Kinematics of interacting galaxies

A 3D-view from the CALIFA survey

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and the CALIFA collaboration

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Mapping the kinematics in nearby systems

- Detailed analysis of individual systems.
- Most of these studies focus on a particular component of interacting system: stars, ionized, neutral or molecular gas (e.g., Colina+05, Wild +14, Iono+05).
- From rotational patterns to complex velocity fields.

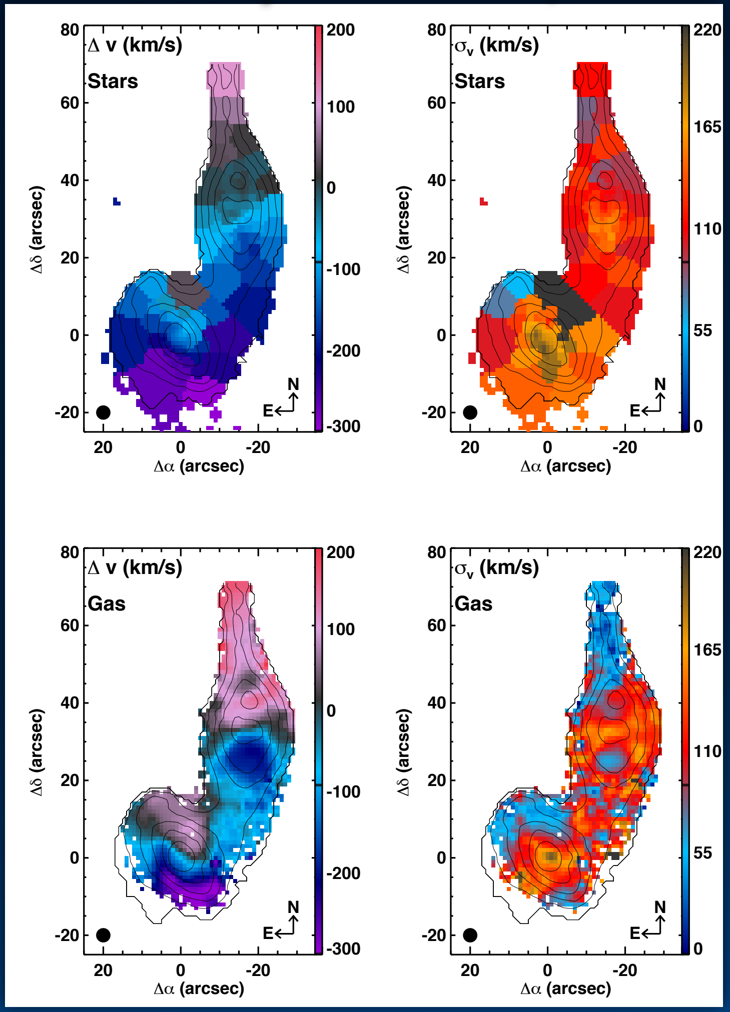
HST-image

CALIFA Maps

Velocity Vel. Dispersion

Stars

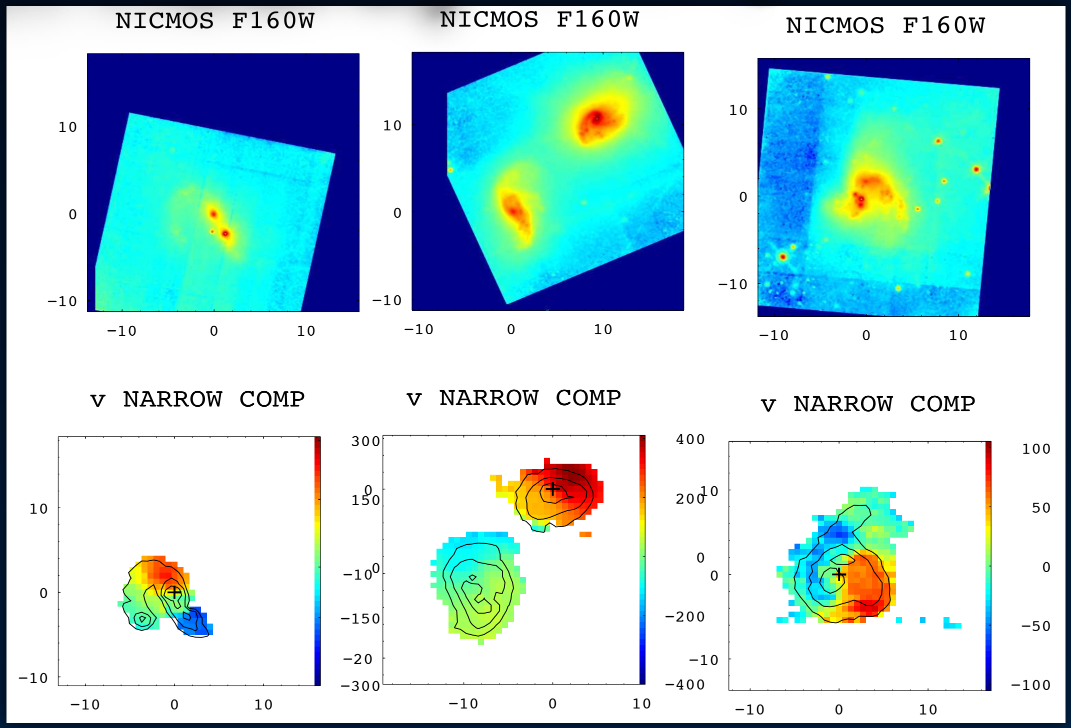
Ionized gas

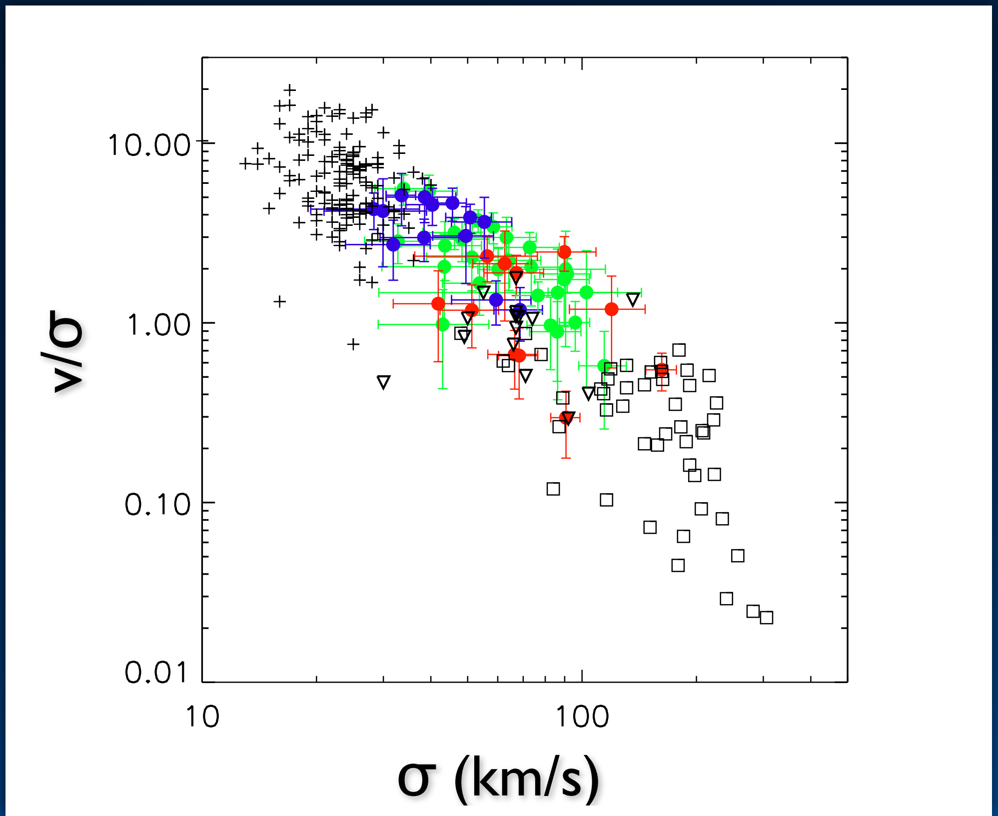


Wild+2014

Mapping the kinematics in nearby mergers

- Bellochi+2013: (U)LIRGs at different interacting stages (N < 60).
- Velocity field from Hα emission line.
- ~ 70% of the sample dominated by rotation.





