A Complex Stellar Line-Of-Sight Velocity Distribution in NGC 524

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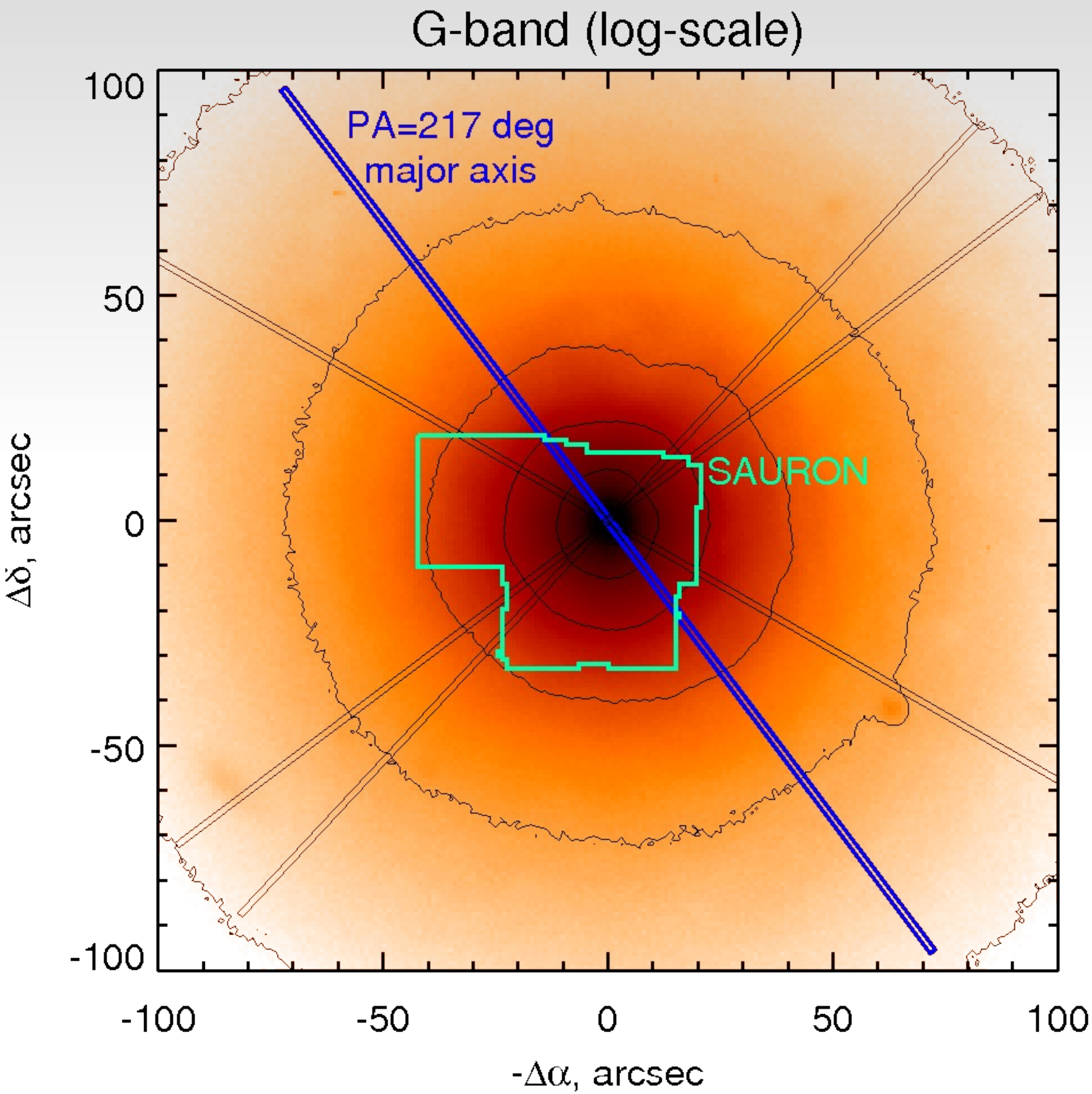
INTRODUCTION



- M_B = -21.7 mag
- Galaxy settled in the centre of a rich group

  Garcia 1993
- Circular isophotes
  ε<0.05

  Magrelli 1992
- Photometric inclination $i_{ph}<18^o$ is *inconsistent* with kinematic measurements revealed quite fast rotation of the galaxy

  Sil'chenko 2000
  Simien & Prugniel 2000
  Emsellem et al. 2004

OBSERVATIONS AND DATA REDUCTION

Long-slit spectroscopic observations

- 6-m BTA, SCORPIO
- PA_{slit} = 217 deg
- two spectral domains:
  - "green" — 4800-5550A, Δλ=2.2A
    strong stellar absorption lines Hβ, [OIII], [NI], seeing 2"
  - "red" — 6100-7100A, Δλ=3.1A
    Hα, [NII], [SII], seeing 1"

