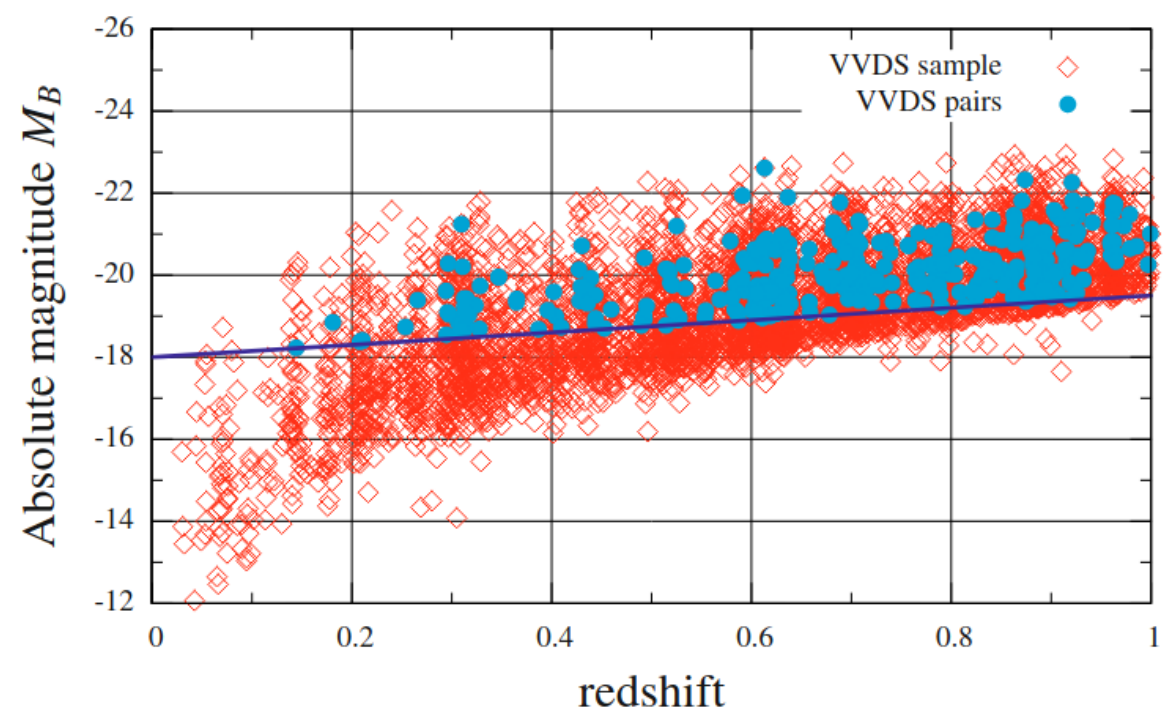
Three magnitud-limited surveys:

- VVDS-Wide. $I < 22.5$.
- VVDS-Deep. $I < 24.0$.
- VVDS-UDeep. $23 < I < 24.75$.

Nearly 35 000 **redshifts**.
Le Fèvre+04; 297 citations.
Le Fèvre+05; 617 citations.
Garilli+08; 128 citations.
Le Fèvre+13; 274 citations.

https://cesam.lam.fr/vvds/

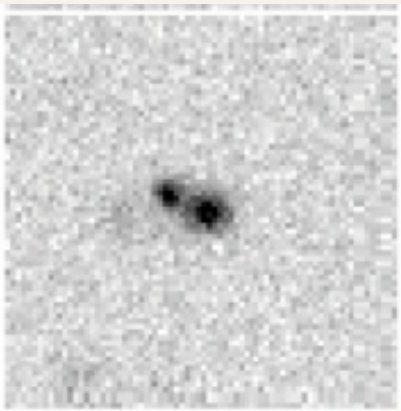
Major mergers in VVDS (de Ravel, Le Fèvre+09)