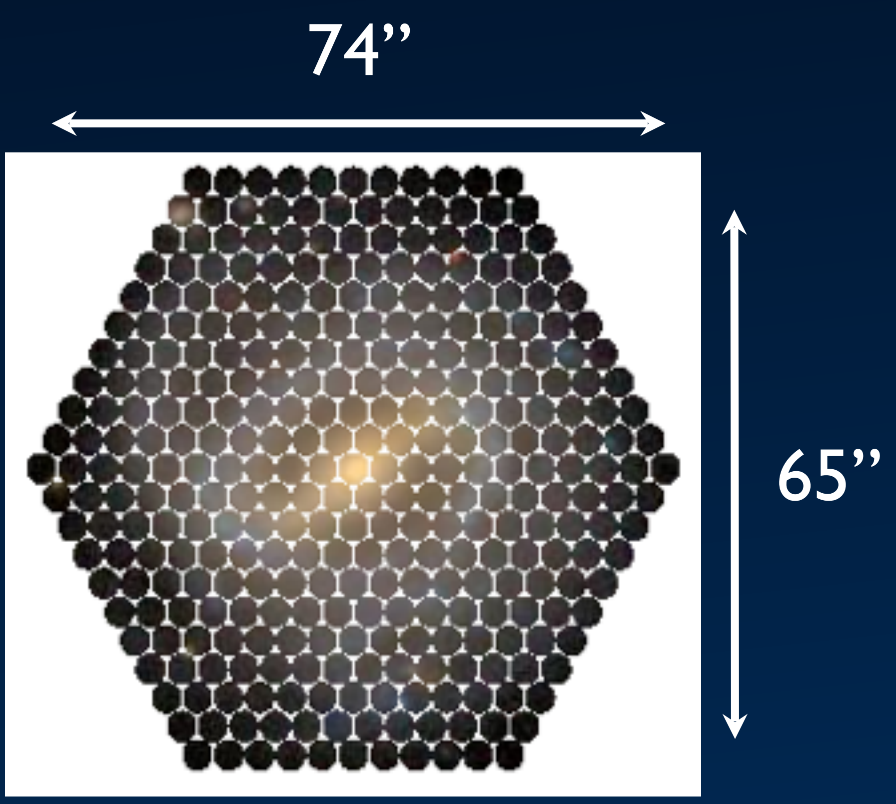
Mapping the kinematics in nearby mergers

- How the internal structure (kinematics) of galaxies is affected as the merger evolves?
- Do the stellar and ionized gas components evolve differentially?
- Quantifying the level of 'distortions' produced induced by the interactions using a homogeneous control sample of non-interacting galaxies.

The CALIFA survey

Sánchez+2012, Husseman+2013, García-Benito+2015

- 937 galaxies from SDSS/DR7 of all Hubble Types.
- Nearby galaxies selected by size (45" < D_{25} < 80"; 0.005 < z < 0.03).
- PMAS/PPAK-IFU @ CAHA 3.5m.
- Wide range of stellar masses (9.4 < $\log(M_{star}/M_{\odot})$ < 11.4).
- > 450 galaxies observed.