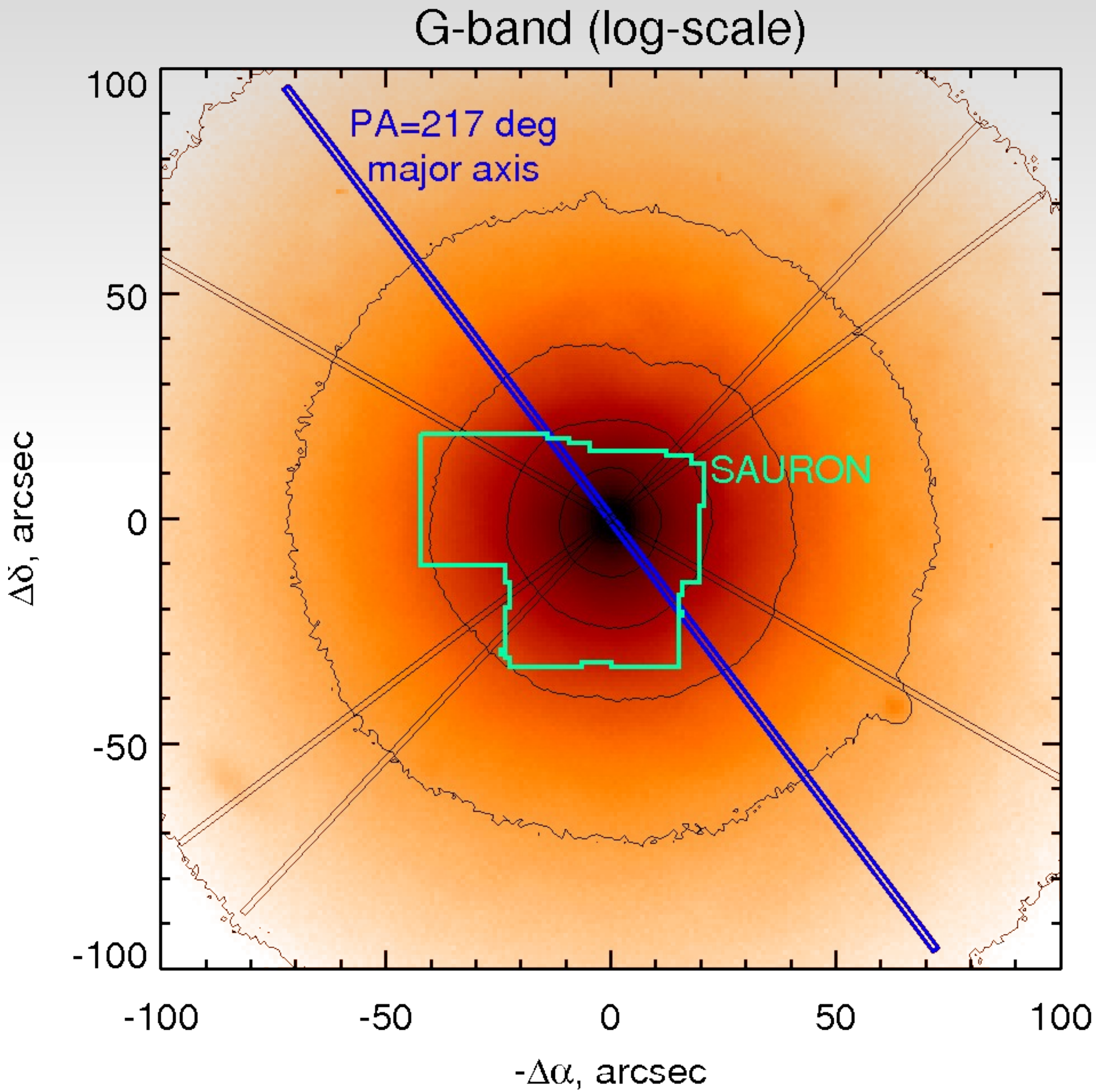
IFU spectroscopic data

- 4.2-m WHT, SAURON
- spectral range 4800-5400A, Δλ=4.8A
- 3 lenslet array positions
- sampling — 0.94"
- The science-ready data cube was kindly provided by Eric Emsellem

Data reduction

- bias subtraction and flat fielding
- CH removal
- building the wavelength solution using arc-line spectra
- constructing the spectral line spread function (LSF) variation model
- night sky spectrum subtraction taking into account the LSF variation
- adaptive binning

OBSERVATIONS AND DATA REDUCTION

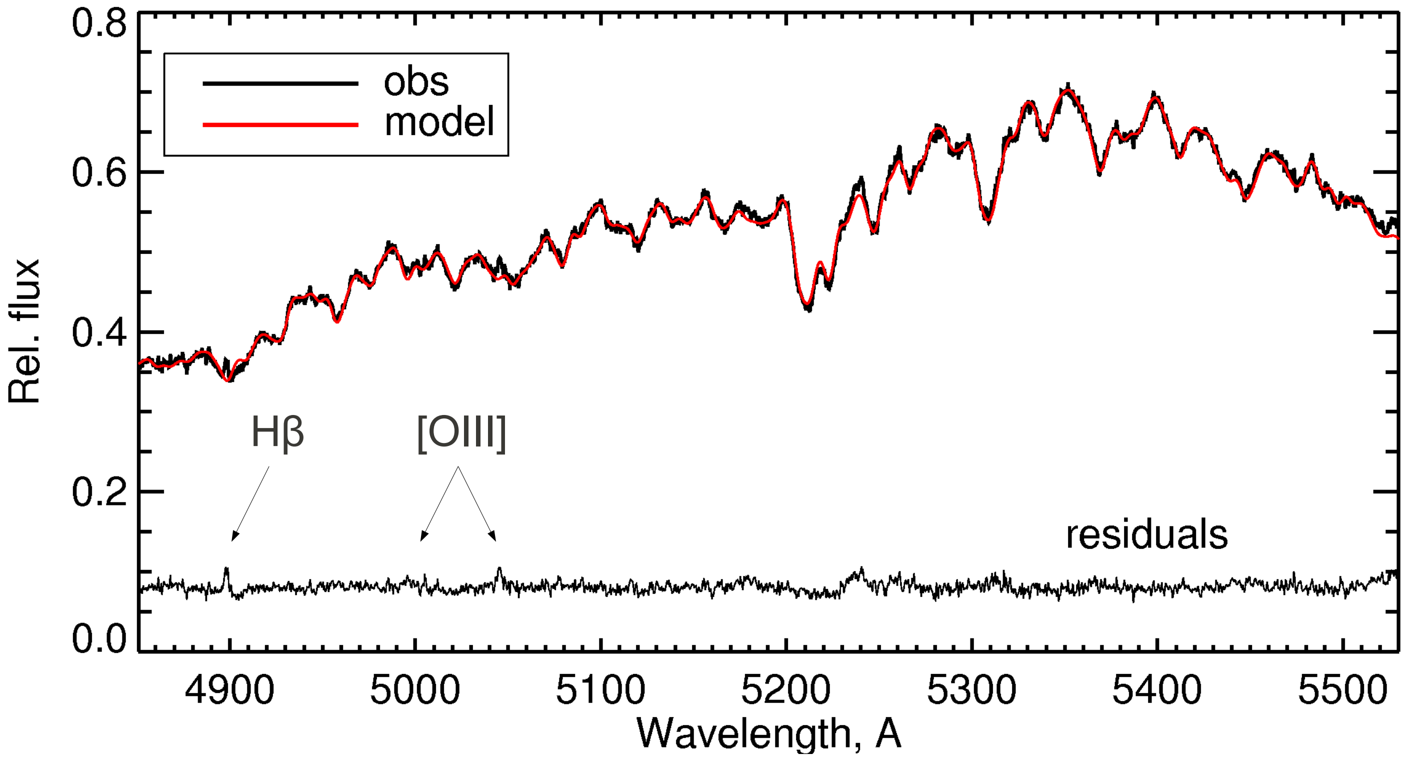


DATA ANALYSIS:
SSP-EQUIVALENT PARAMETERS AND EMISSION LINE KINEMATICS

Full spectral fitting technique NBUSRTS Chilingarian et al. 2007:

- high-resolution simple stellar population models PEGASE.HR Le Borgne et al. 2004
  SSP-equivalent ages T and metallicities [Z/H]
- stellar kinematics (Gauss-Hermite parametrization van der Marel & Franx 1993
  velocity, dispersion, h3, h4

The emission line spectrum was fitted with pure Gaussians



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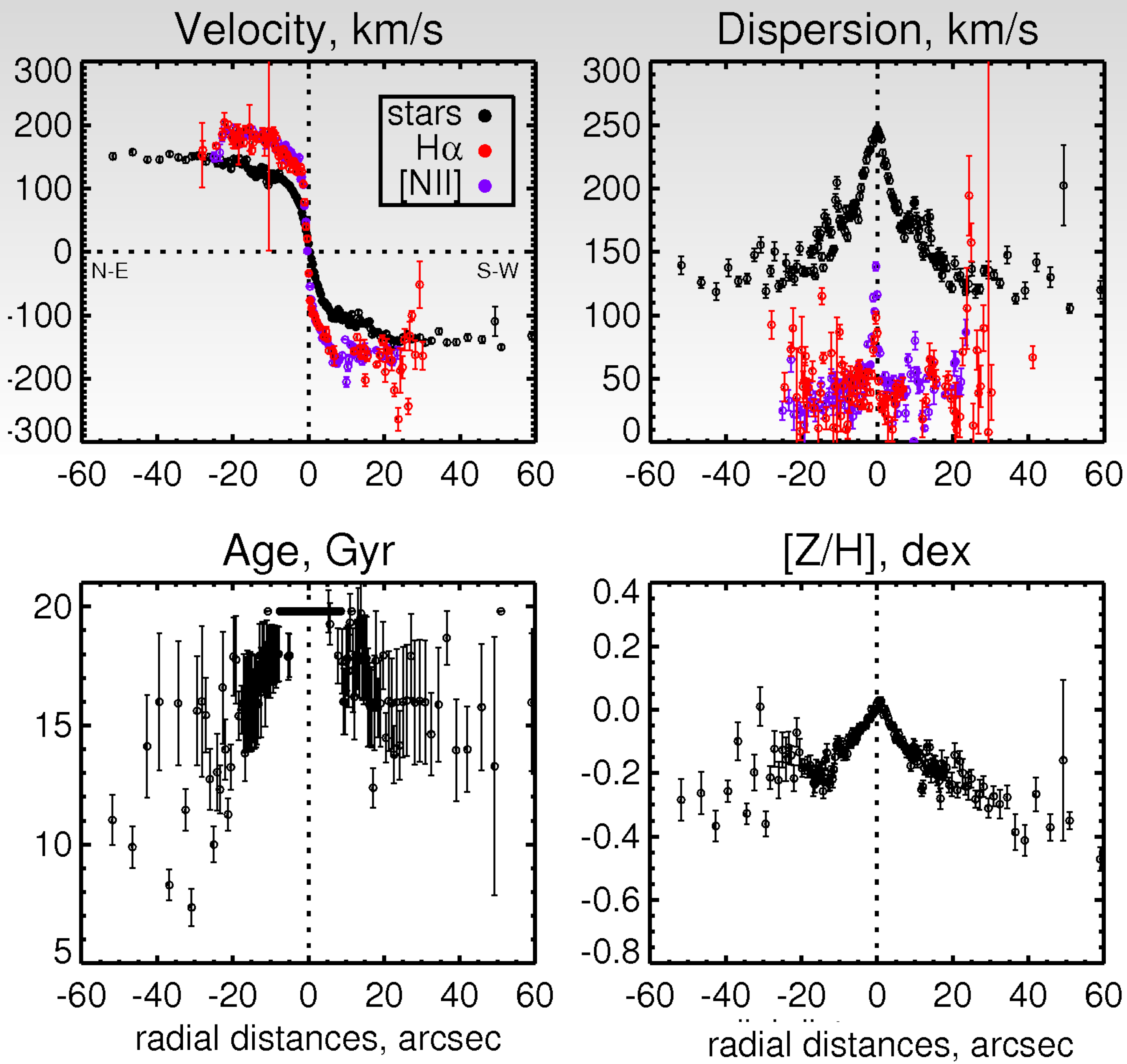