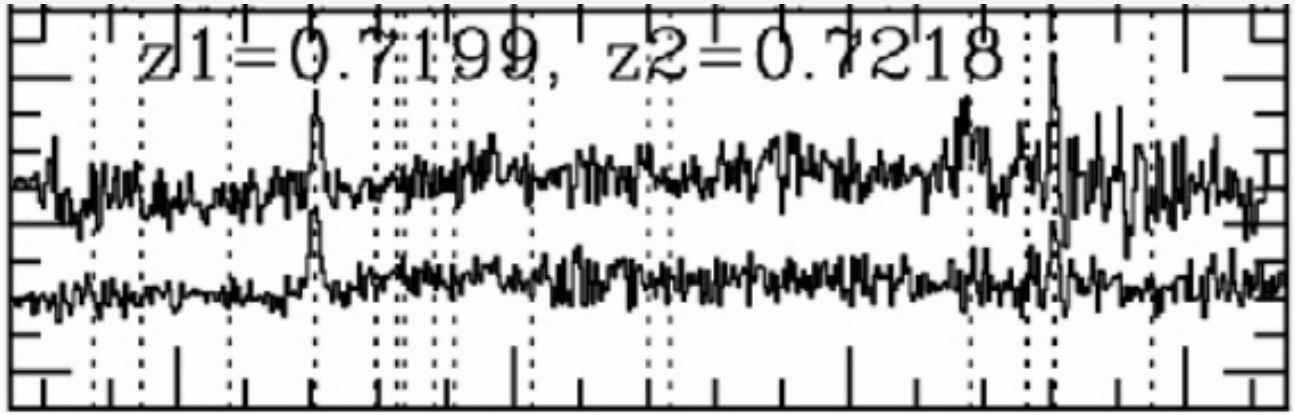


Major mergers ($\Delta M_{\rm B} < 1.5$) of $M_B < -18 - 1.1z$ galaxies

with $\Delta v < 500$ km s^{-1} and $r_{\rm p} < 100 h^{-1}$ kpc

at $z < 1$





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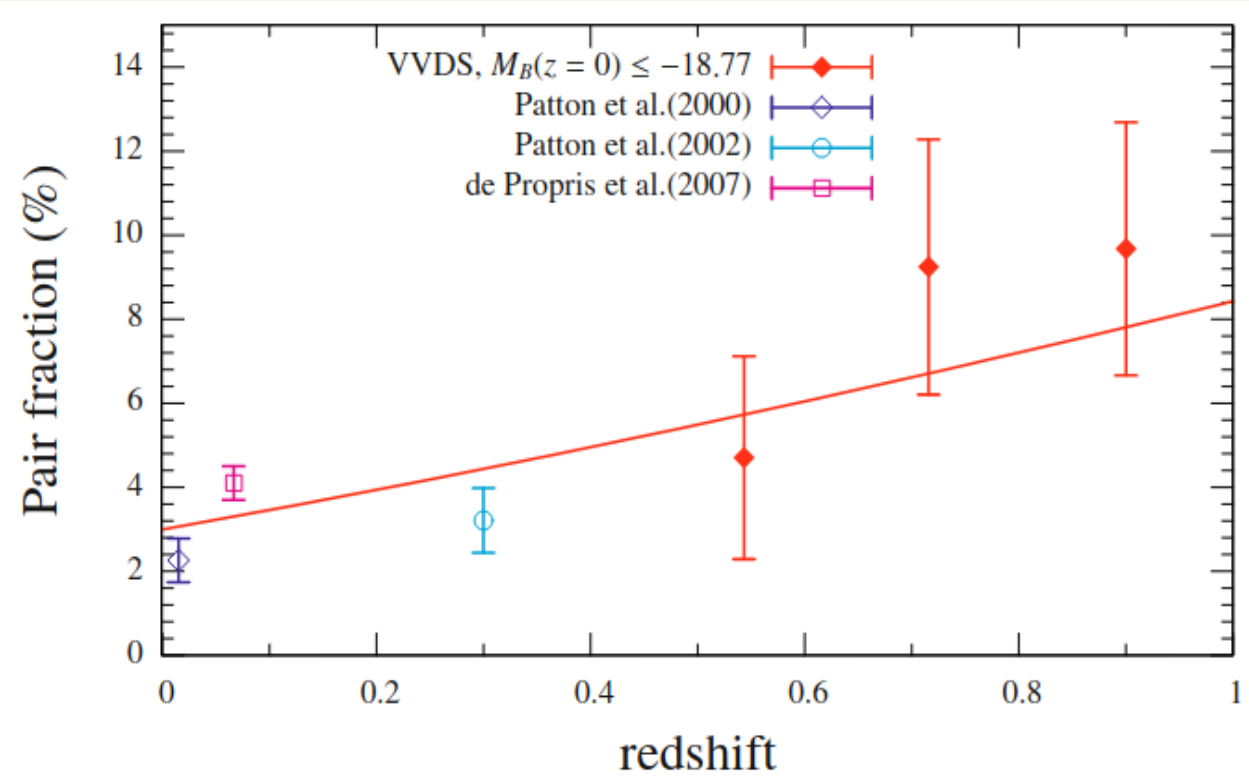
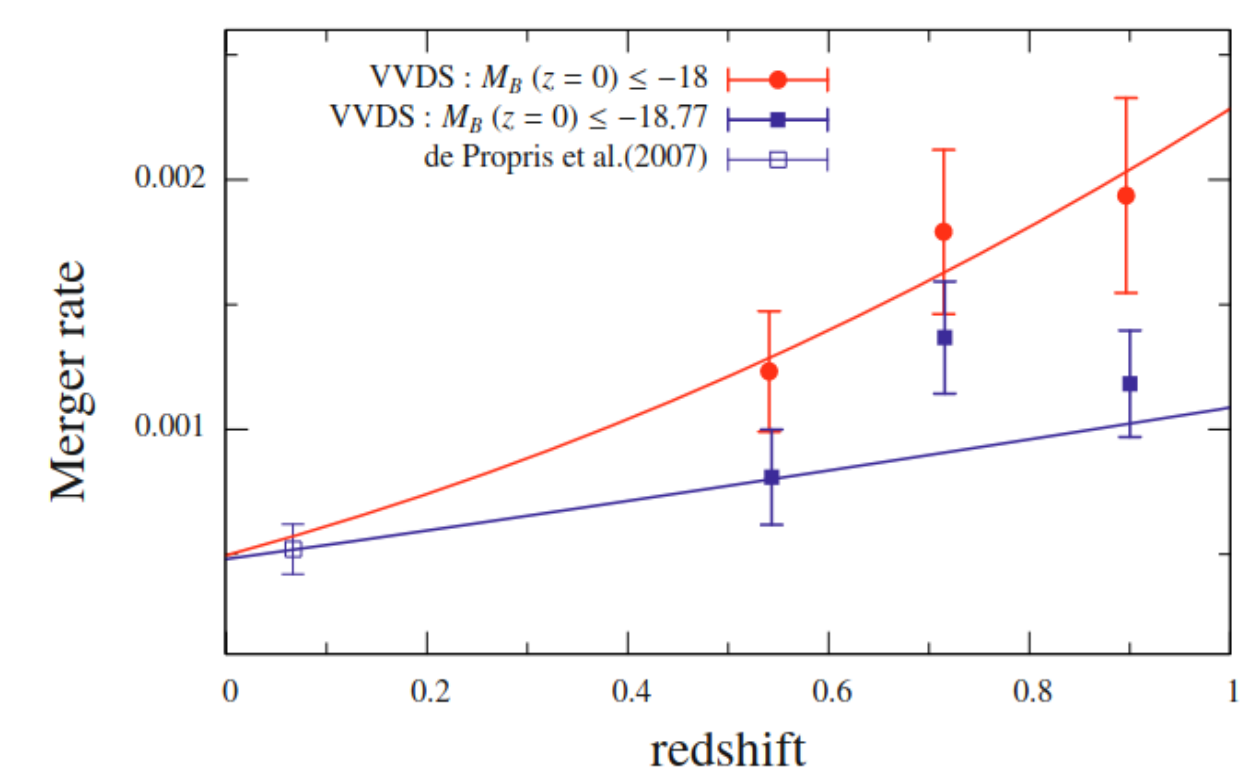


Increase with z confirmed with spectroscopically pairs.

The major merger fraction and rate evolve faster for fainter (less massive) sources.

$\sim$ 20% of the mass in local galaxies is from mergers at $z < 1$.

Major mergers in VVDS (de Ravel, Le Fèvre+09)



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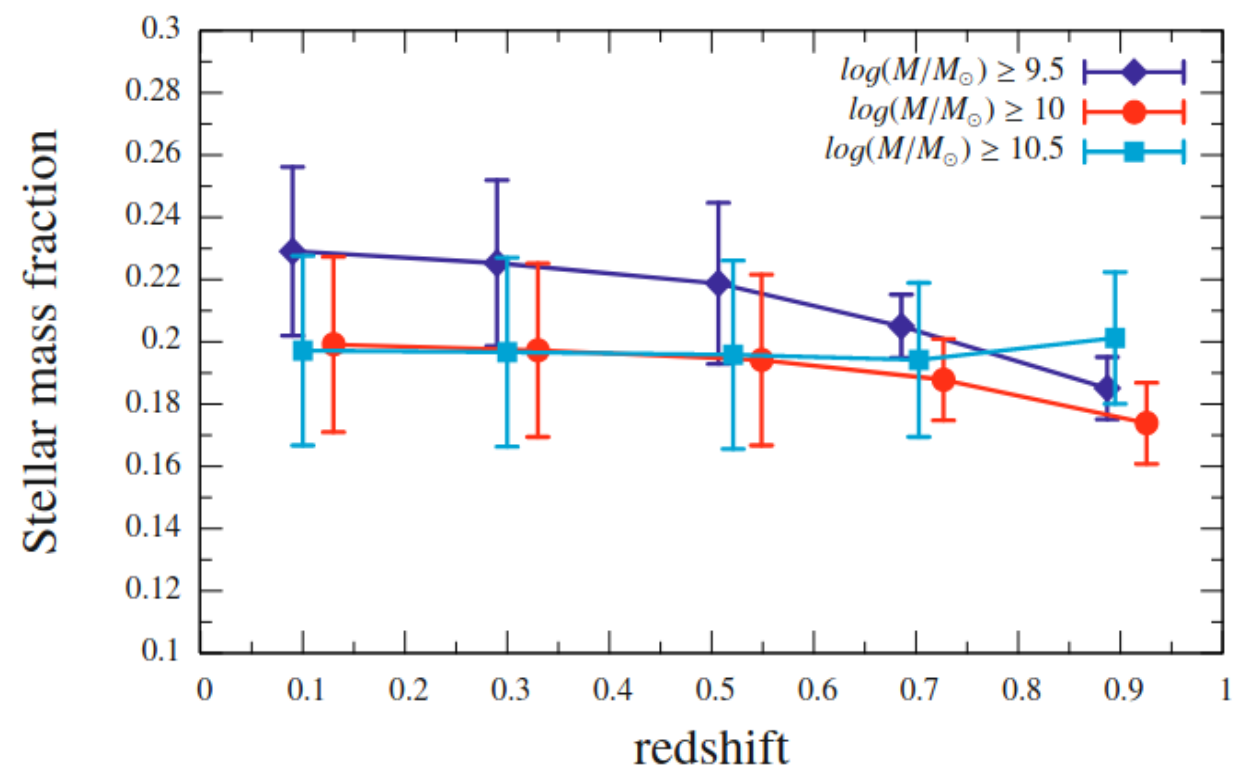

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Galaxy mergers at LAM

Postdoctoral position (2009-2012)
with Olivier

First estimation of
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López-Sanjuan, Le Fèvre, et al. 2011