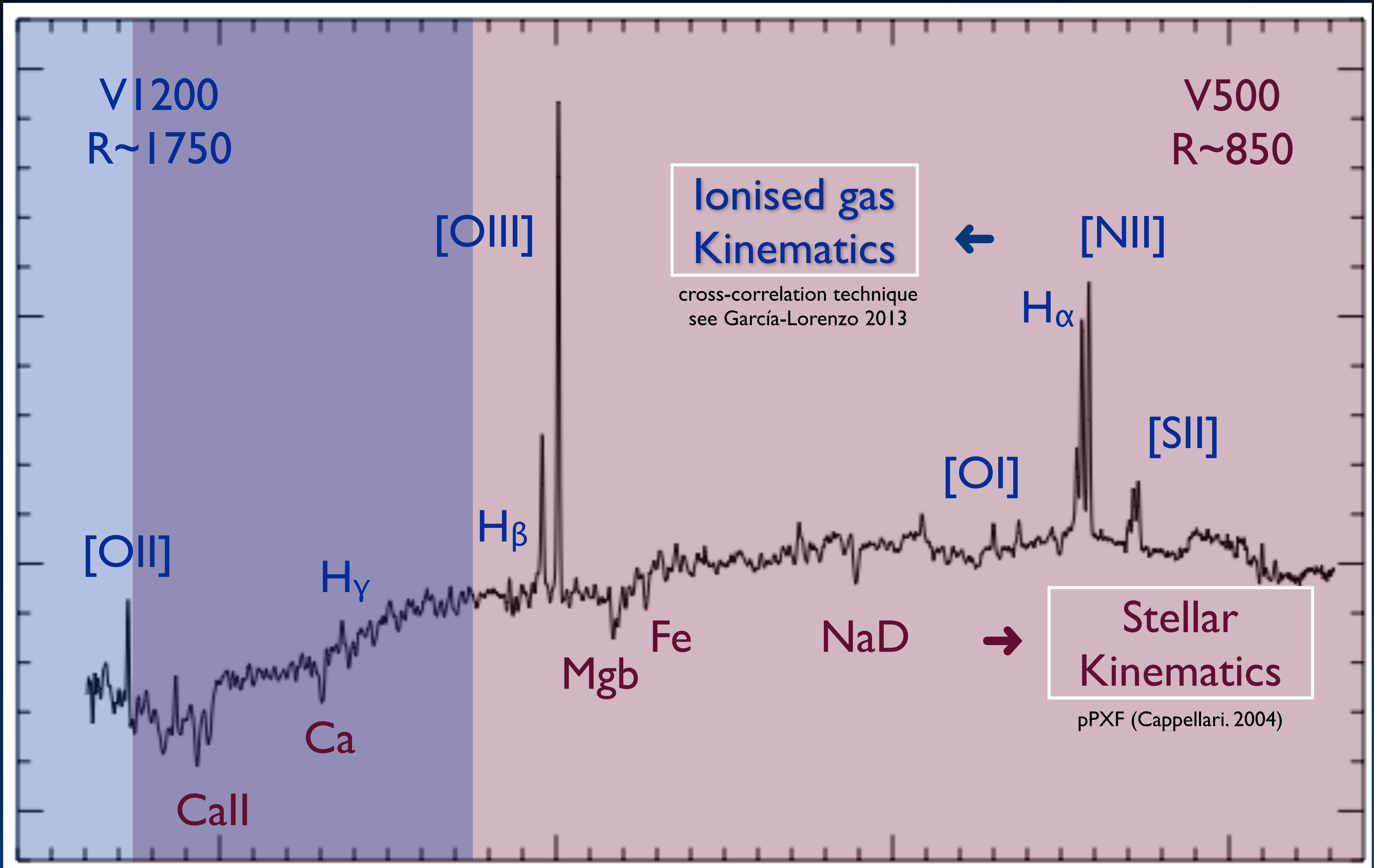


@ 2'' ~ 0.5-1.0 kpc

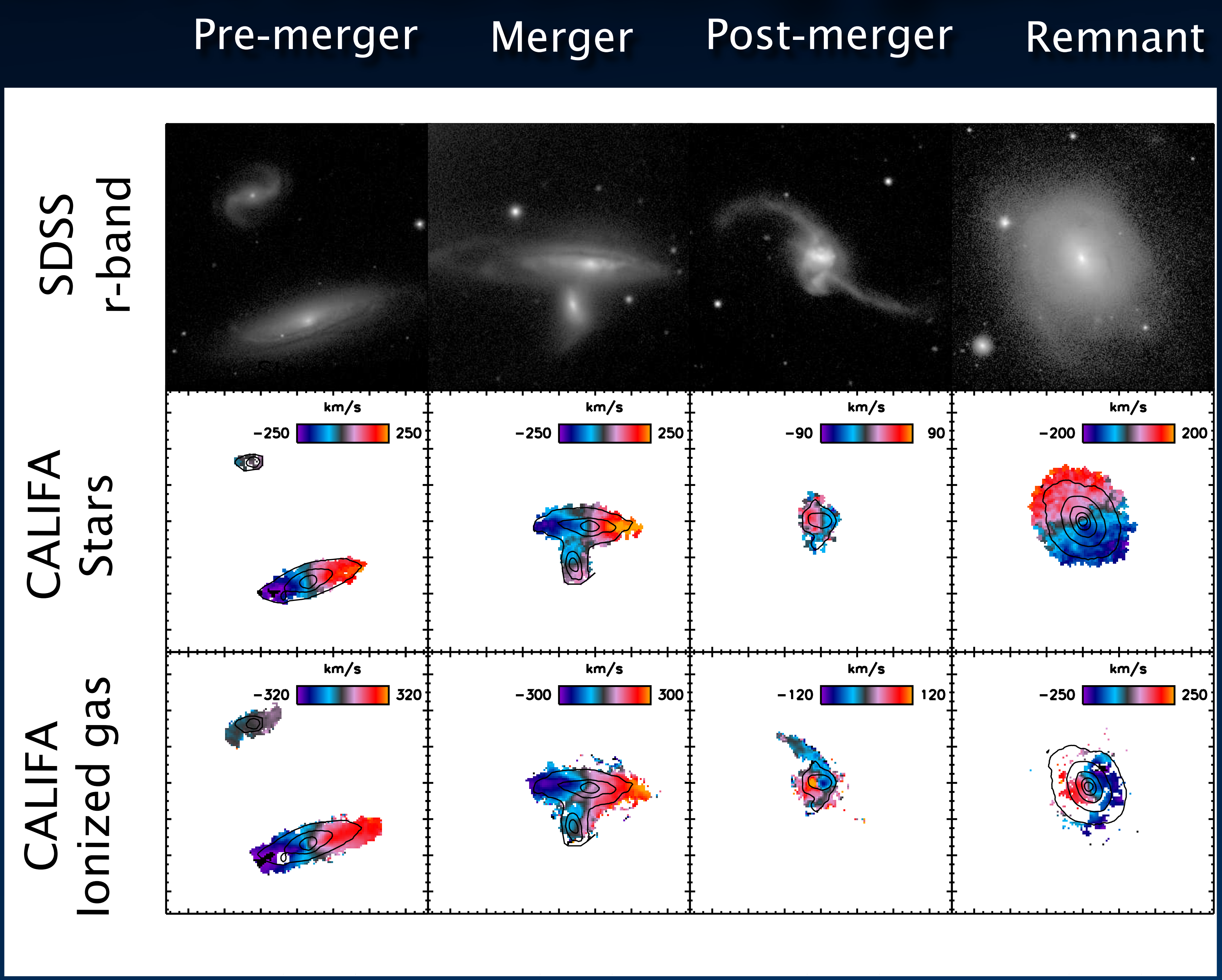
http://califa.caha.es/

The CALIFA survey

Sánchez+2012, Husseman+2013, García-Benito+2015



CALIFA interacting galaxies



103 galaxies at different stages of merger

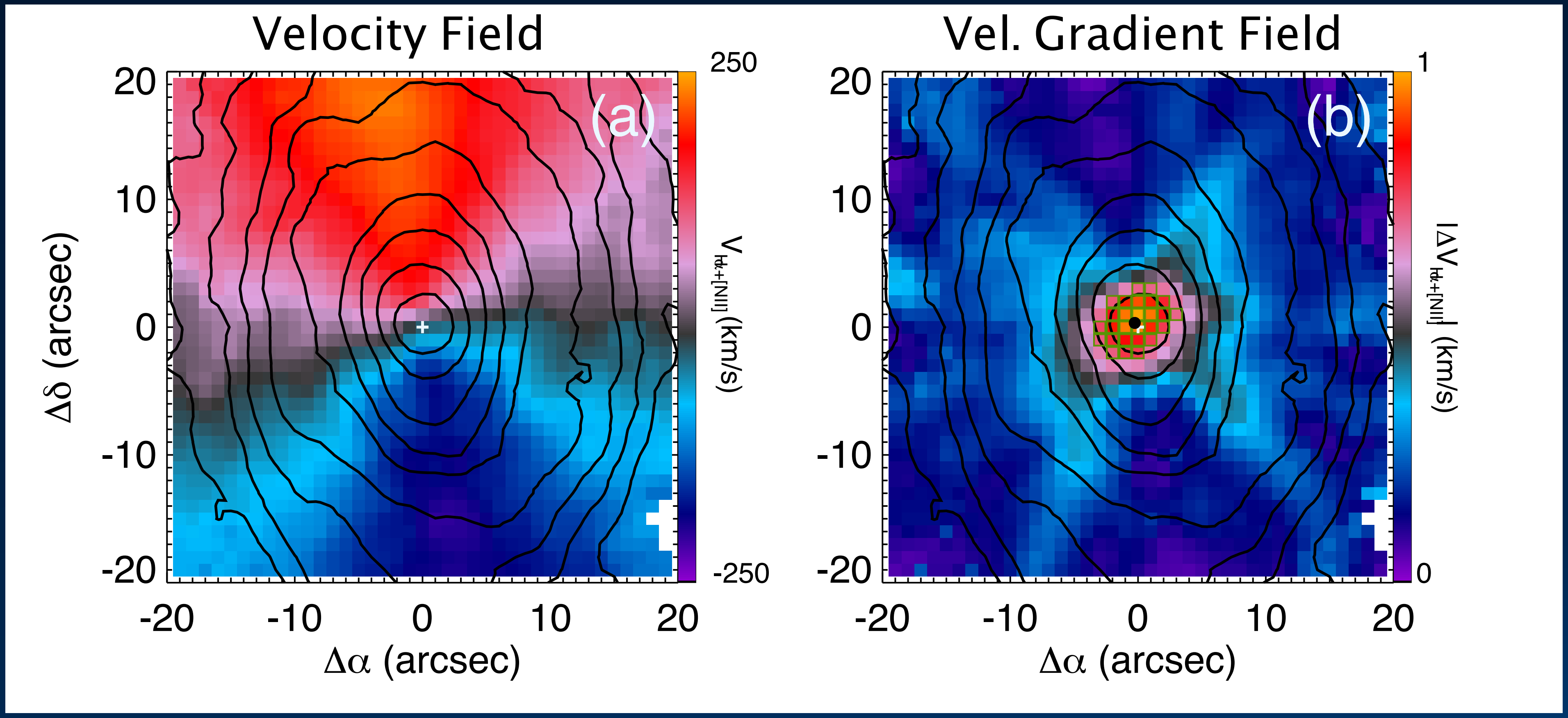
+ 80 non-interacting galaxies as control sample (Barrera-Ballesteros+2014)

Characterization of Velocity Fields

An «assumption-free» method

Kinematic Centre

(García-Lorenzo+2015)



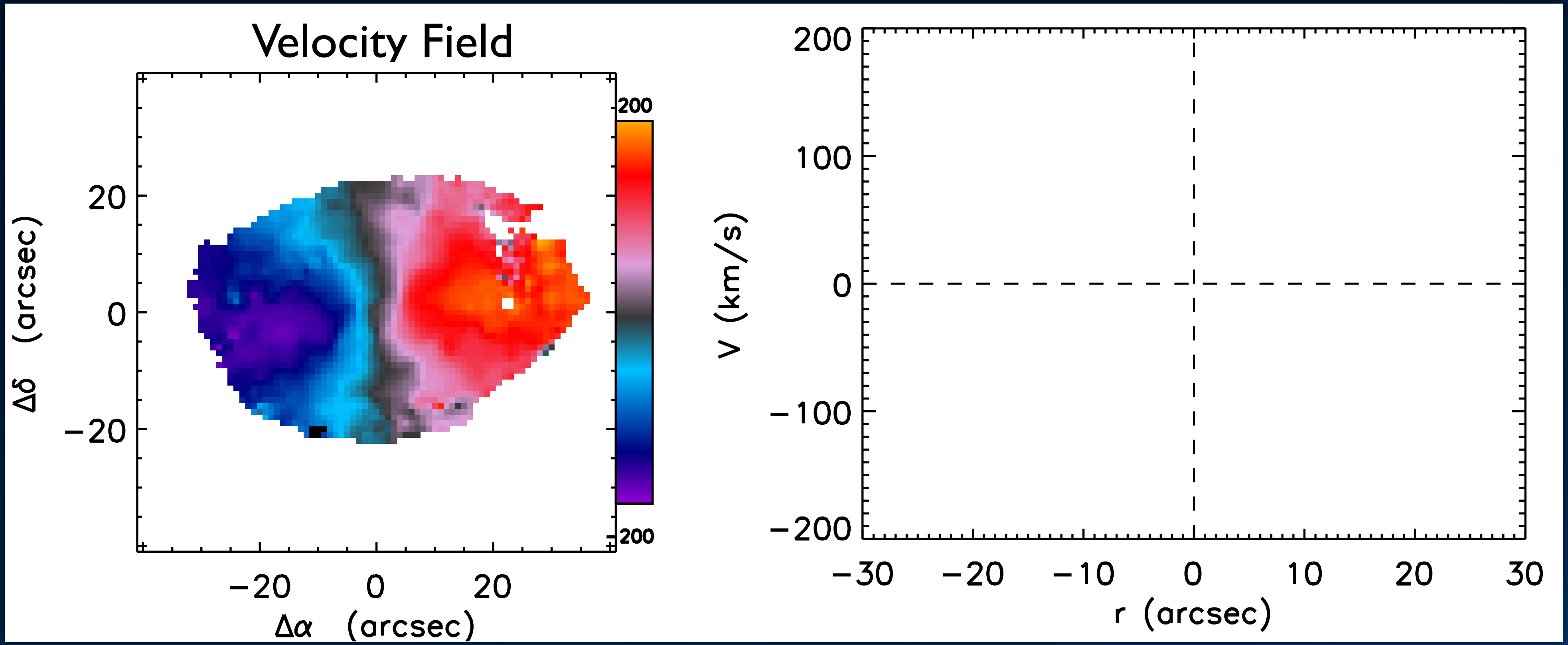
For a pure-rotational disc, its gradient peak is located at the optical nucleus.

Characterization of Velocity Fields

An “assumption-free” method

Kinematic PA

(García-Lorenzo+2015, Barrera-Ballesteros+2014)