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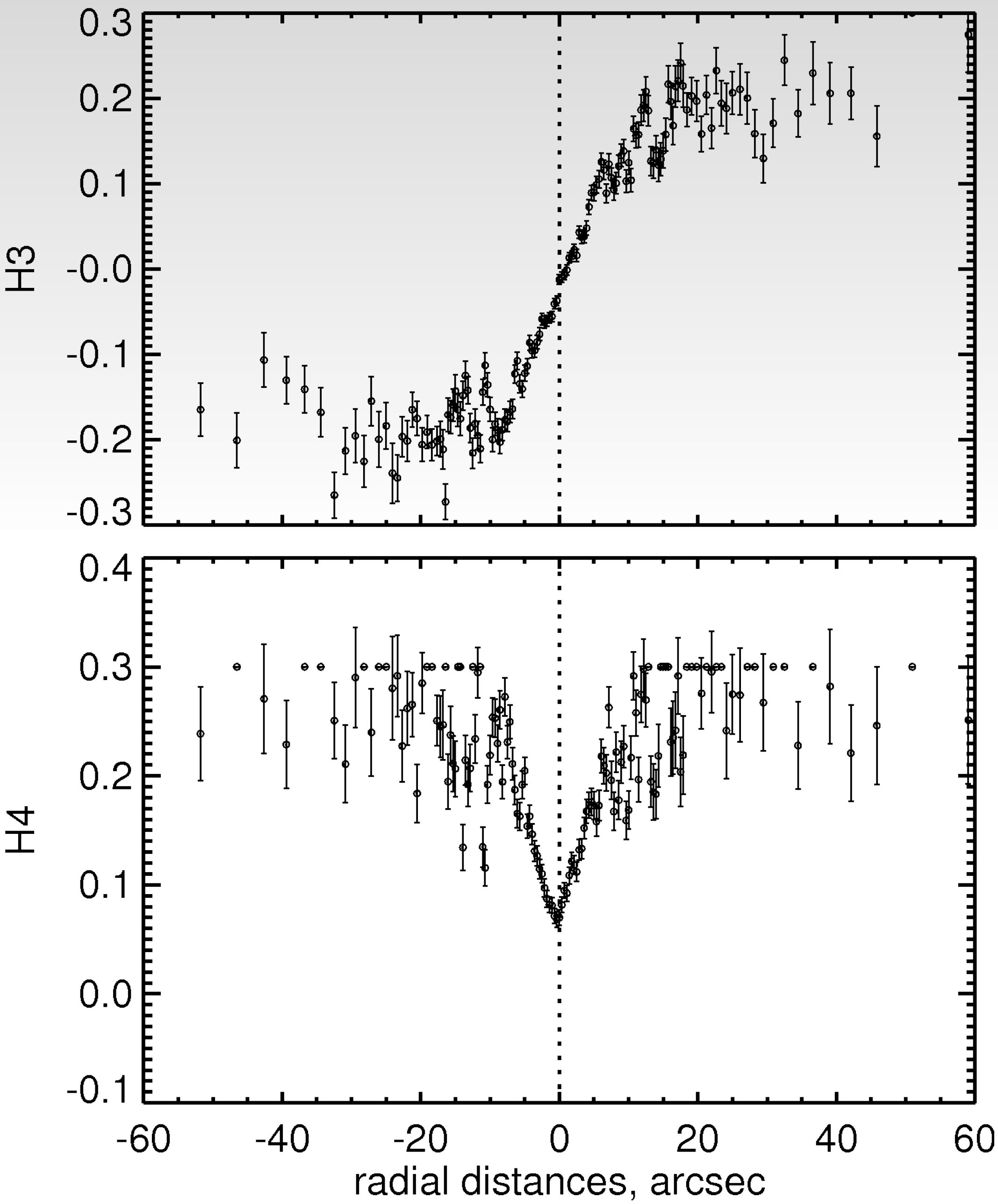


The derived parametric LOSVD exhibits a strong asymmetry leading to the *non-physical* values of h3 and h4 corresponding to negative LOSVD "wings".

DATA ANALYSIS:
NON-PARAMETRIC LOSVD

- $F(w) = \int F_r(w-u)\,L(u)\,du$ (1)

$w = \ln(\lambda)$

$u = \ln(1 + \frac{v}{c})$

$F(w)$ - logarithmically rebinned model spectrum

$L(v)$ - normalized LOSVD

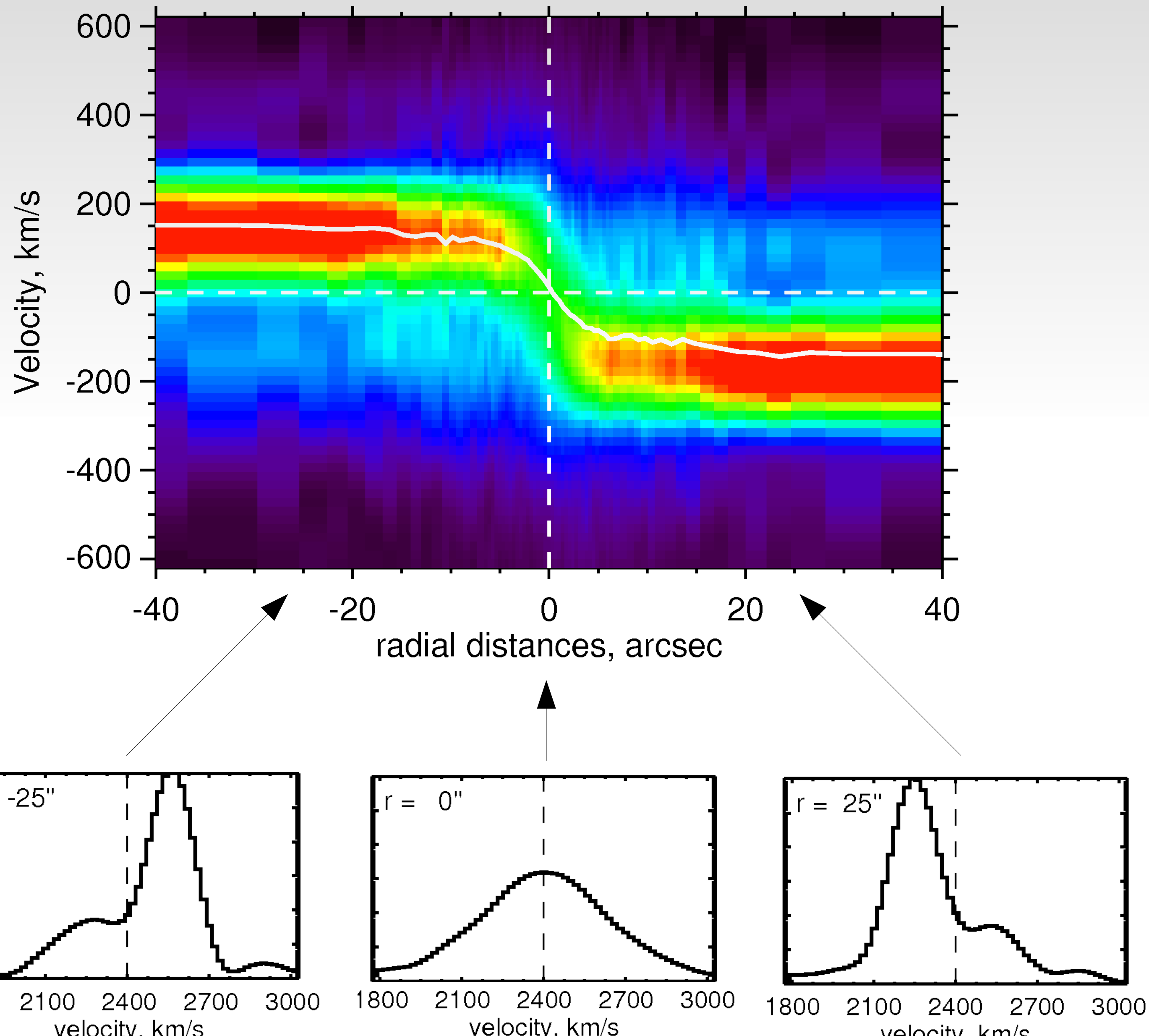
F_r - rest-frame SSP model

- The Eq. 1 can be considered as a linear inverse problem whose solution is very sensitive to the noise in the data. We use the quadric or cubic penalization P depending on spectral resolution (for details see Press et al. 2007, Numerical Recipes)