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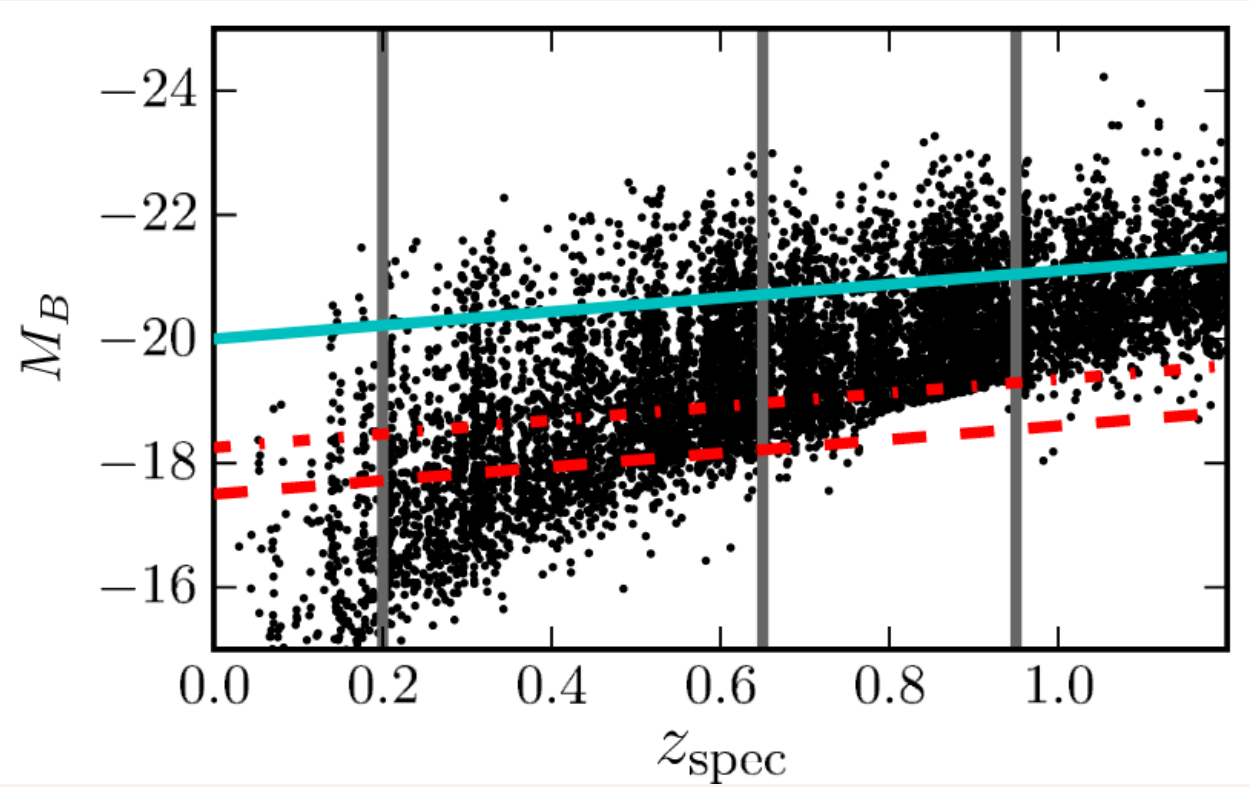


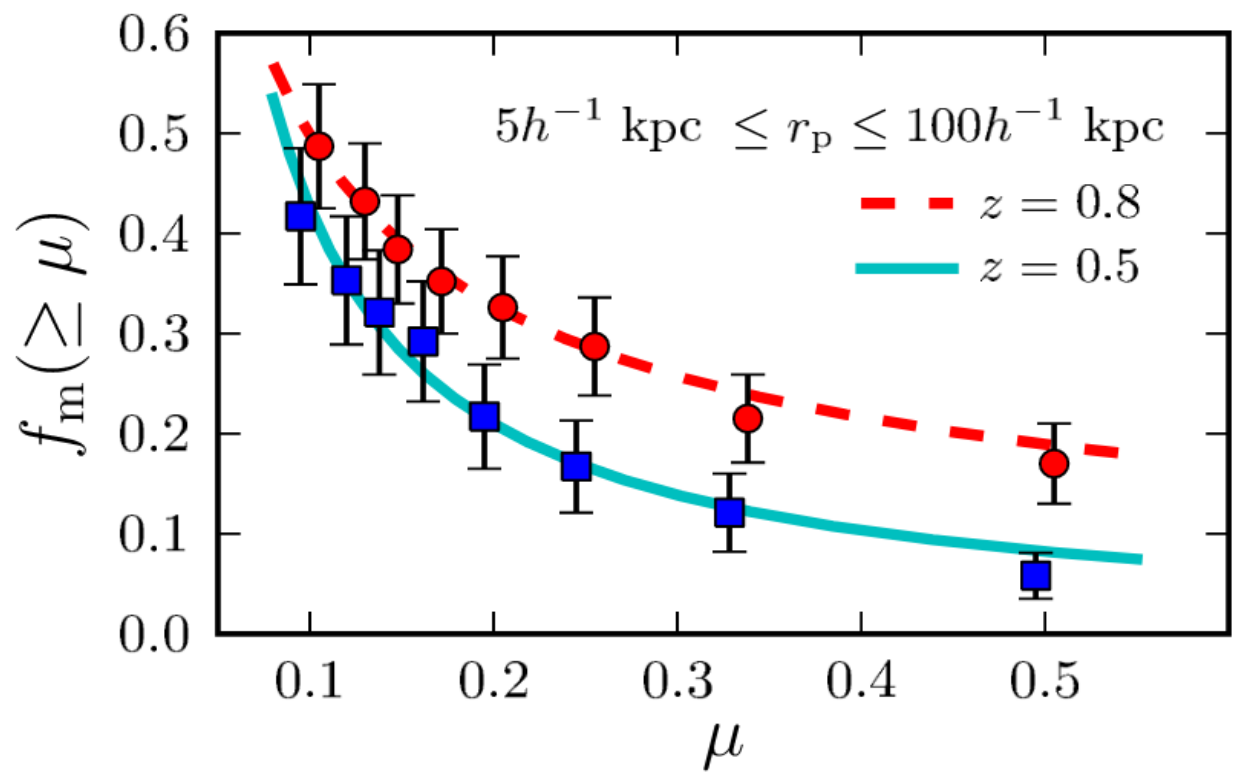
Close pairs ($\Delta v < 500\ \mathrm{km\,s^{-1}}$ and $r_\mathrm{p} < 100 h^{-1}\ \mathrm{kpc}$)
of $M_\mathrm{B} < -20 - 1.1z$ galaxies.

Analysis as a function of $\mu = L_{\mathrm{B},2}/L_{\mathrm{B},1}$ down to $\mu = 1/10$.

The minor merger fraction does not evolve with redshift $\propto (1+z)^{-0.4\pm0.7}$

25% of the local mass from mergers at $z < 1$ (19% major + 6% minor).