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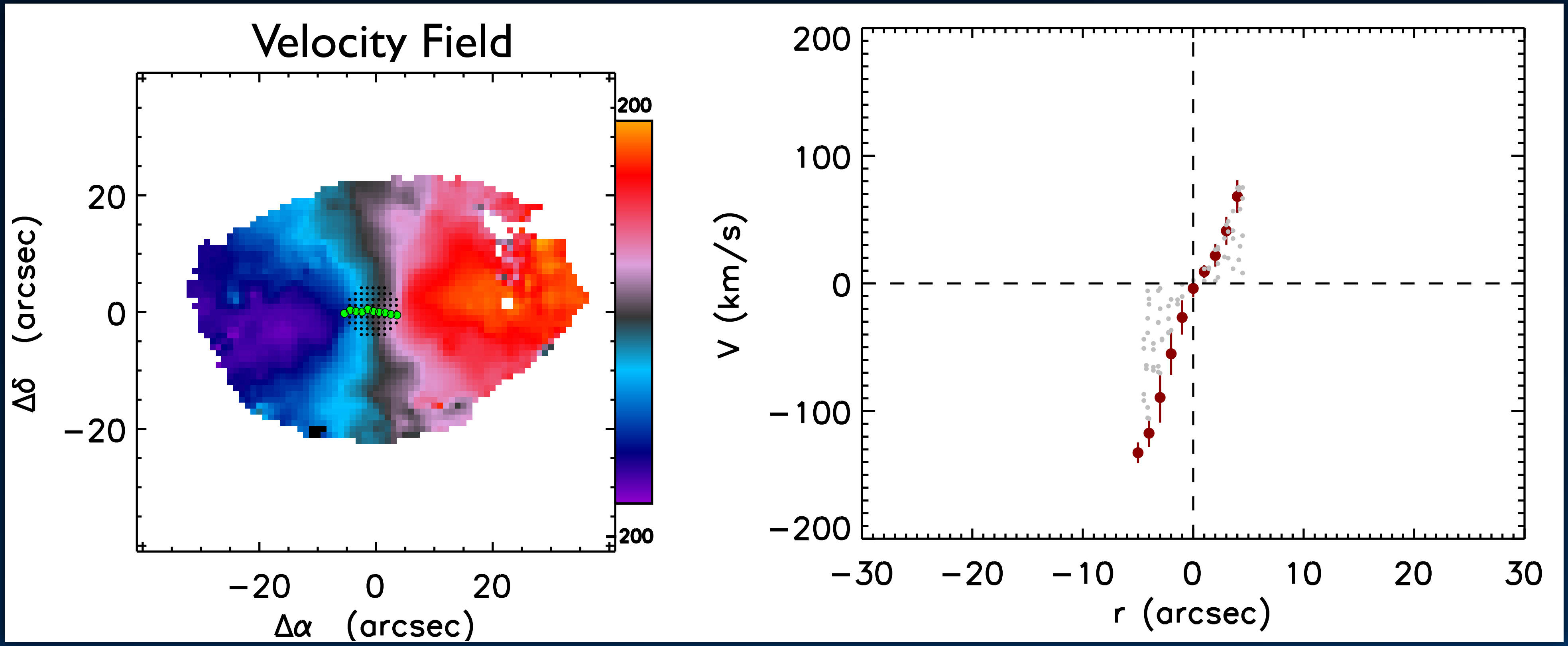

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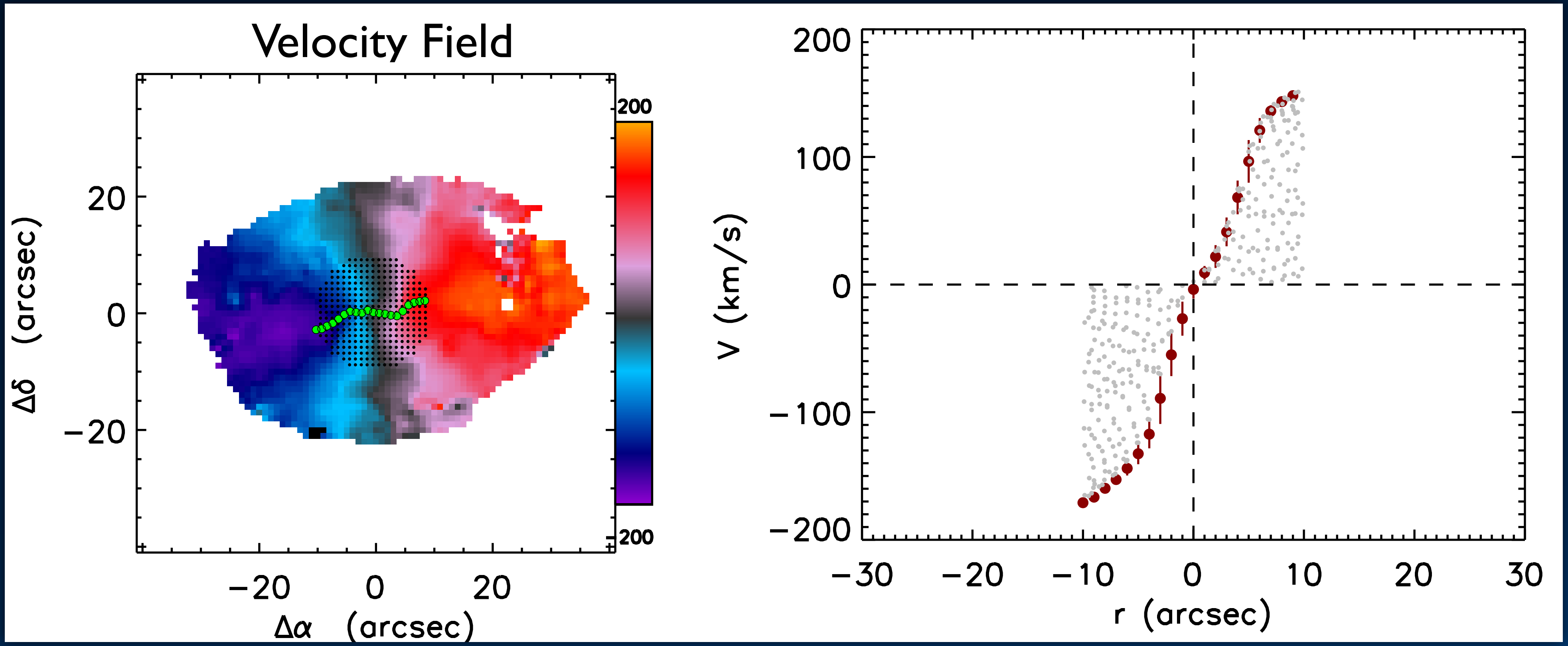

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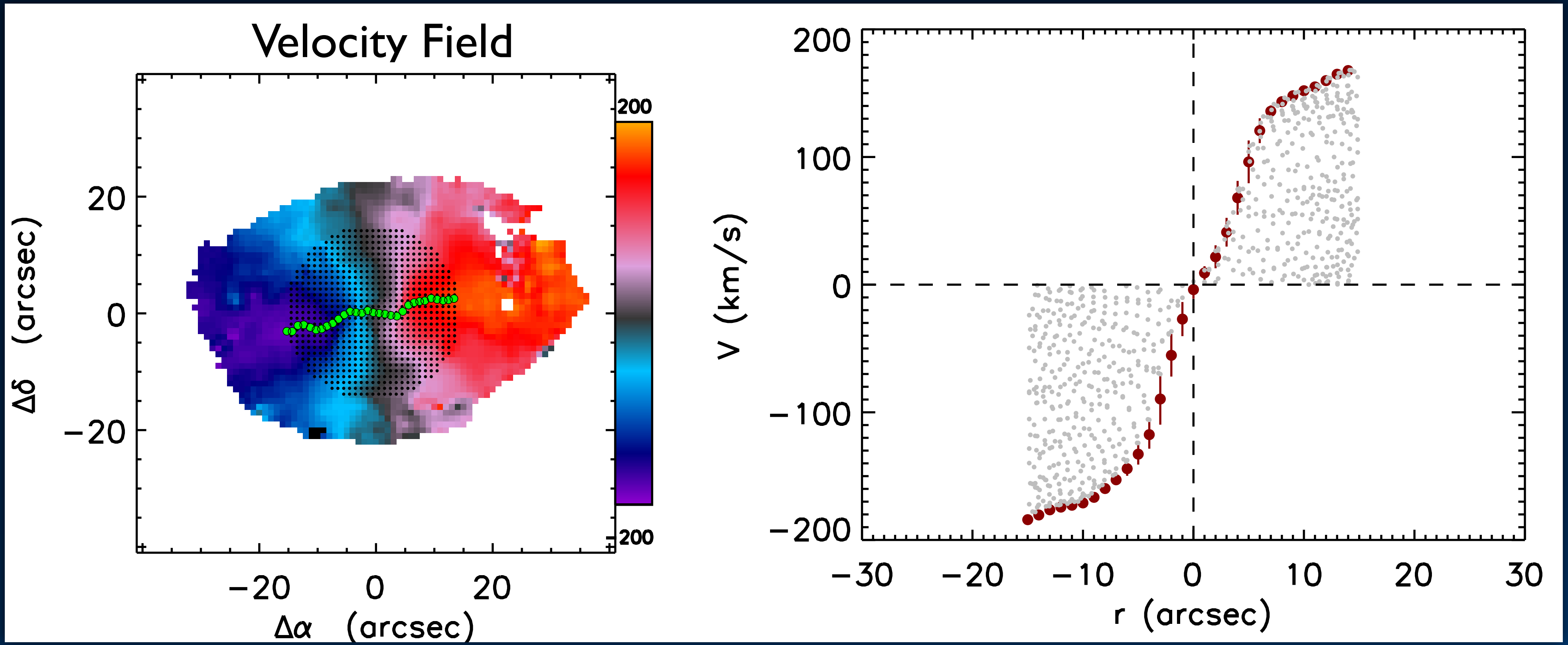

