arXiv: 1804.03569

Evidence for the formation of the young counter-rotating stellar disk from gas acquired by IC 719★

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Received ...; accepted ...

ABSTRACT

Aims. The formation scenario of extended counter-rotating stellar disks in galaxies is still debated. In this paper, we study the S0 galaxy IC 719 known to host two large-scale counter-rotating stellar disks in order to investigate their formation mechanism.
Methods. We exploit the large field of view and wavelength coverage of the Multi Unit Spectroscopic Explorer (MUSE) spectrograph to derive two-dimensional (2D) maps of the various properties of the counter-rotating stellar disks, such as age, metallicity, kinematics, spatial distribution, the kinematical and chemical properties of the ionized gas, and the dust map.
Results. Due to the large wavelength range, and in particular to the presence of the Calcium Triplet $\lambda\lambda$8498, 8542, 8662 Å (CaT hereafter), the spectroscopic analysis allows us to separate the two stellar components in great detail. This permits precise measurement of both the velocity and velocity dispersion of the two components as well as their spatial distribution. We derived a 2D map of the age and metallicity of the two stellar components as well as the star formation rate and gas-phase metallicity from the ionized gas emission maps.
Conclusions. The main stellar disk of the galaxy is kinematically hotter, older, thicker and with larger scale-length than the secondary disk. There is no doubt that the latter is strongly linked to the ionized gas component: they have the same kinematics and similar vertical and radial spatial distribution. This result is in favor of a gas accretion scenario over a binary merger scenario to explain the origin of counter-rotation in IC 719. One source of gas that may have contributed to the accretion process is the cloud that surrounds IC 719.

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The Astrophysical Journal, 769:105 (10pp), 2013 June 1 doi:10.1088/0004-637X/769/2/105

LENTICULAR GALAXY IC 719: CURRENT BUILDING OF THE COUNTERROTATING LARGE-SCALE STELLAR DISK*

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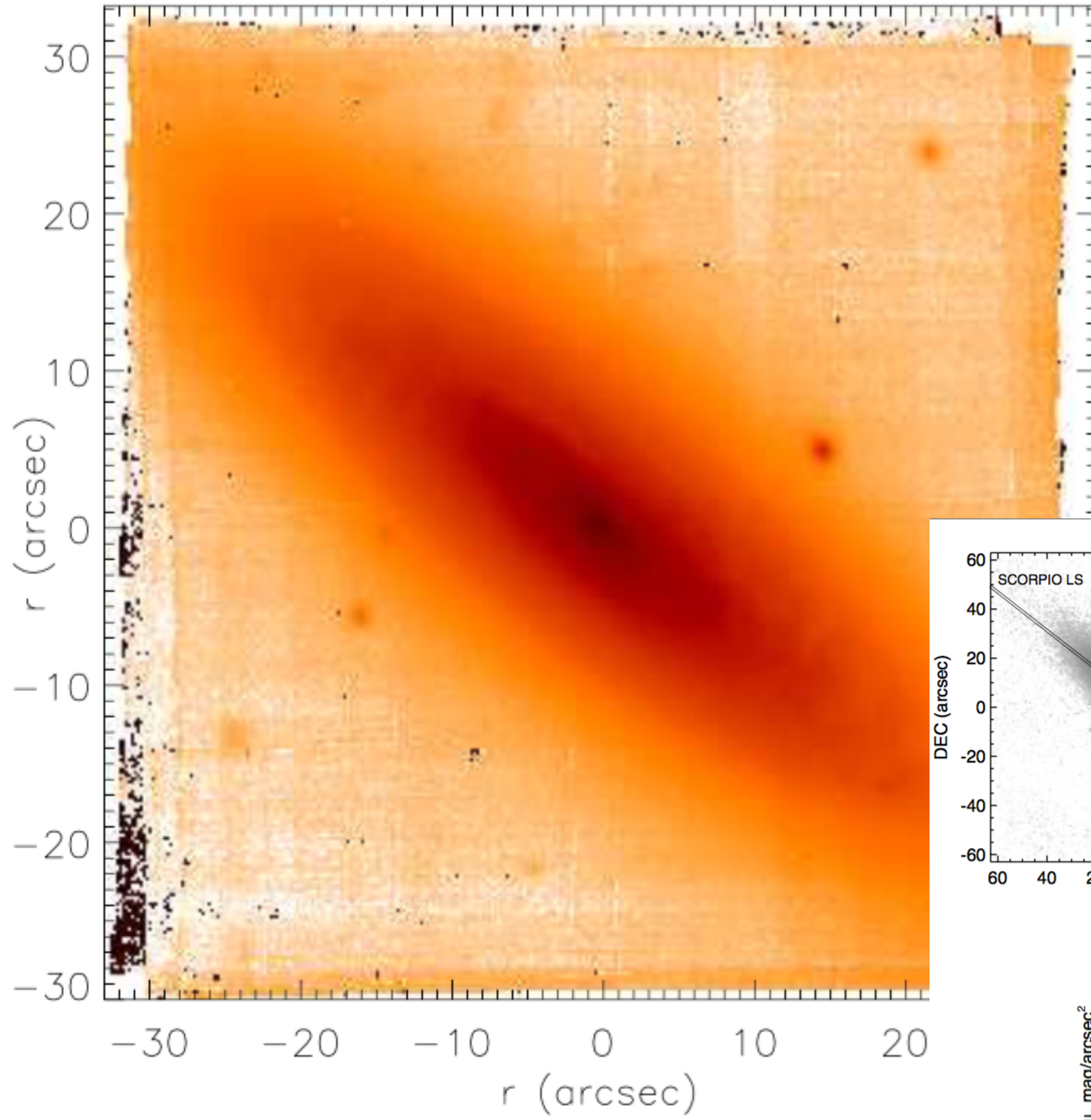
Received 2012 December 24; accepted 2013 April 8; published 2013 May 10