$$\chi^2 + \lambda P$$

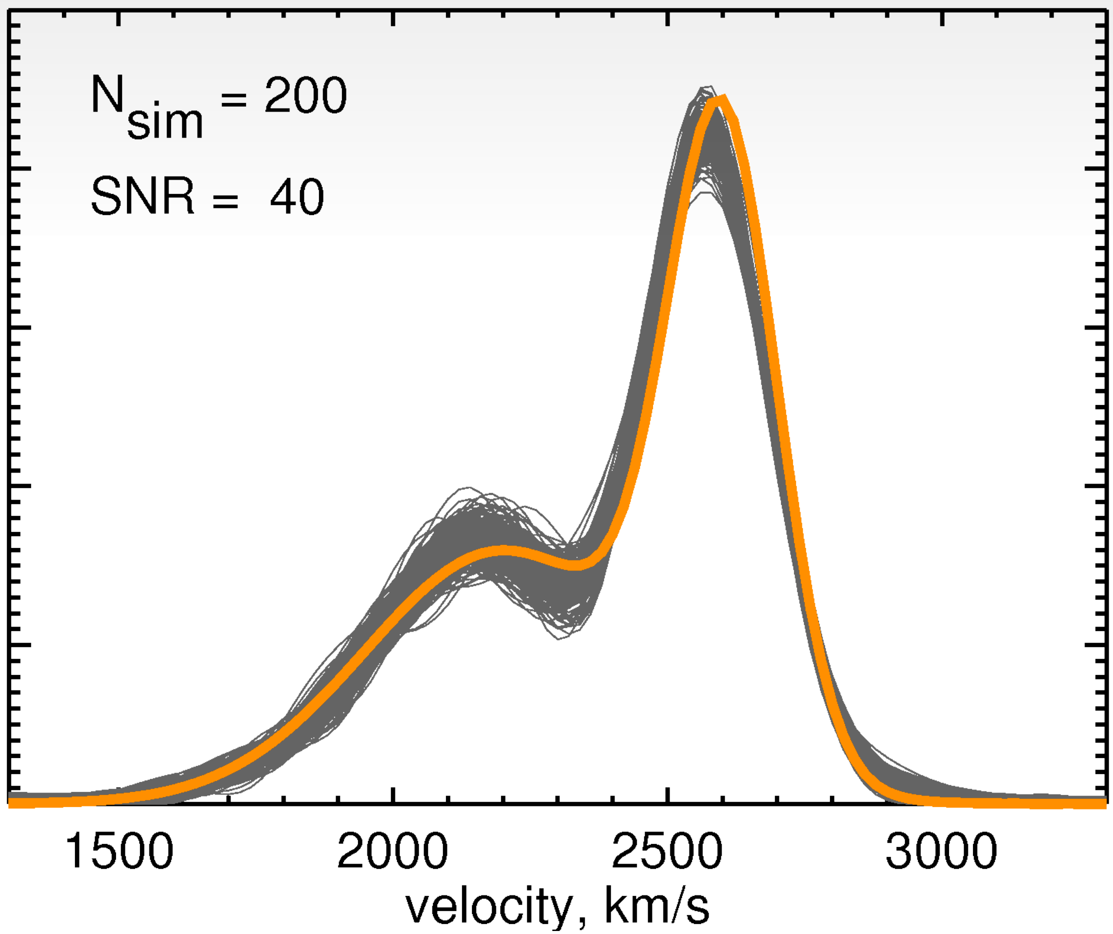
- We used the output SSP model of the NBURSTS fitting as a template spectrum F_r