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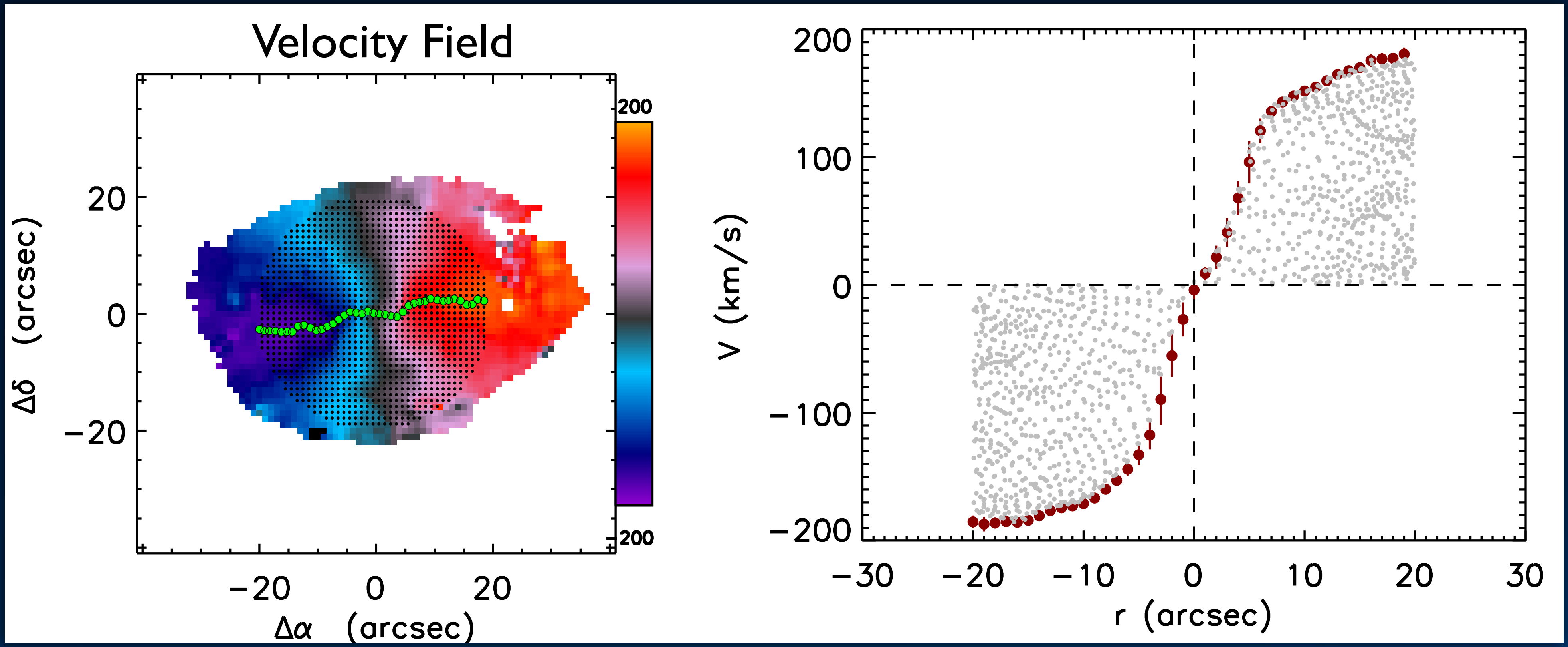

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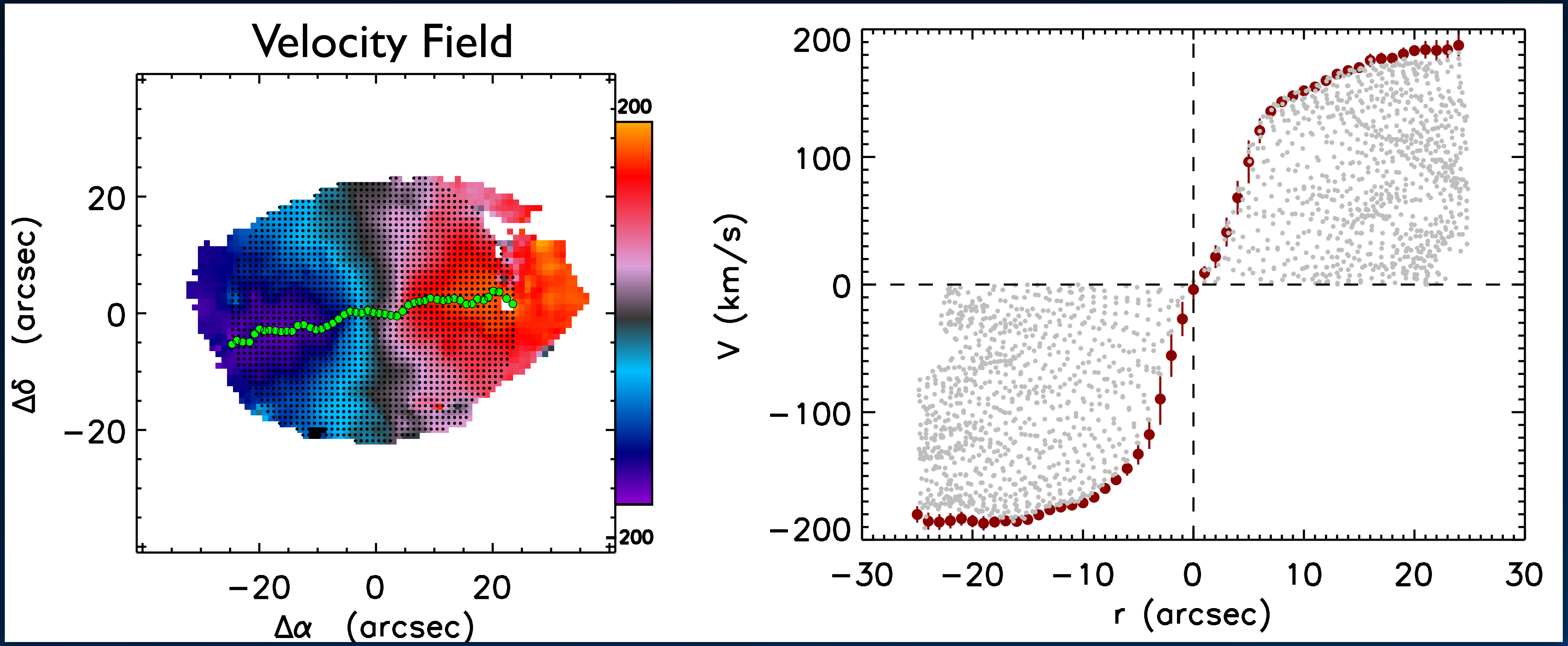