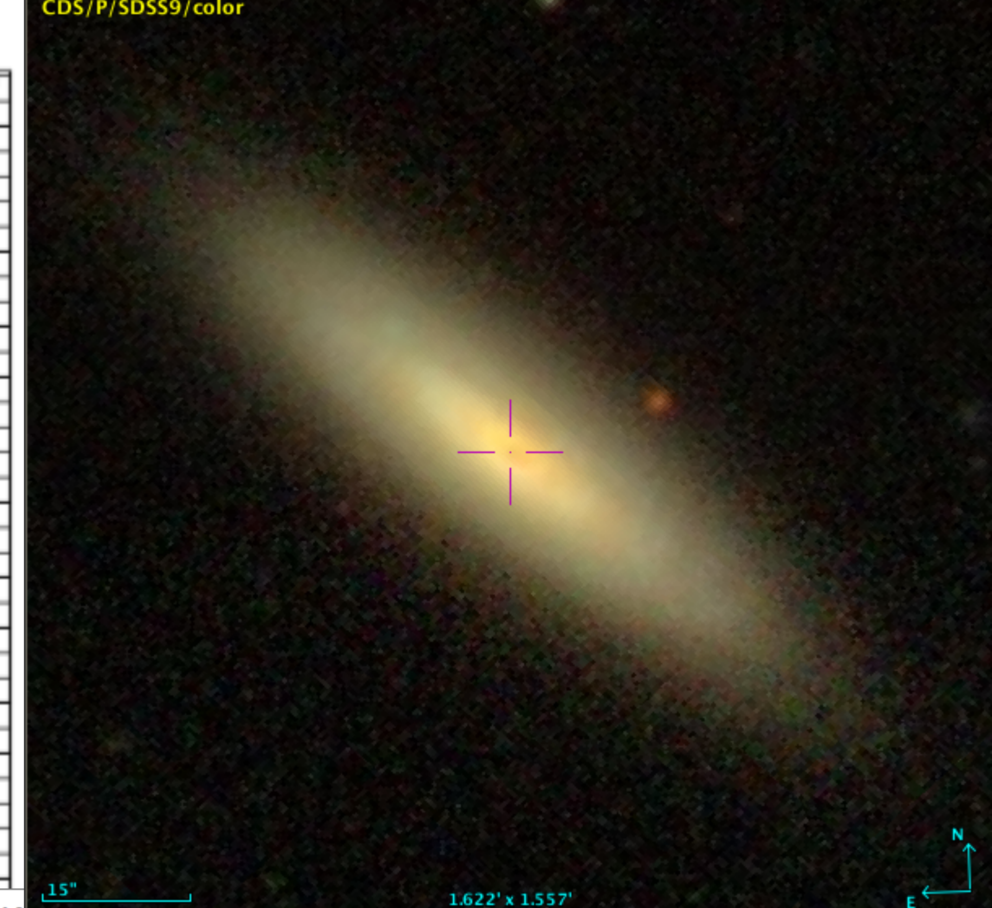
ABSTRACT

We have obtained and analyzed long-slit spectral data for the lenticular galaxy IC 719. In this gas-rich S0 galaxy, its large-scale gaseous disk counterrotates the global stellar disk. Moreover, in the IC 719 disk, we have detected a secondary stellar component corotating the ionized gas. By using emission line intensity ratios, we have proven the gas excitation by young stars and thus claim current star formation, the most intense in a ring-like zone at a radius of 10″ (1.4 kpc). The oxygen abundance of the gas in the star-forming ring is about half of the solar abundance. Since the stellar disk remains dynamically cool, we conclude that smooth prolonged accretion of the external gas from a neighboring galaxy provides the current building of the thin large-scale stellar disk.

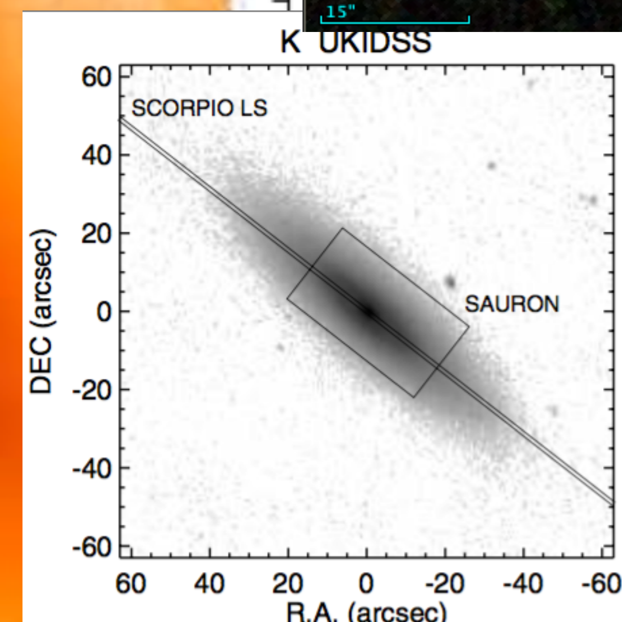
Key words: galaxies: elliptical and lenticular, cD – galaxies: evolution – galaxies: individual (IC 719) – galaxies: ISM – galaxies: kinematics and dynamics



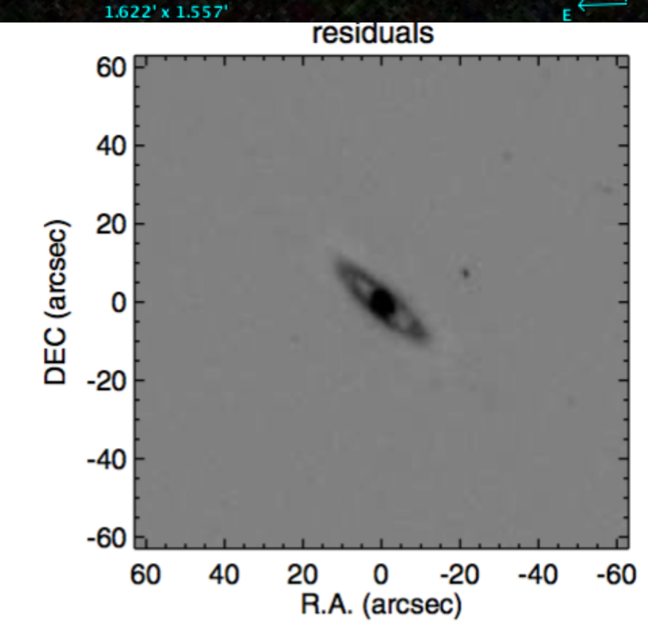
r (arcsec)
r (arcsec)