DATA ANALYSIS:
NON-PARAMETRIC LOSVD



DATA ANALYSIS:
NON-PARAMETRIC LOSVD

Monte-Carlo realizations



DATA ANALYSIS:
TWO-COMPONENT PARAMETRIC LOSVD RECOVERY

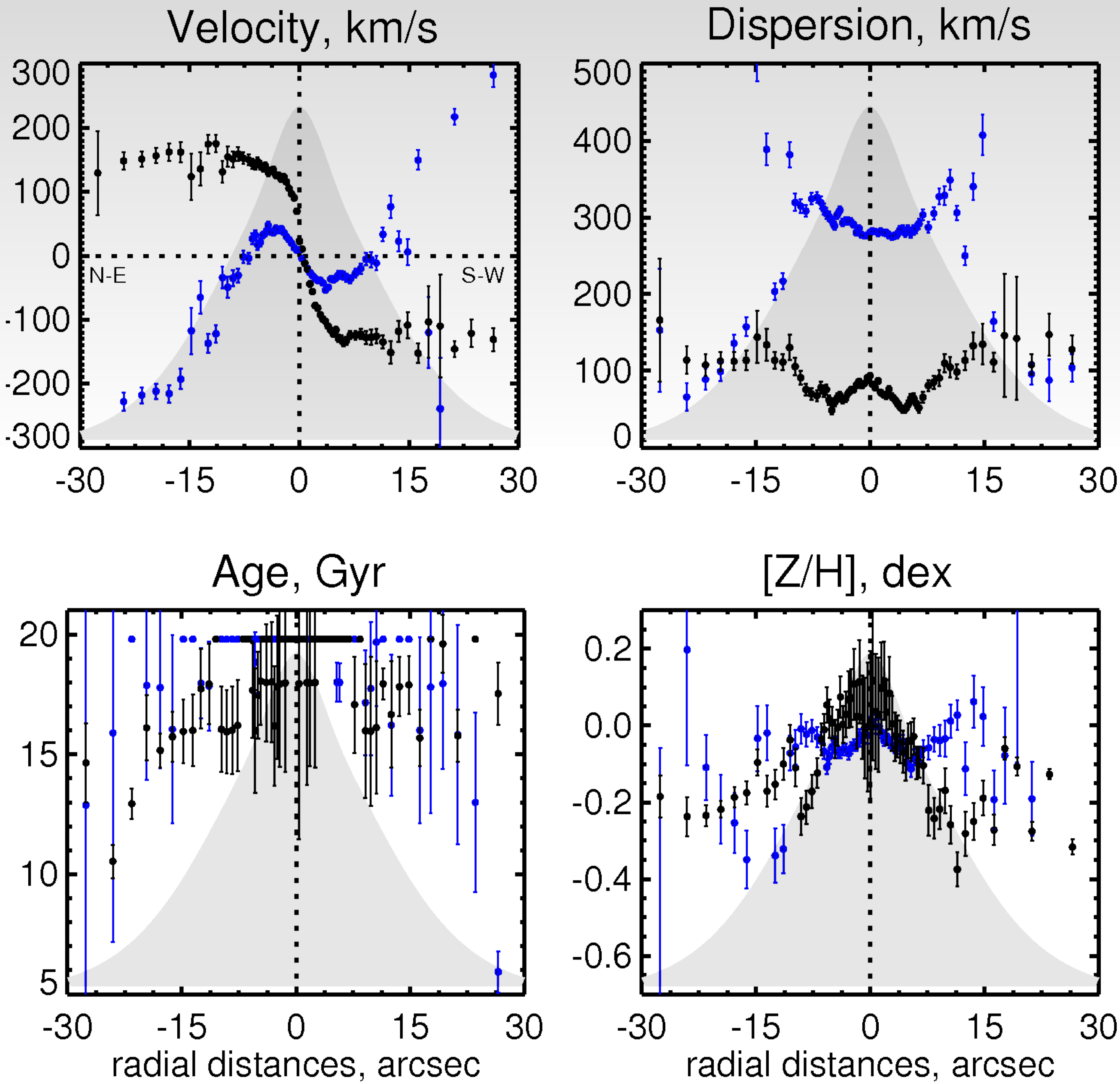
Another approach we use is a full spectral fitting using a two-component model where different stellar population components have two different pure Gaussian LOSVDs. An optimal template is represented by the linear combination of two SSPs each convolved with its own LOSVD, hence the χ^2 value is computed as follows:

$$\chi^2 = \sum_{N_\lambda} \frac{[F_i - P_p \cdot \sum_{j=1}^{j=2} k_j \cdot S(T_j, Z_j) \otimes \mathcal{L}(v_j, \sigma_j)]^2}{\delta F_i^2}$$

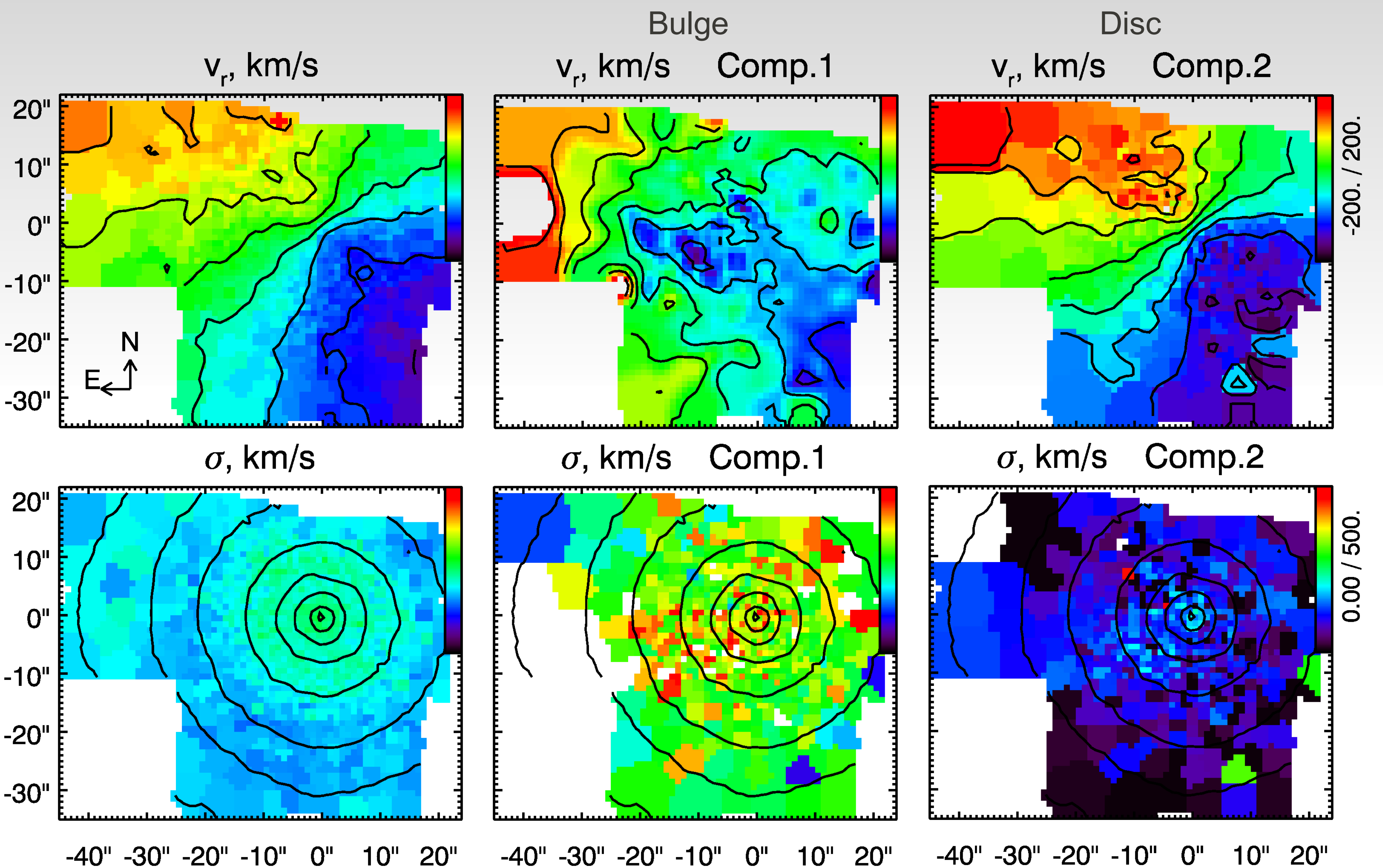
F, δF - observed flux and its uncertainty;
S(T, Z) - is the flux from the j-th synthetic spectrum of SSP with given age T and metallicity Z;
P_p - multiplicative Legendre polynomials of order p for correcting the continuum.
L(V,sigma) - is the Gaussian normalized LOSVD correspond to given velocity V and velocity dispersion sigma.