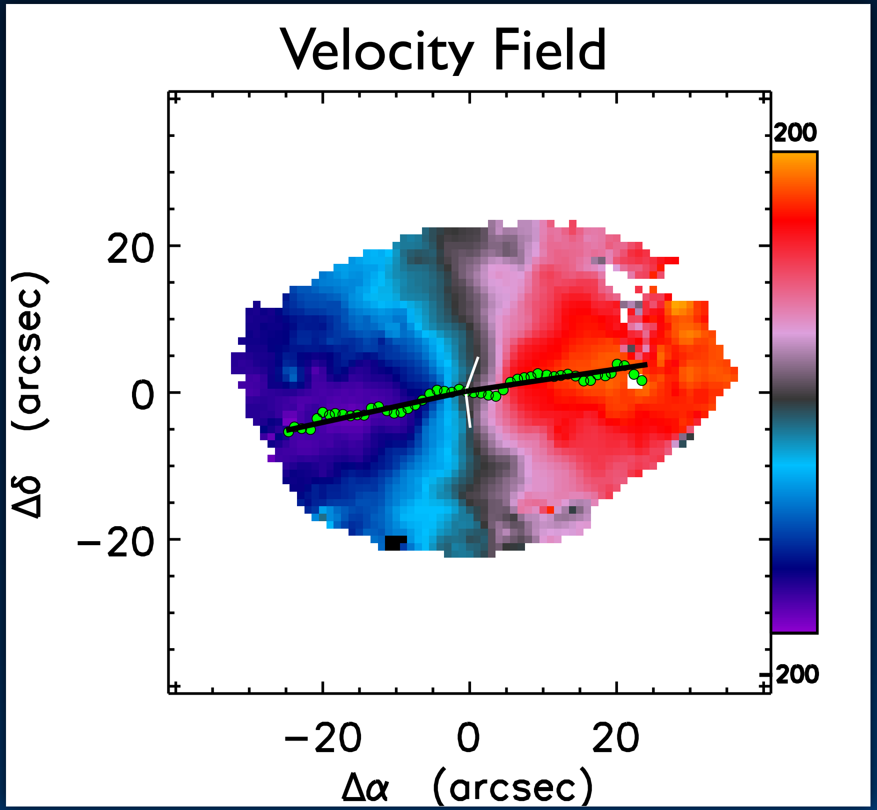
Characterization of Velocity Fields

An “assumption-free” method

Kinematic PA

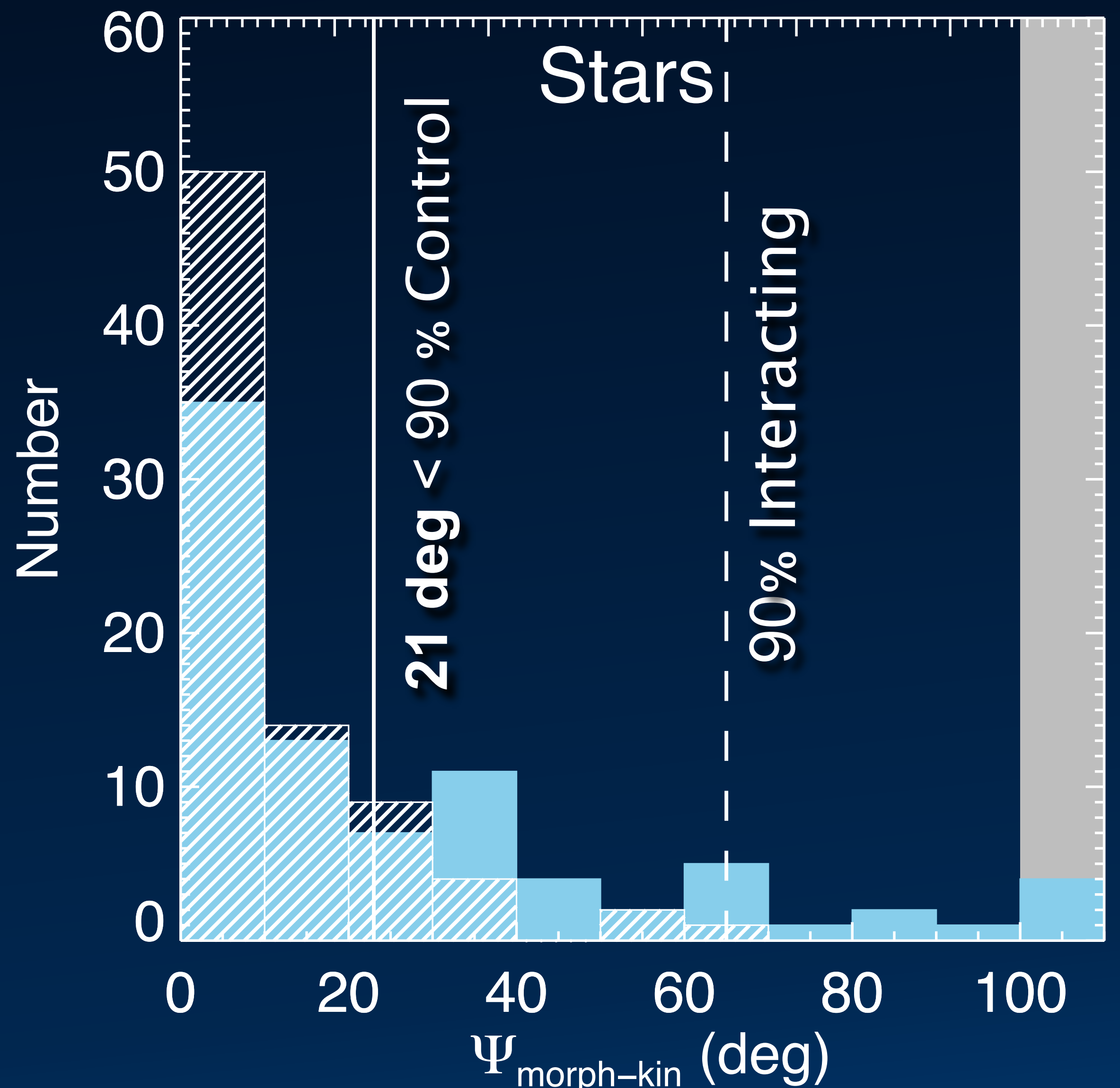
(García-Lorenzo+2015, Barrera-Ballesteros+2014)

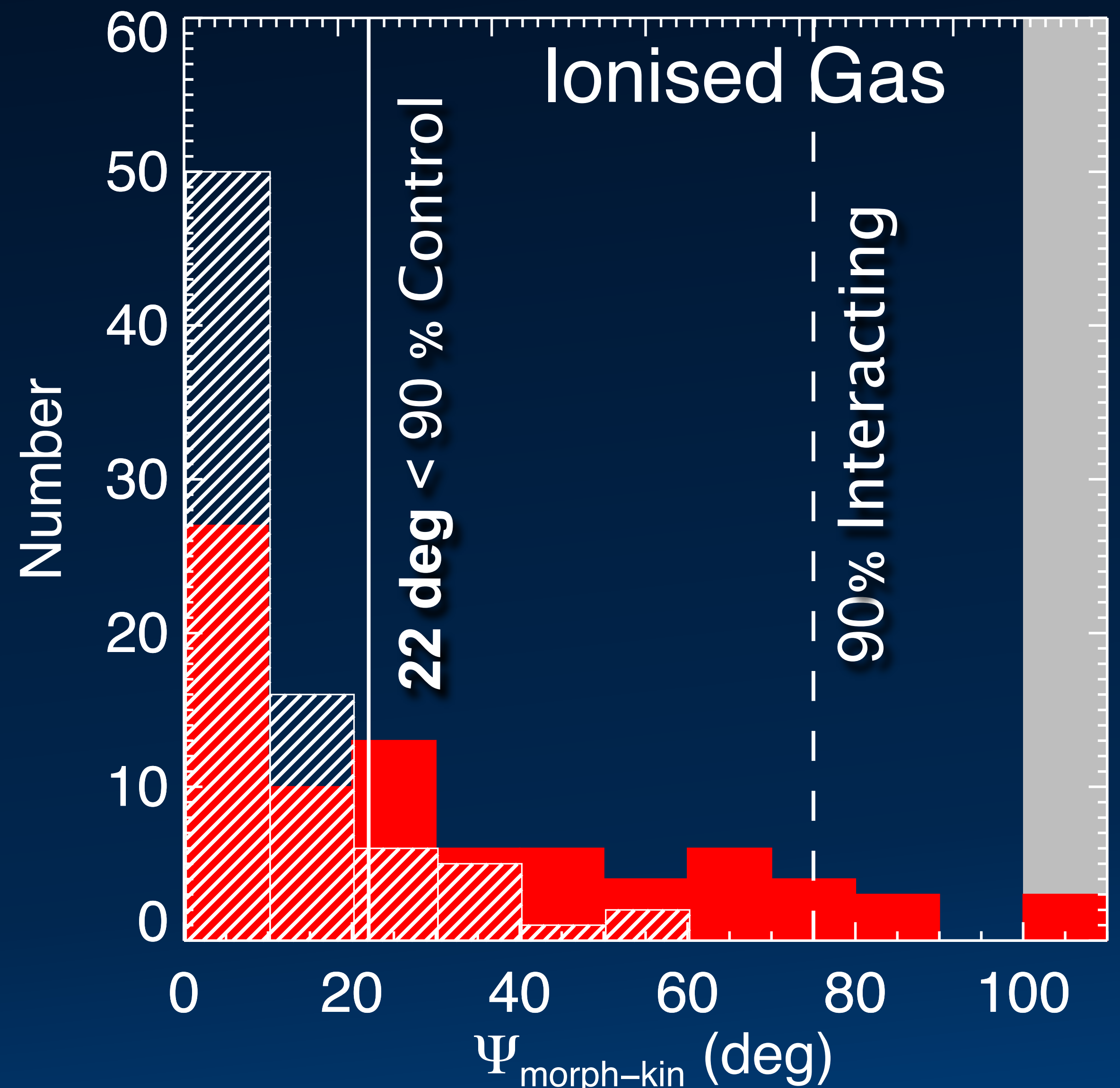
- Average kinematic PA (PA_{kin}).
- Radial deviation of kinematic PA (δPA_{kin}).
- Derived for both kinematic sides.
- + Morphologial PA (Ellipse fitting)