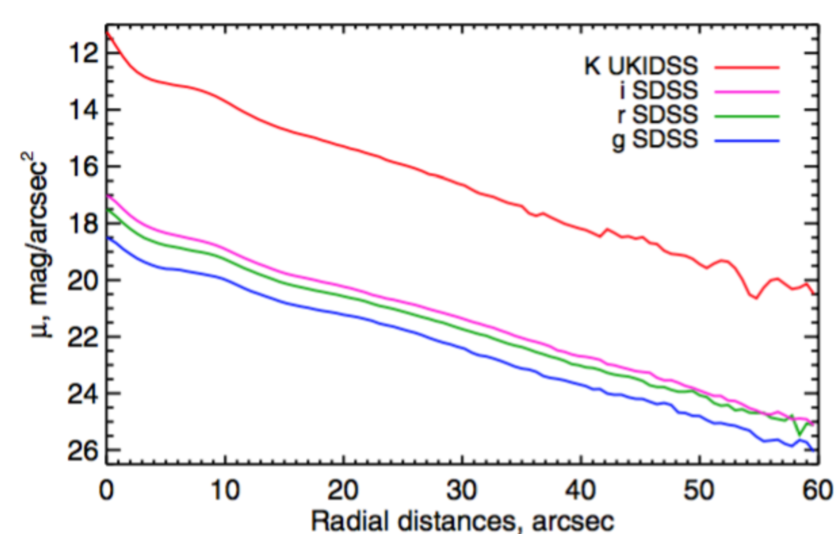
CDS/P/SDSS9/color
15"
1.622' x 1.557'
N
E



K UKIDSS
SCORPIO LS
SAURON
DEC (arcsec)
R.A. (arcsec)