Minor mergers in VVDS



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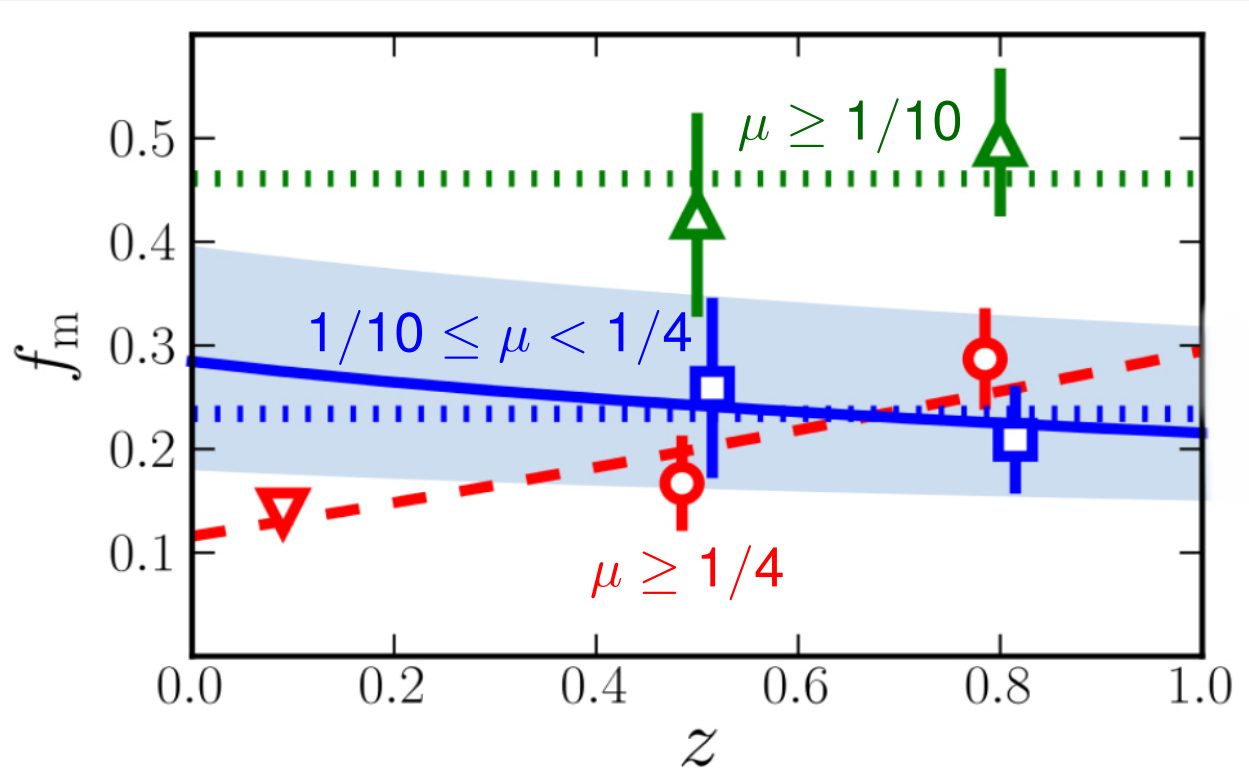

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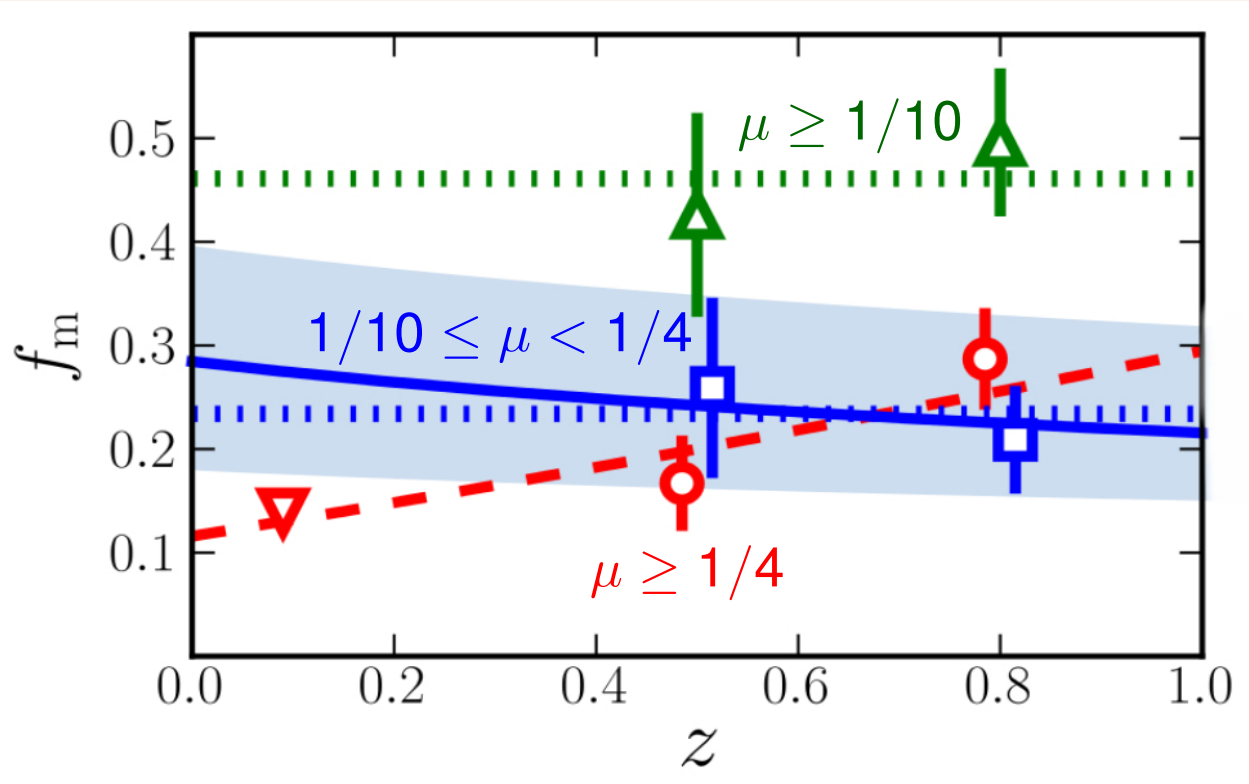

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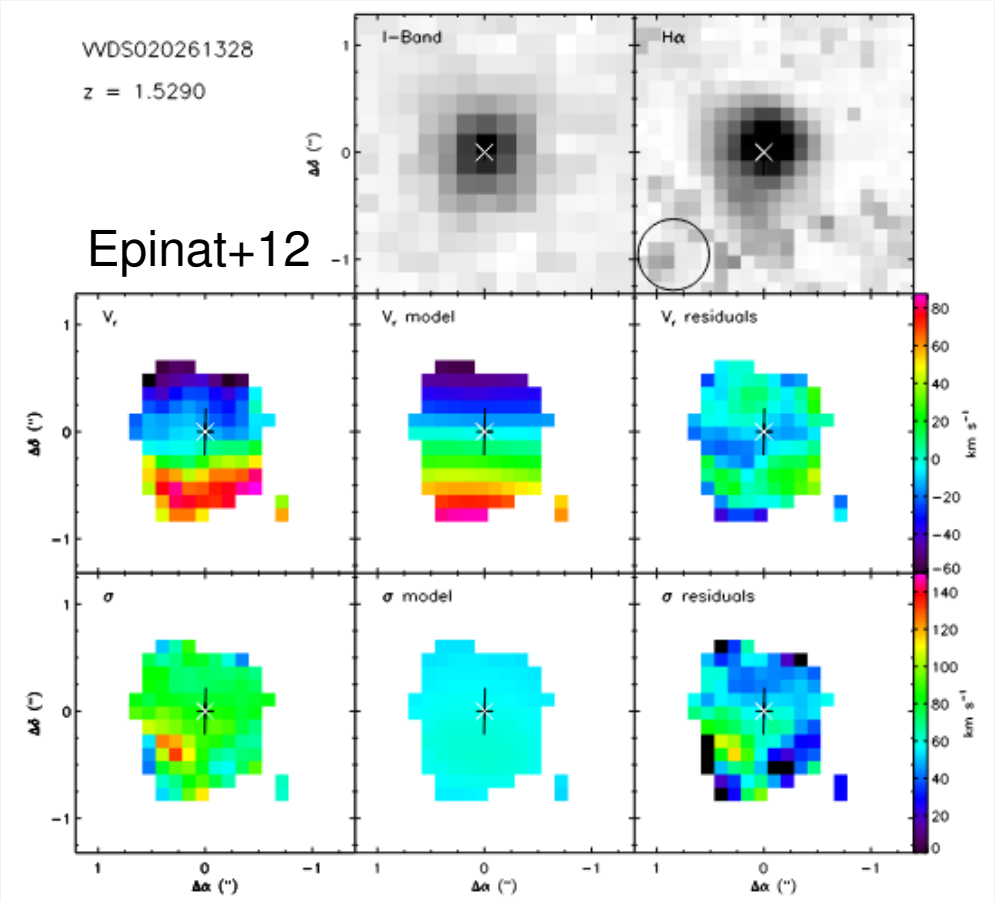
The MASSIV survey