Morpho-kinematic PA misalignments

$$\psi_{morph\text{-}kin} = | PA_{morph} - PA_{kin} |$$



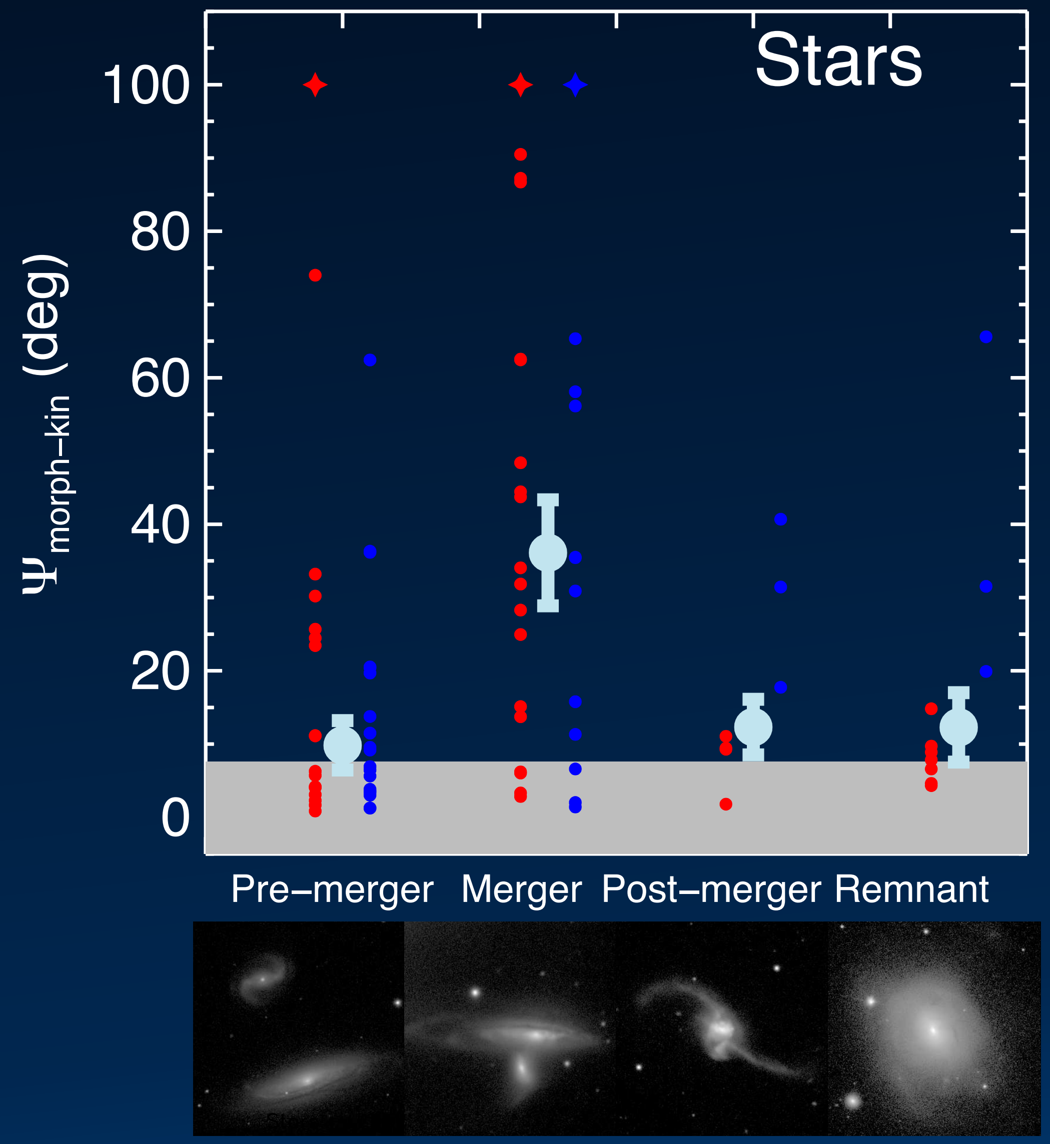


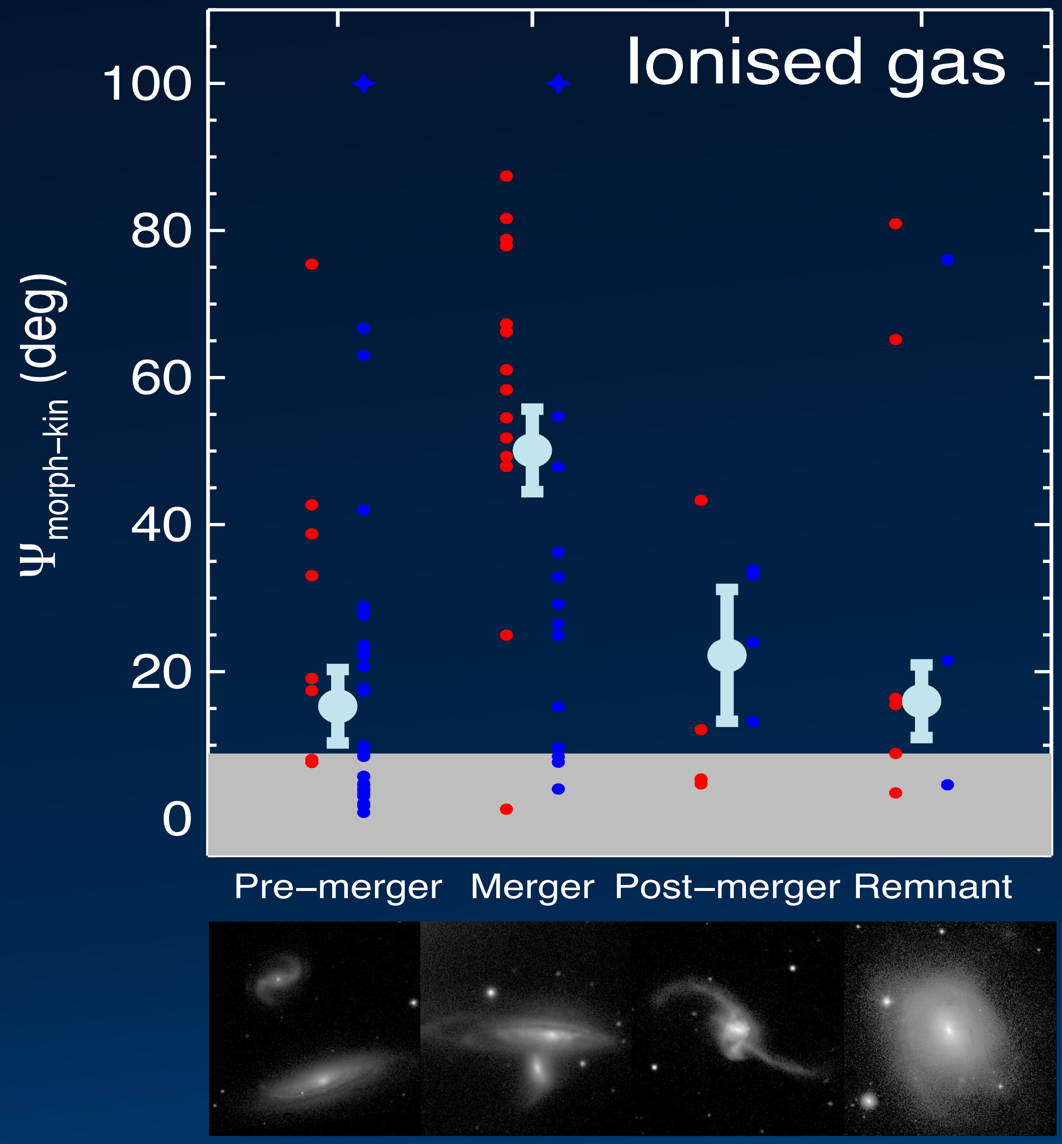
43% of interacting sample with $\psi_{morph\text{-}kin}$ > 21 degrees.

52% of interacting sample with $\psi_{morph\text{-}kin}$ > 22 degrees.

Morpho-kinematic PA misalignments

$$\psi_{\text{morph-kin}} = |\ PA_{\text{morph}} - PA_{\text{kin}}\ |$$





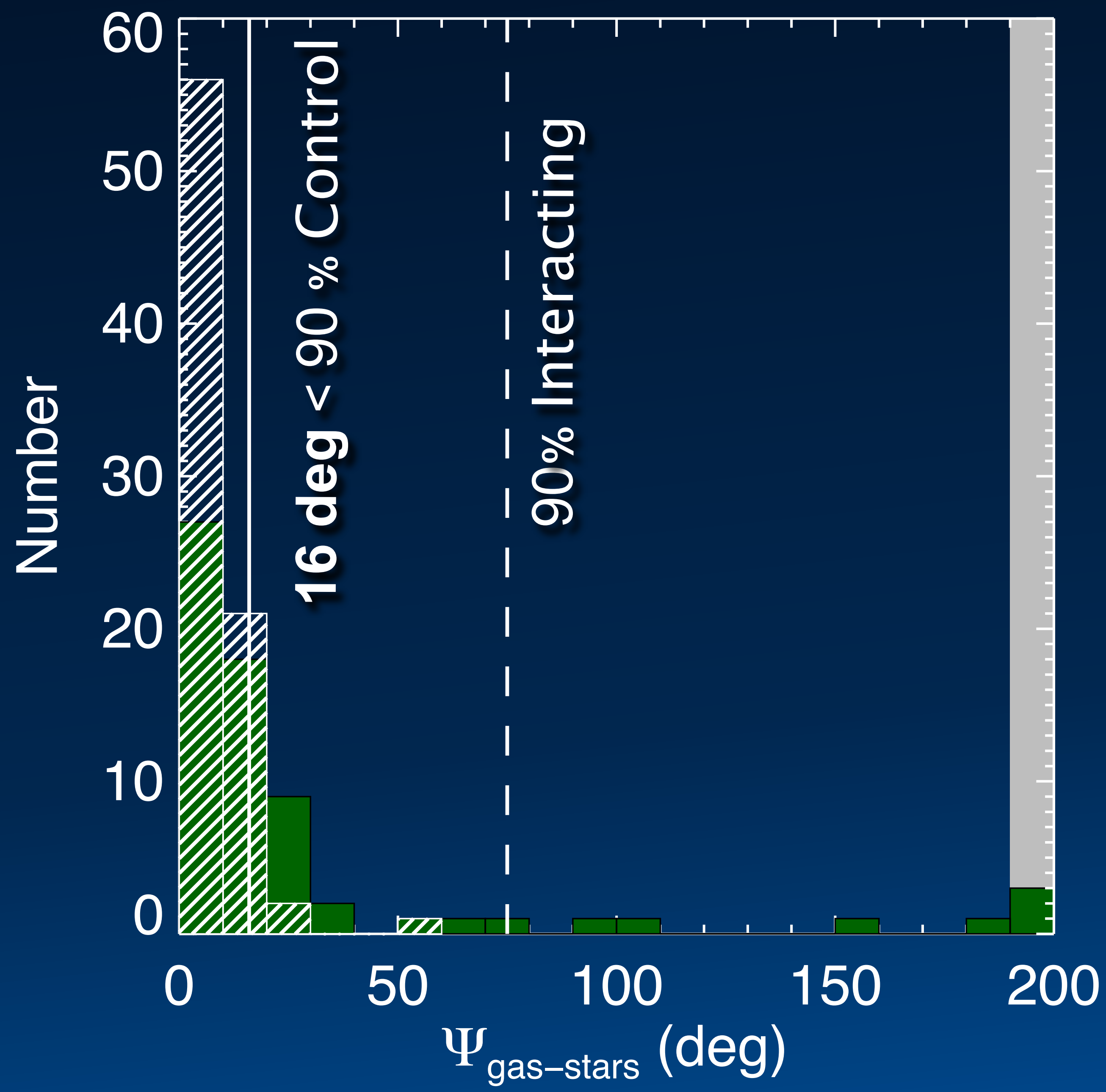
Enhancement of $\psi_{\text{morph-kin}}$ at the **merger** stage.