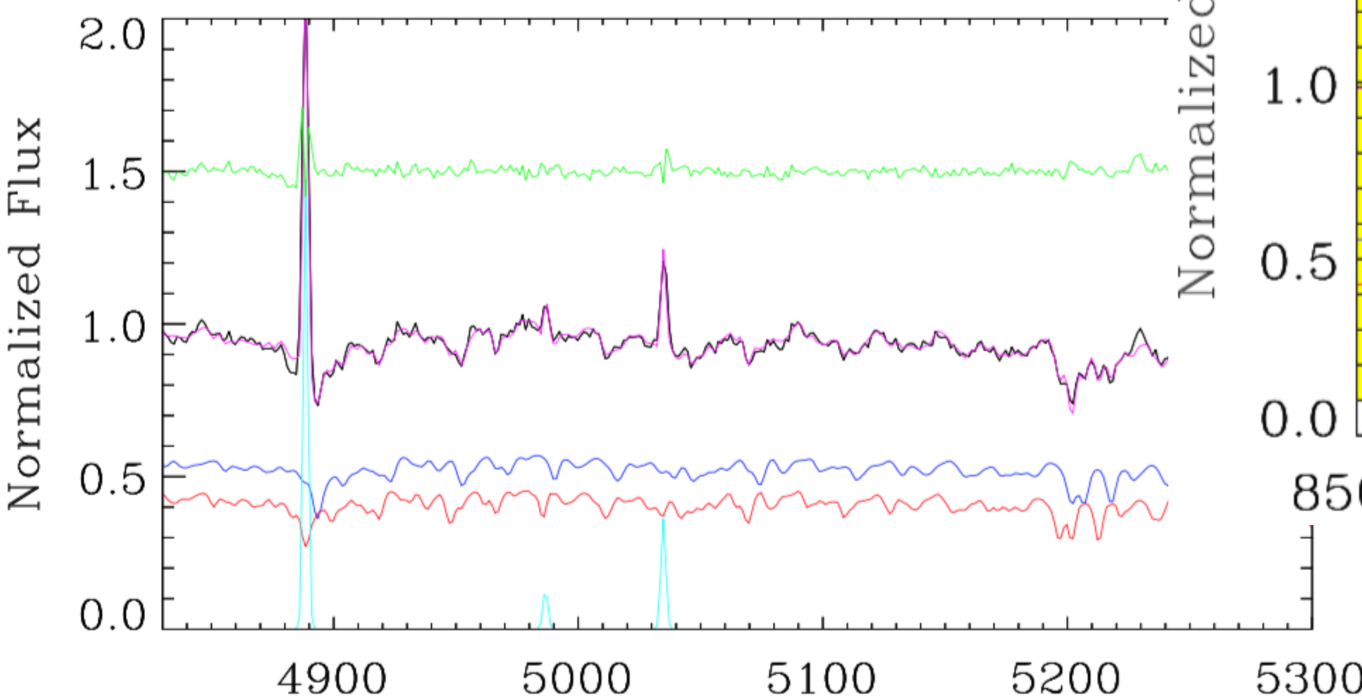