MASSIV
Mass assembly survey with SINFONI in VVDS

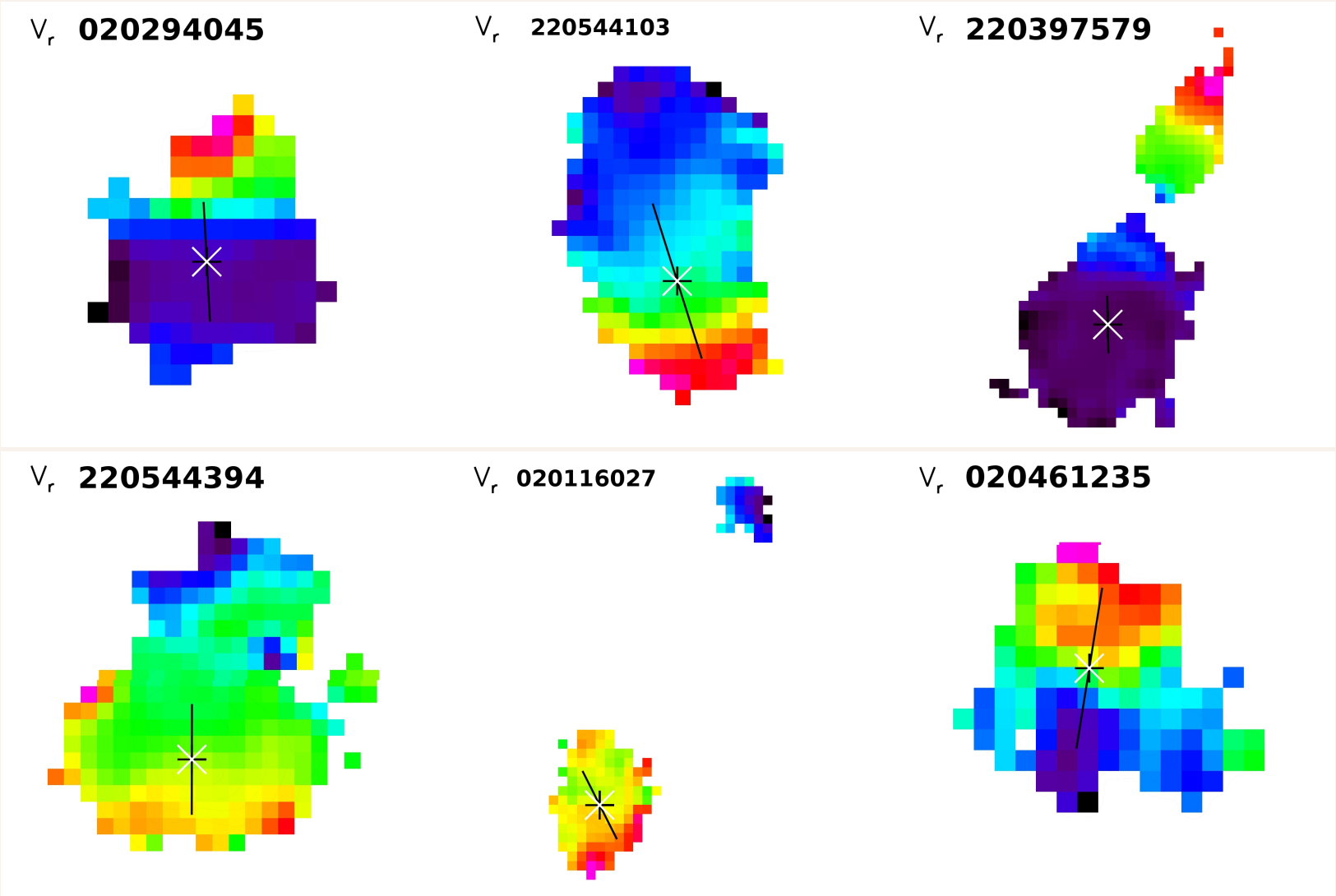
Contini+12, Epinat+12

- 84 star-forming galaxies from VVDS at $0.9 < z < 1.8$.
- $J-$ or $H-$band observations to target Hα bright emission line.
- High spatial resolution ($< 0.8''$): velocity field and dispersion map from Hα, metallicity from [NII]/Hα.



Mergers in MASSIV

$\sim$ 30% of the MASSIV sample presents signs of interactions.



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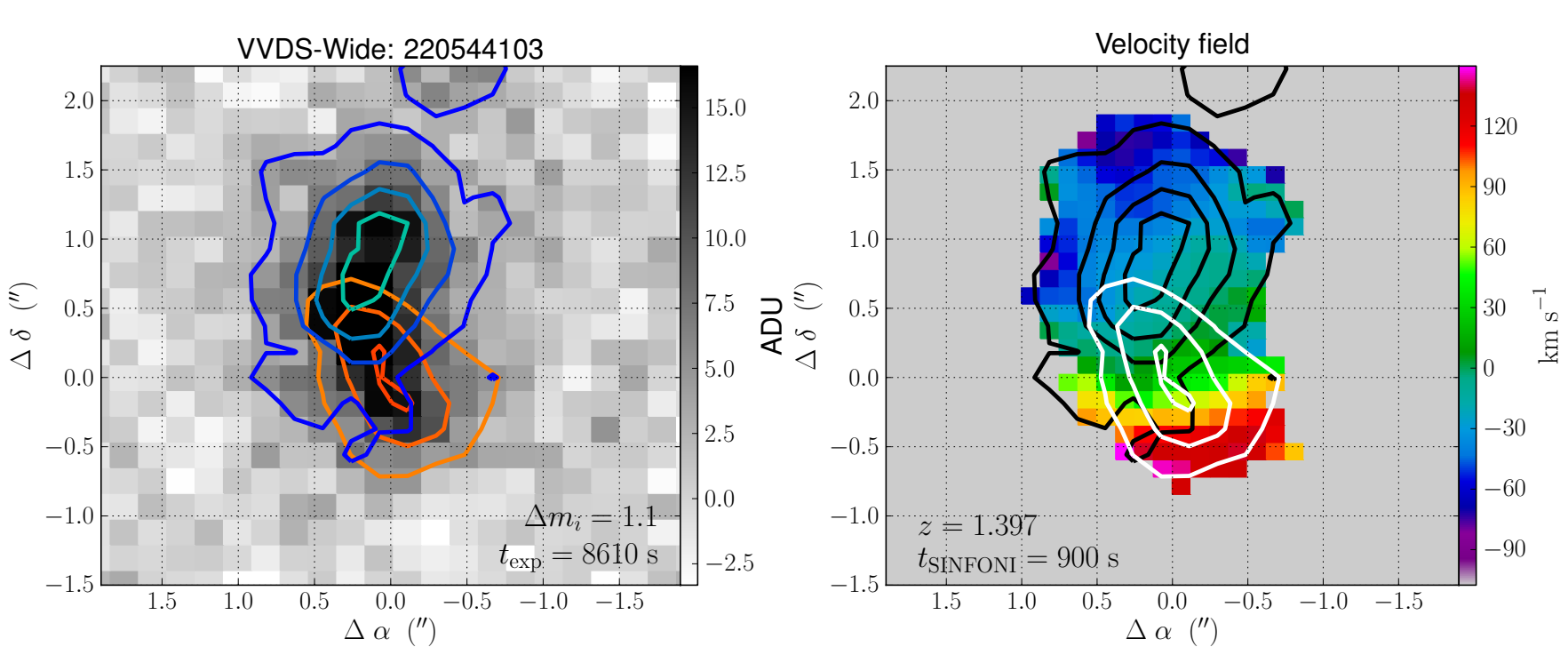