Stellar-Gas Kinematic PA misalignments

$$\psi_{gas\text{-}stars} = |\, PA_{gas} - PA_{stars} \,|$$

43% (28/66) of interacting sample with $\psi_{gas\text{-}stars}$ > 16 degrees.

18% (12/66) of interacting sample with $\psi_{gas\text{-}stars}$ > 30 degrees.



Stellar-Gas Kinematic PA misalignments

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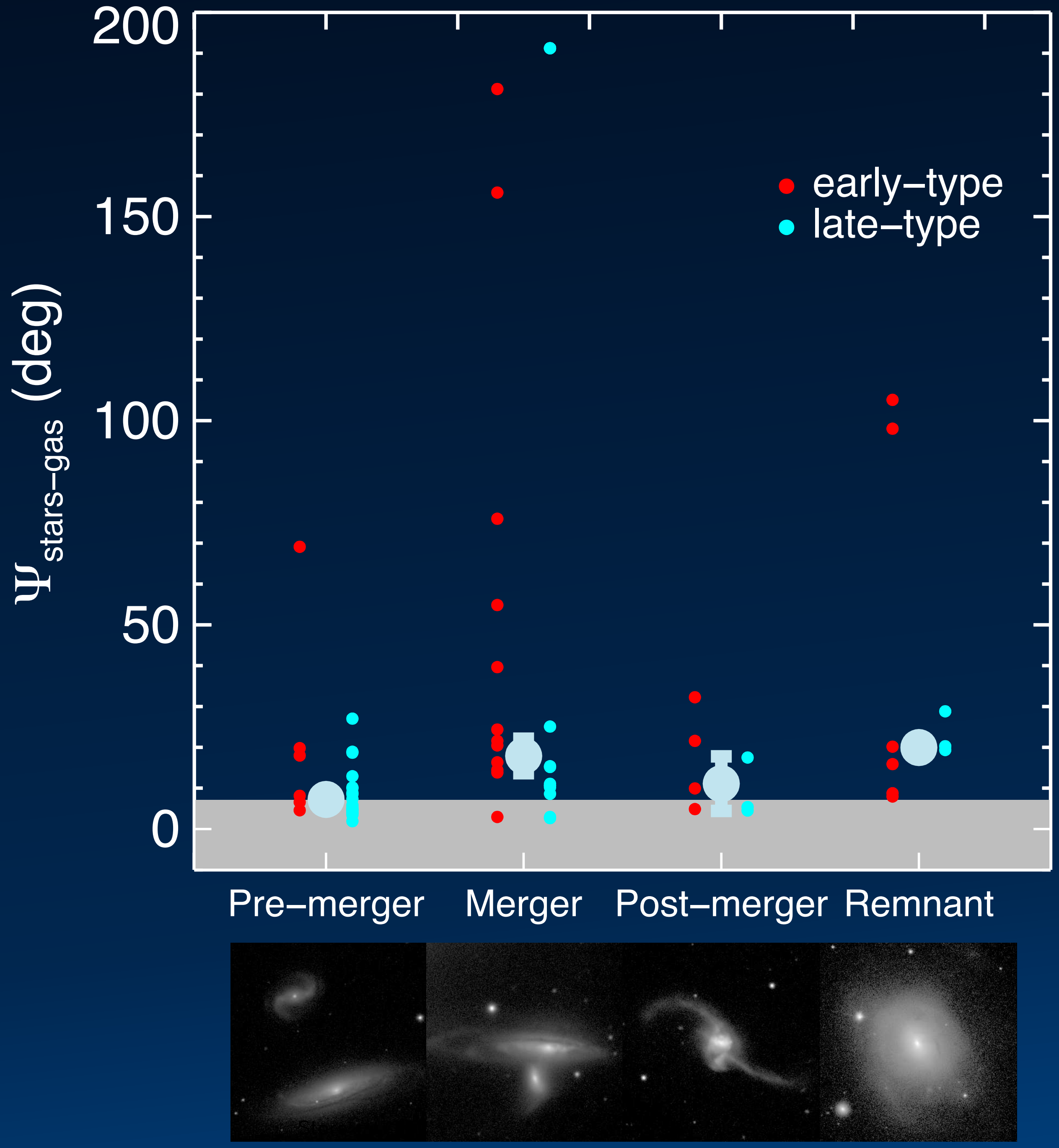
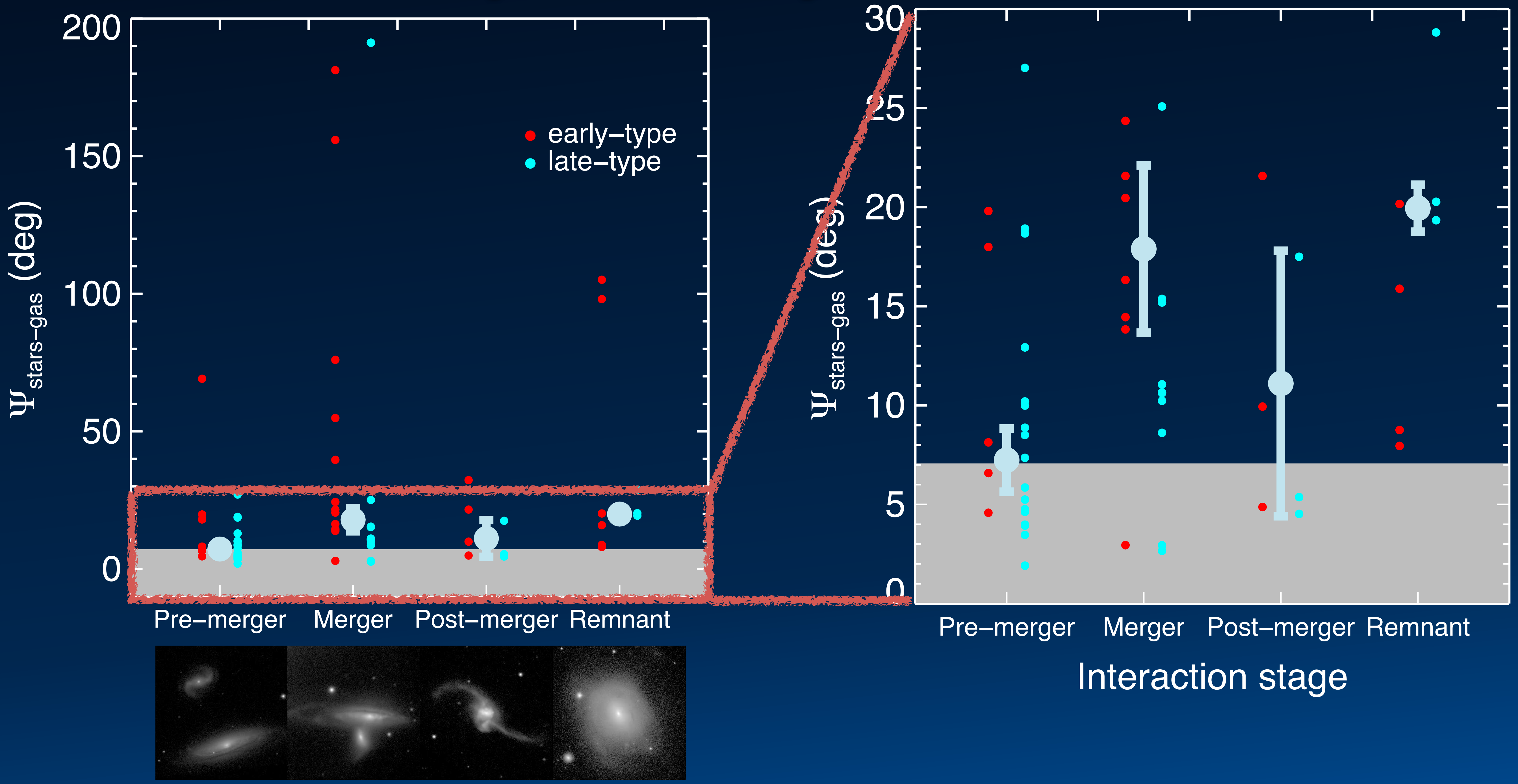


Large misalignments observed mostly in early-type galaxies, at different stages of interaction.

Stellar-Gas Kinematic PA misalignments

$$\Psi_{gas\text{-}stars} = |\ PA_{gas} - PA_{stars}\ |$$



Summary

- Covering a wide range of environmental and internal parameters, the CALIFA survey allow us to compare the 2D kinematic properties of galaxies at different stages of interaction with non-interacting galaxies.

- We develop an “assumption-free” method to characterize homogeneously the stellar and ionized gas velocity fields from those two samples.

- We trace the impact of interactions in the internal structure of galaxies:
  - Larger morpho-kinematic misalignments comparing to control sample in particular for galaxies with evident signatures of interaction.

  - Interacting galaxies show a large impact changing the internal structure of galaxies: **43% (28/66)** shows stellar-gas kinematics larger than non-interacting sample.

For more about physical properties of the CALIFA interacting galaxies see the talk:

Central star formation and chemical enrichment in CALIFA interacting galaxies

S8 - 11:45 am