The important point in this study is that we fixed the relative SSP contributions k_j to the values derived from the light profile decomposition (Sil'chenko O.K. 2009)

DATA ANALYSIS:
TWO-COMPONENT PARAMETRIC LOSVD RECOVERY



COMPARISON ONE-COMPONENT AND TWO-COMPONENT MODELS



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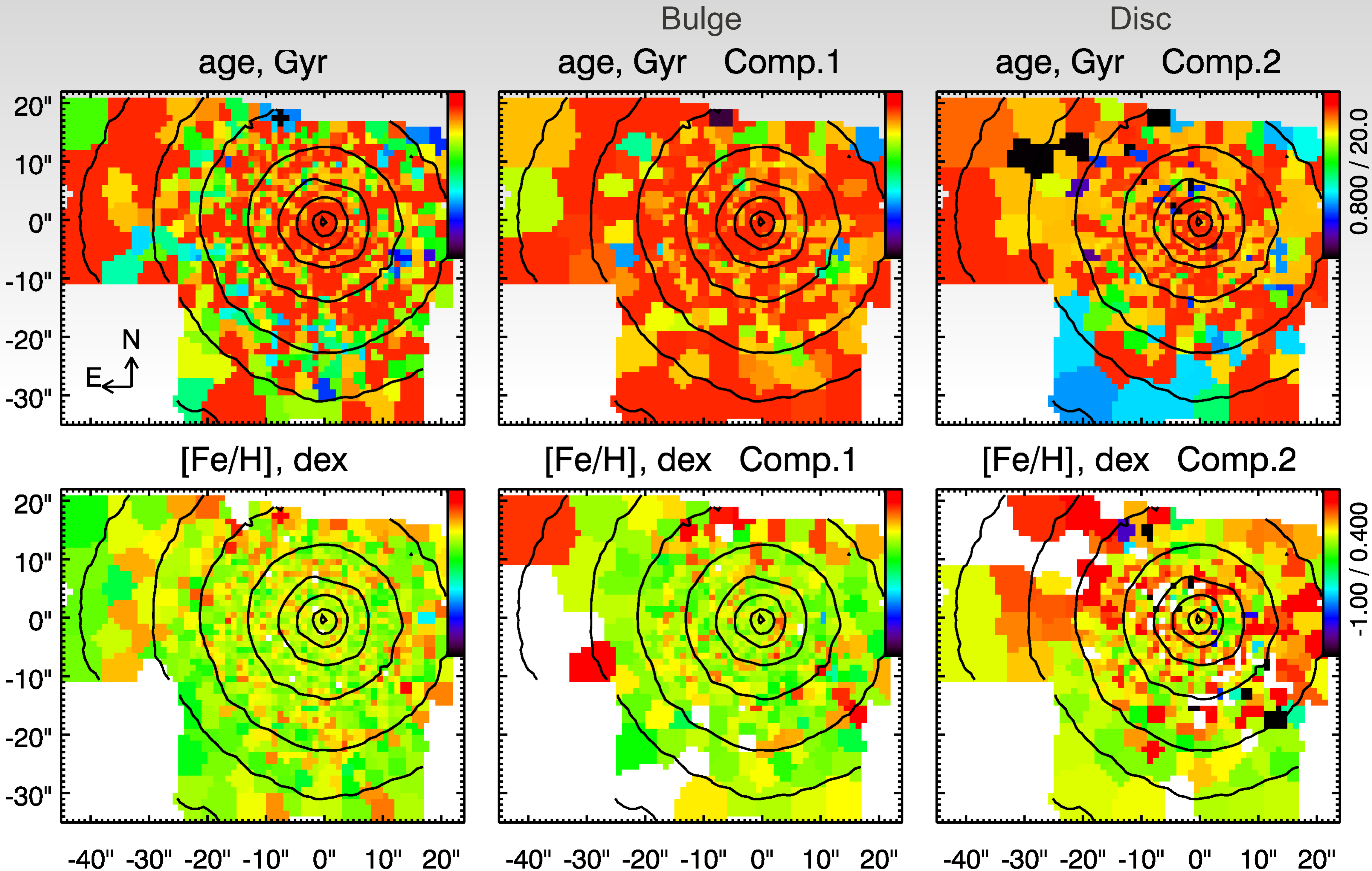