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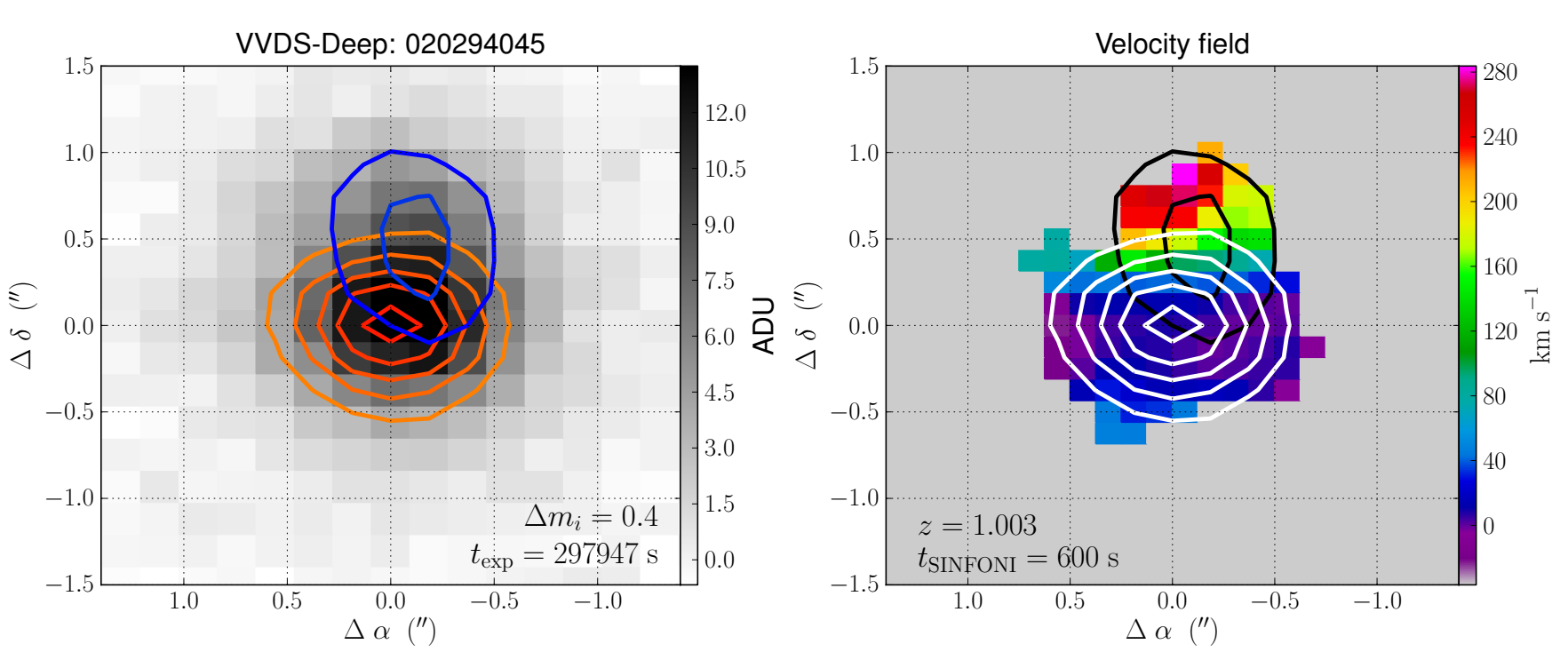
to derive the merger nature (major or minor) of the systems.

We find **13 major mergers** at $0.9 < z < 1.8$.

Mergers in MASSIV



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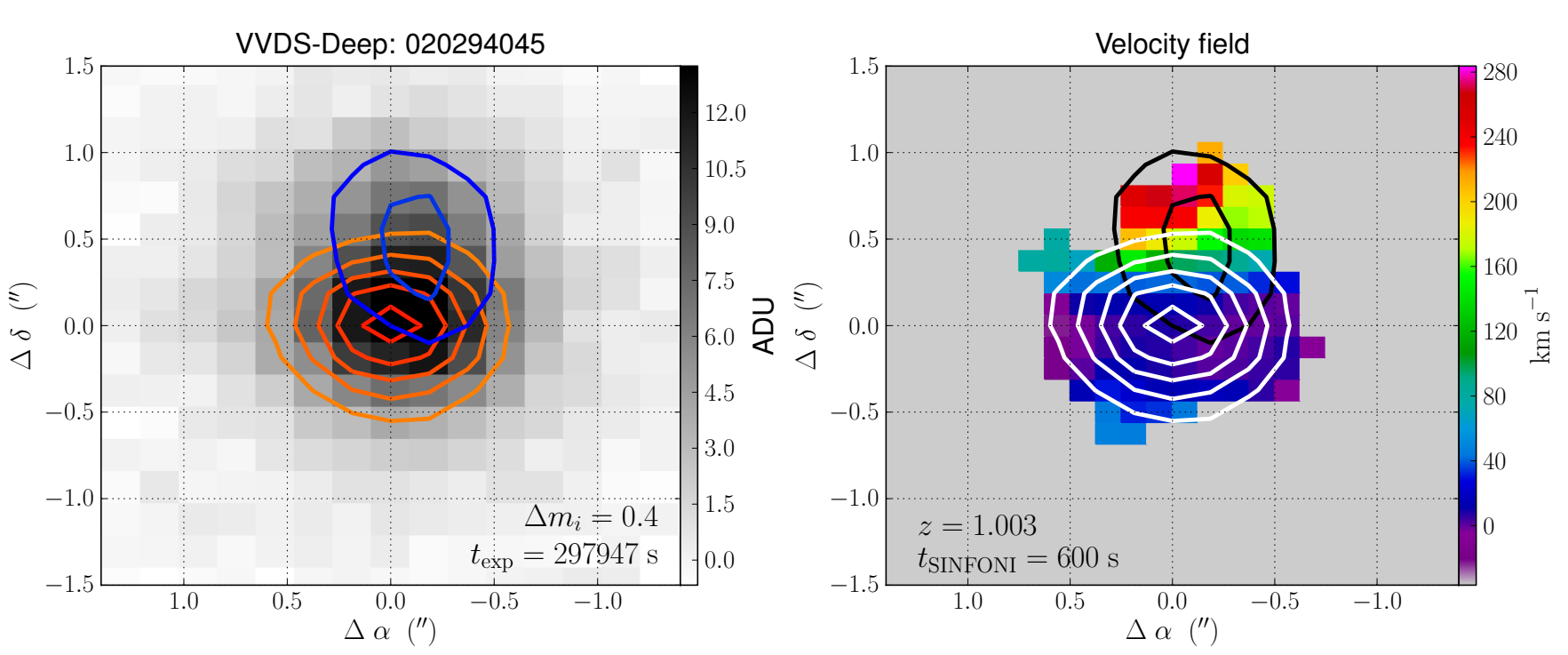