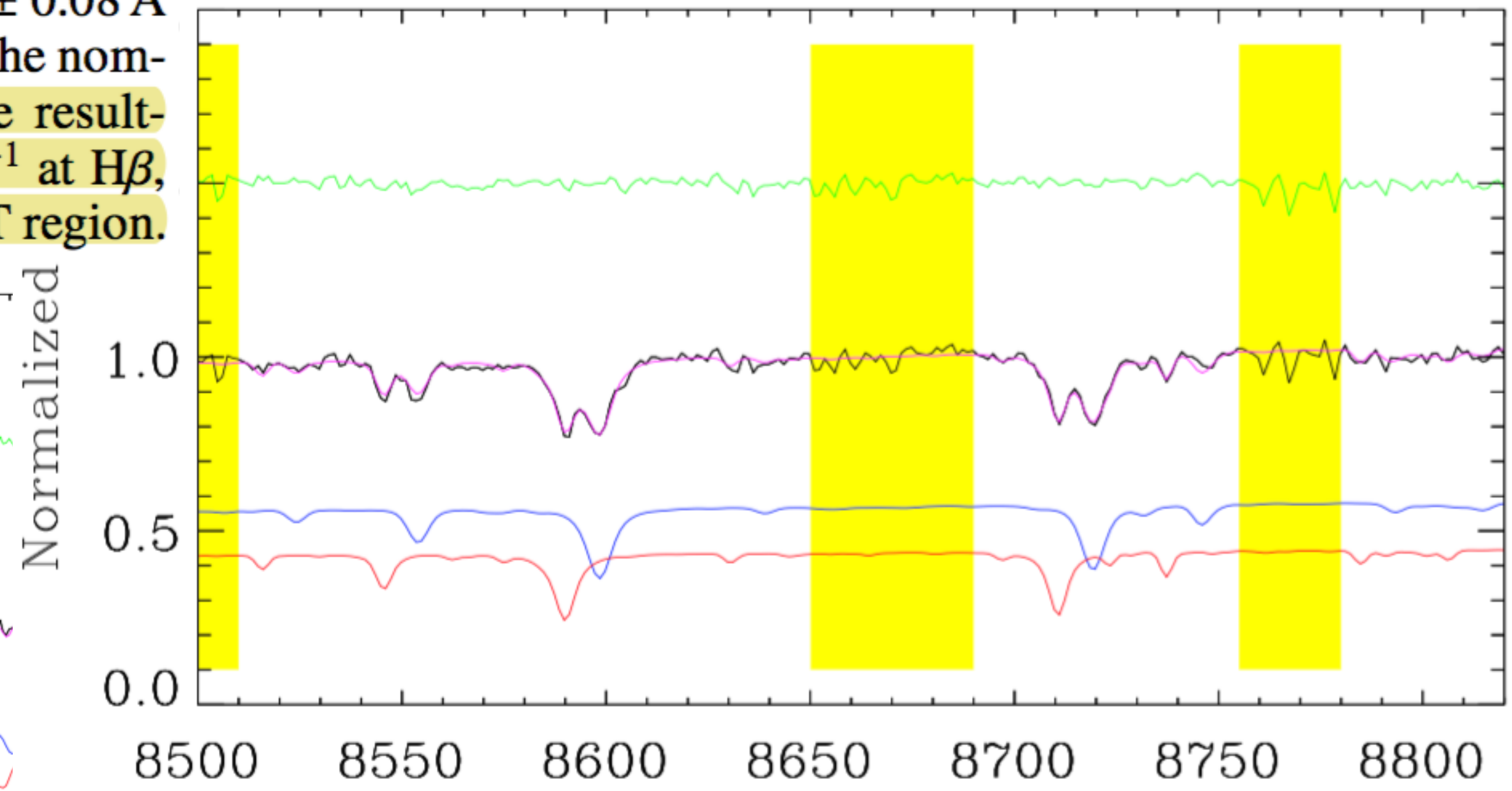
residuals
DEC (arcsec)
R.A. (arcsec)