DISCUSSION

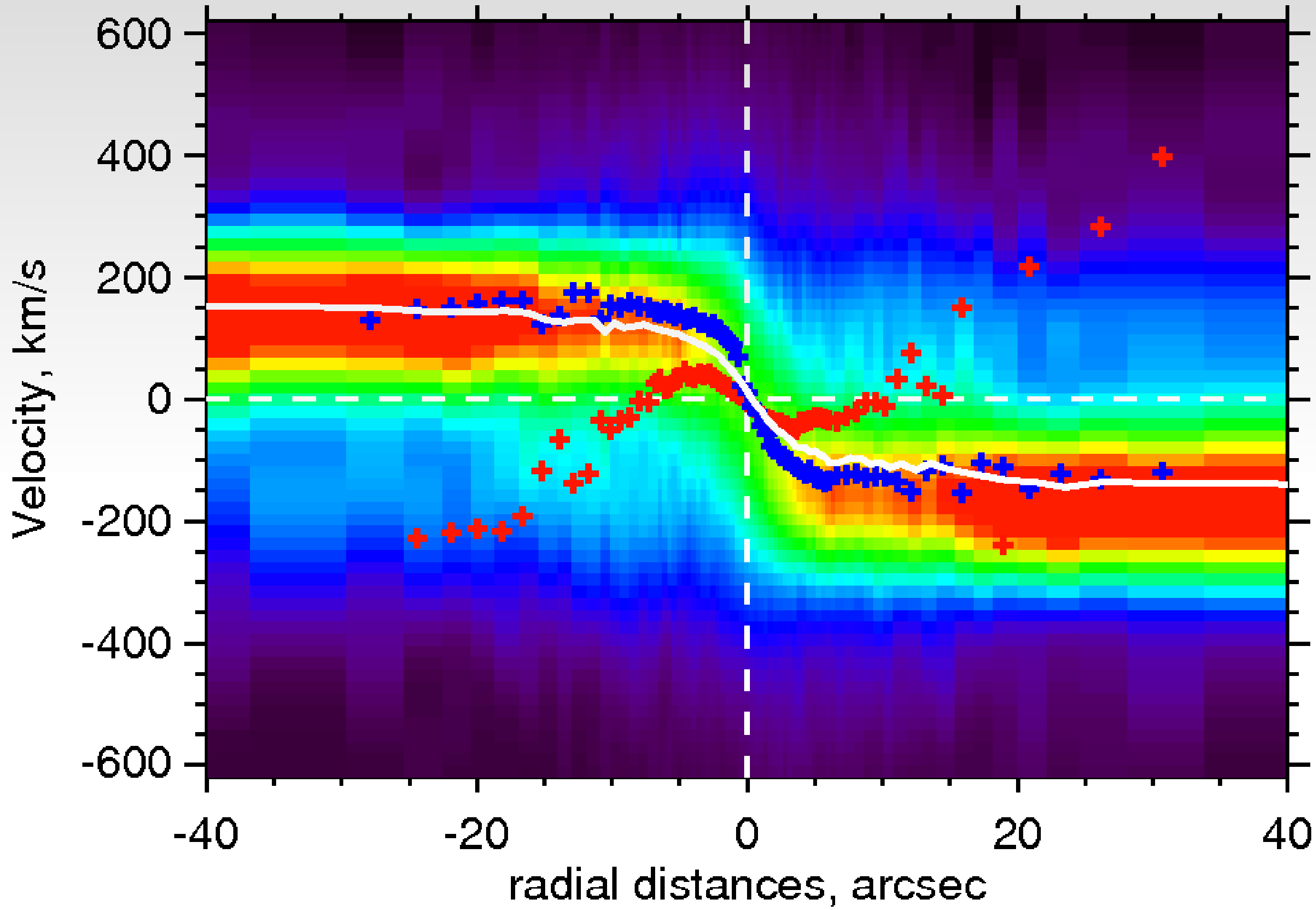
• The origin of NGC 524 has to be investigated in detail using state-of-art numerical simulations. Right now we can speculate about its evolution based on the observational results we have.

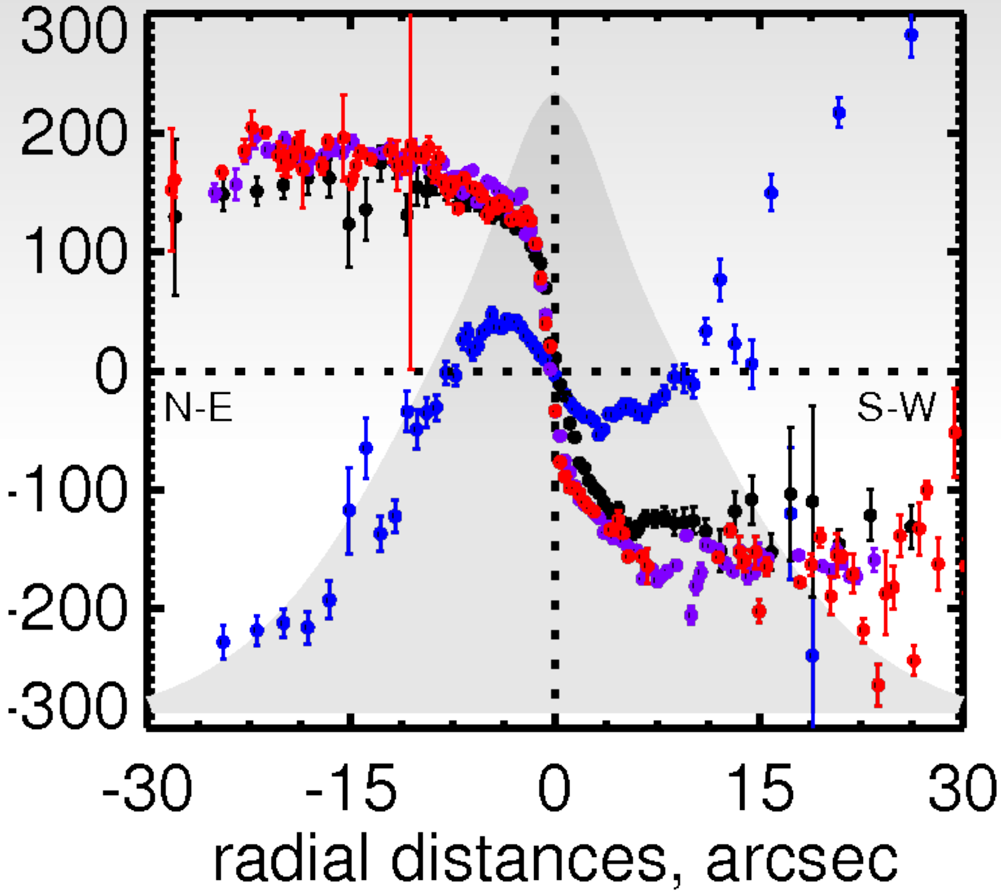
• NGC 524 might have originated from the face-on collision of two initially counter-rotating co-planar giant disc galaxies.

• The gas in the main stellar disc of NGC 524 might have survived from the original galaxy or collected later from mergers with low-mass satellites or from the accretion from the cosmic filaments. However, its surface density is still below the threshold and therefore it prevents the start of the star formation.

Thank you for your attention!

☺


600
400
200
0
-200
-400
-600
Velocity, km/s
-40
-20
0
20
40
radial distances, arcsec


300
200
100
0
-100
-200
-300
N-E
S-W
-30
-15
0
15
30
radial distances, arcsec