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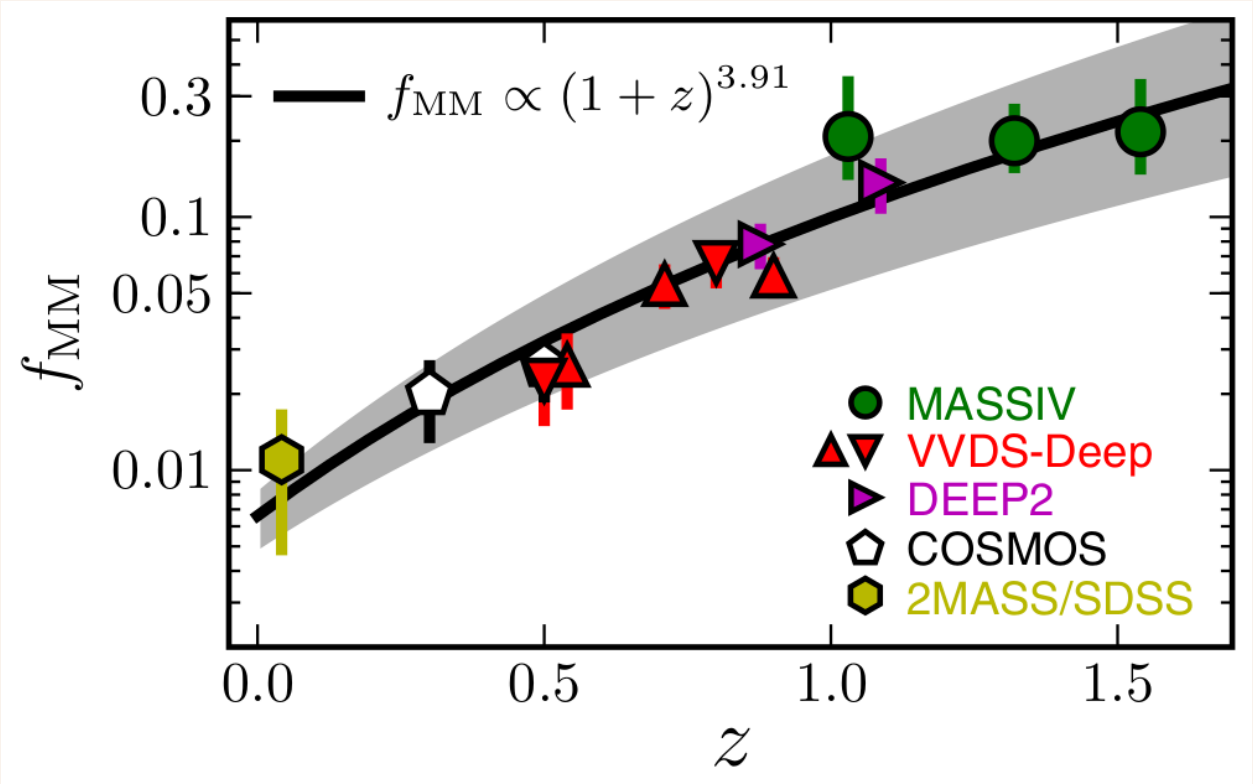
The major merger fraction and rate at $z > 1$



We find a meger fraction of $\sim 20\%$ at $0.9 < z < 1.8$.

The major merger rate is $R_{\rm MM} \sim 0.13$ Gyr^{-1}.

Gas-rich mergers are dominant in the evolution of massive galaxies ($M_\star > 10^{11}\ M_\odot$) at $z > 1$.

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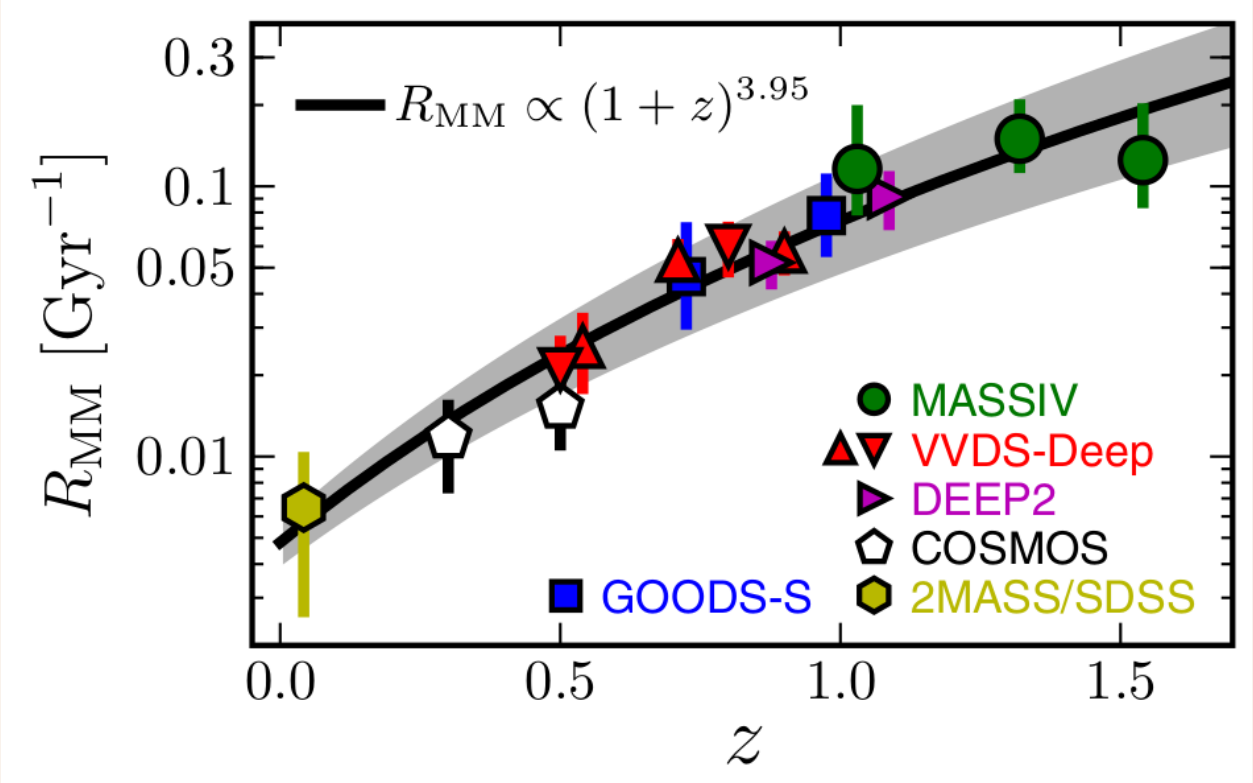

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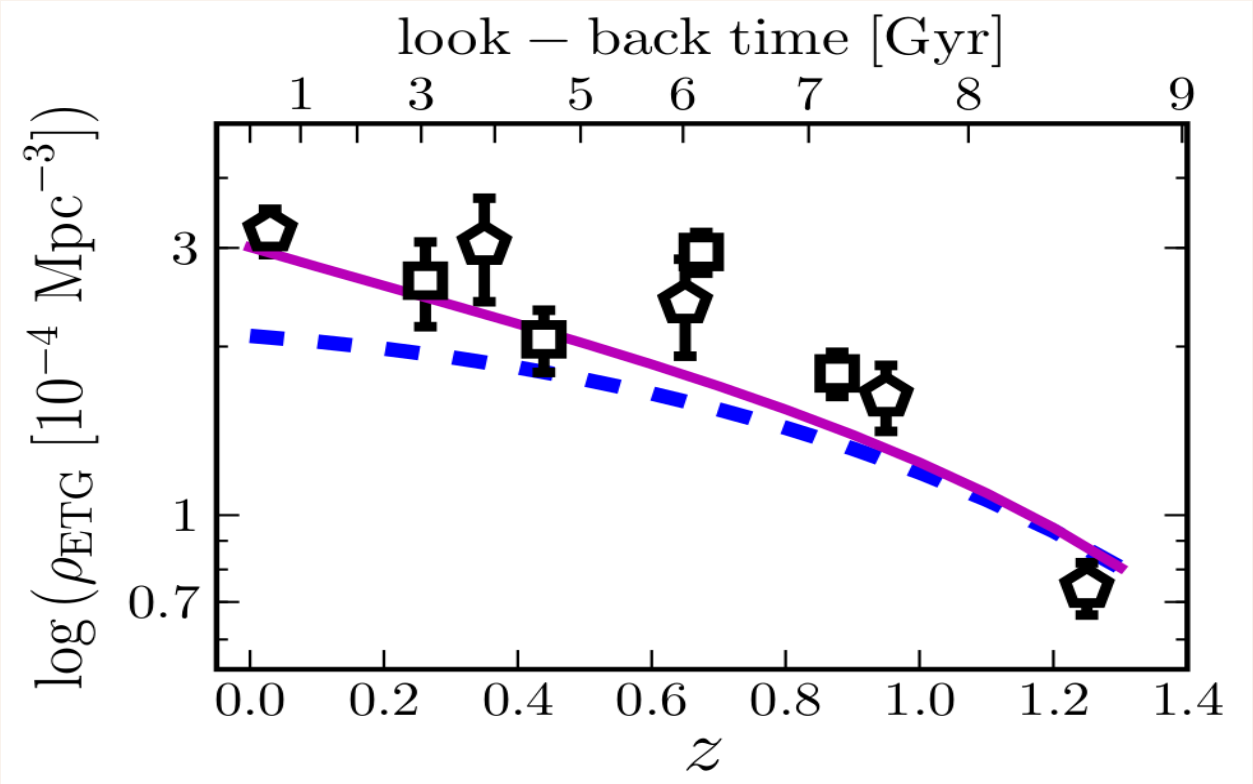

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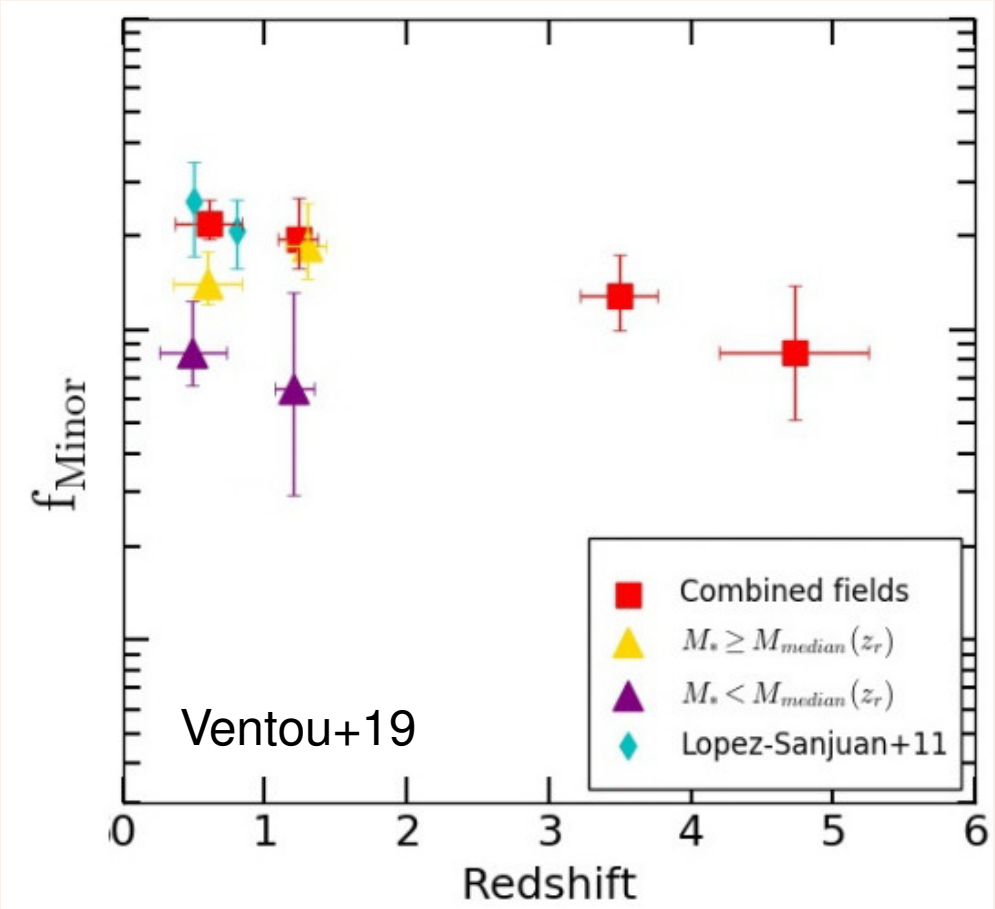
Legacy value

The minor merger fraction is roughly constant at $z < 1$.
Merging accounts for 25% of the mass assembled at $z < 1$,
only 6% due to minor mergers.

Confirmed by subsequent studies:

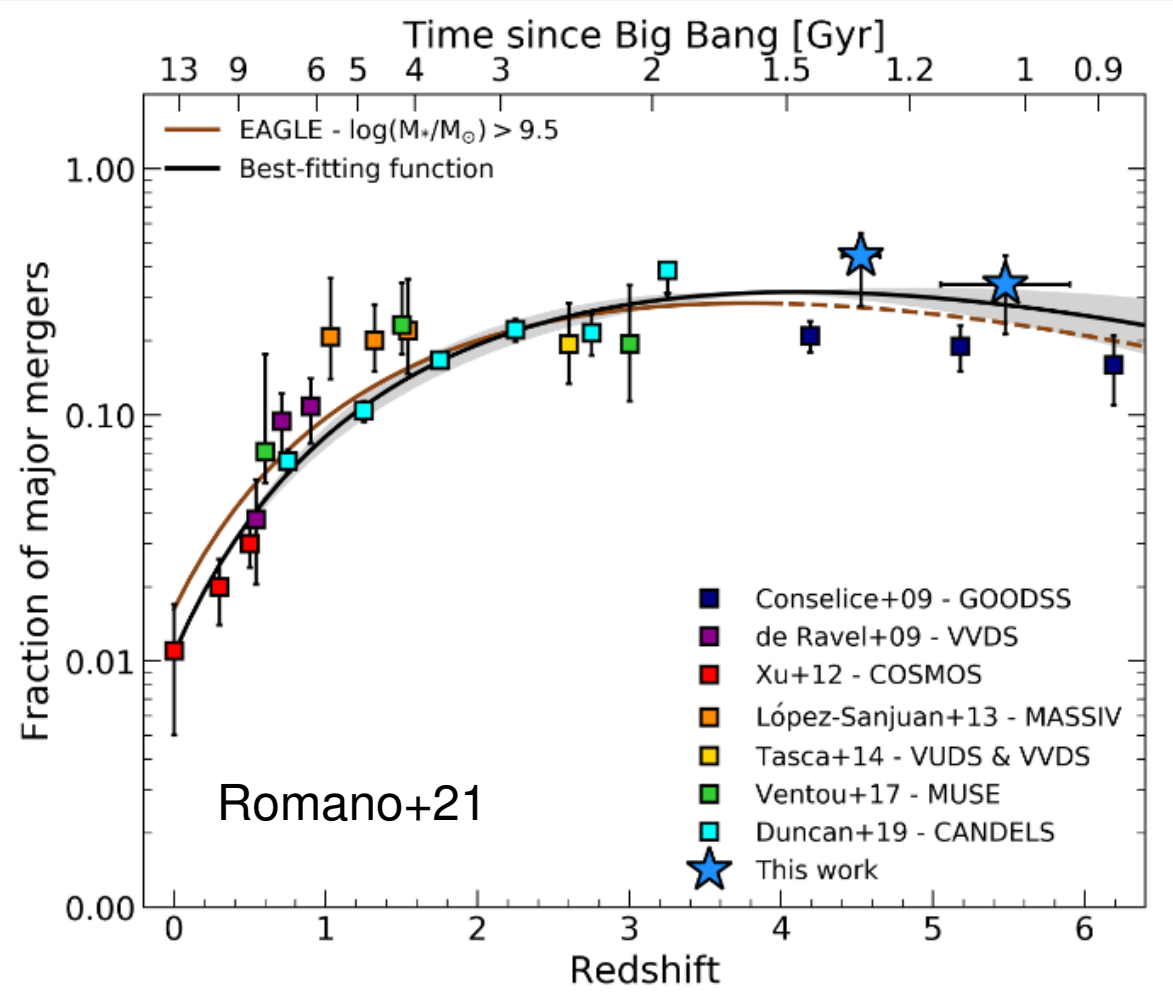
Lotz+11,
López-Sanjuan+12,
Mármol-Queraltó+12,
Newman+12,
Bluck+12,
Ferreras+14,
Man+16,
Ventou+19,
Dai+21,
etc.



Legacy value

The major merger fraction increases at least up to $z = 1.5$.

The MASSIV merasurements are still relevant.



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Merci Olivier!