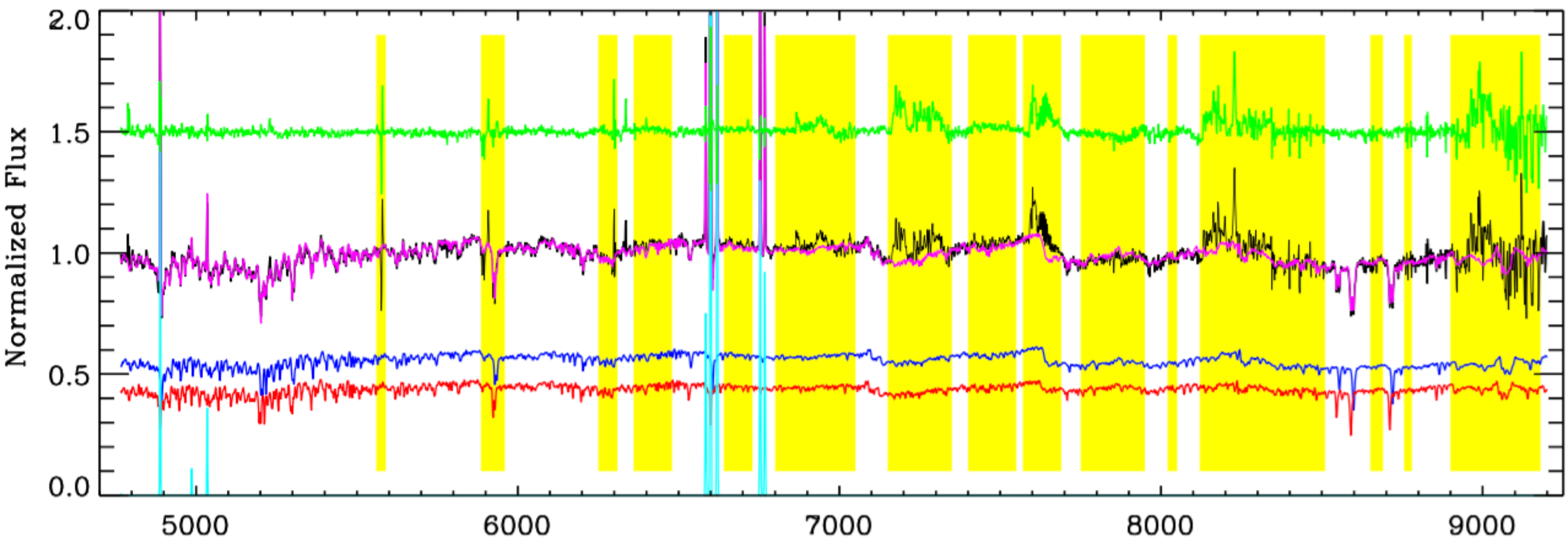


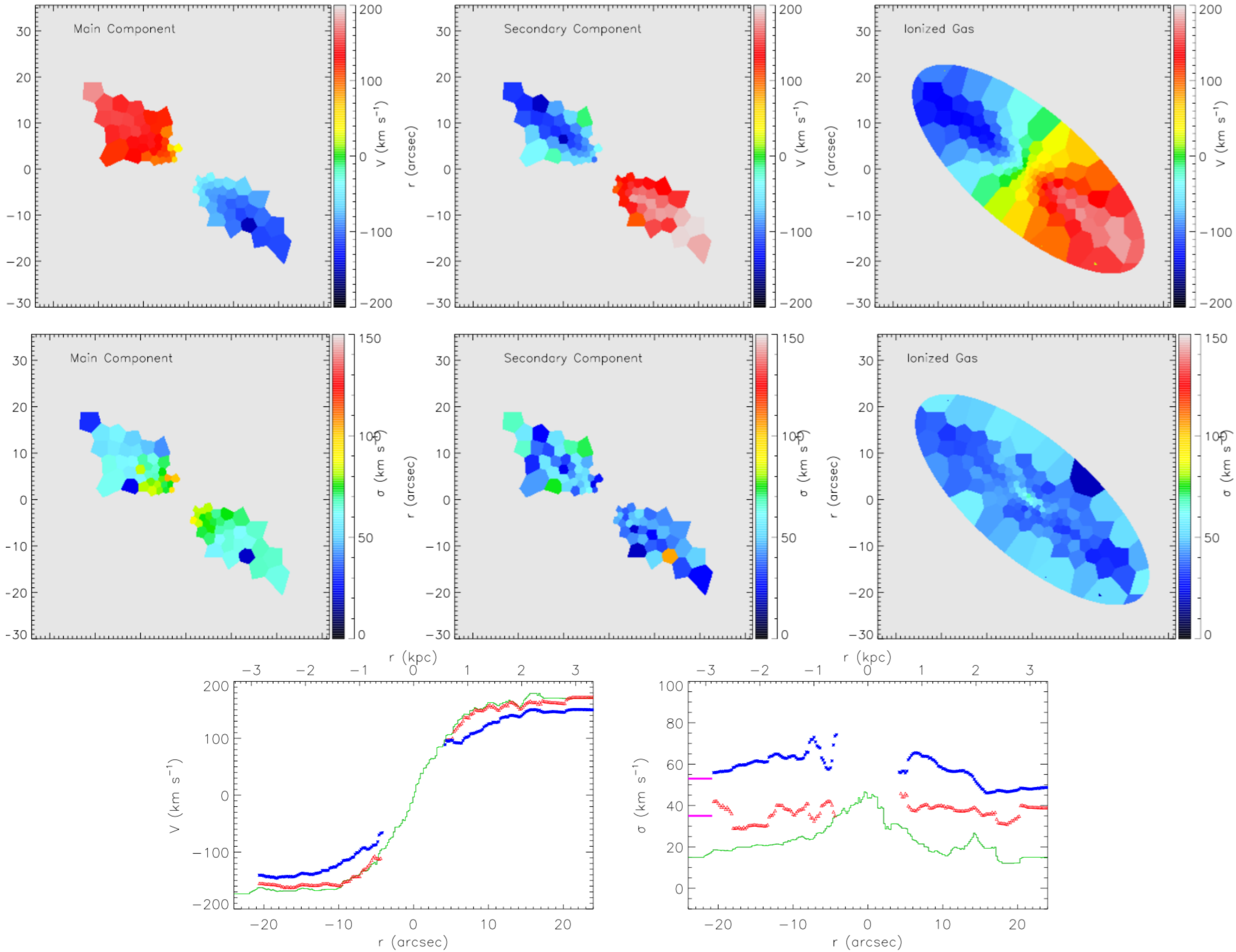
K UKIDSS
i SDSS
r SDSS
g SDSS
μ, mag/arcsec²
Radial distances, arcsec

The *FWHM* shows some variation at different wavelengths, being 2.65 ± 0.08 Å at Hβ, 2.50 ± 0.08 Å at Hα, and 2.39 ± 0.08 Å in the CaT region. This is in very good agreement with the nominal values of the instrument (Bacon et al. 2010). The resulting instrumental velocity dispersion is 69.4 ± 2.1 km s^{-1} at Hβ, 48.5 ± 1.5 km s^{-1} at Hα, and 35.3 ± 1.2 km s^{-1} in the CaT region.

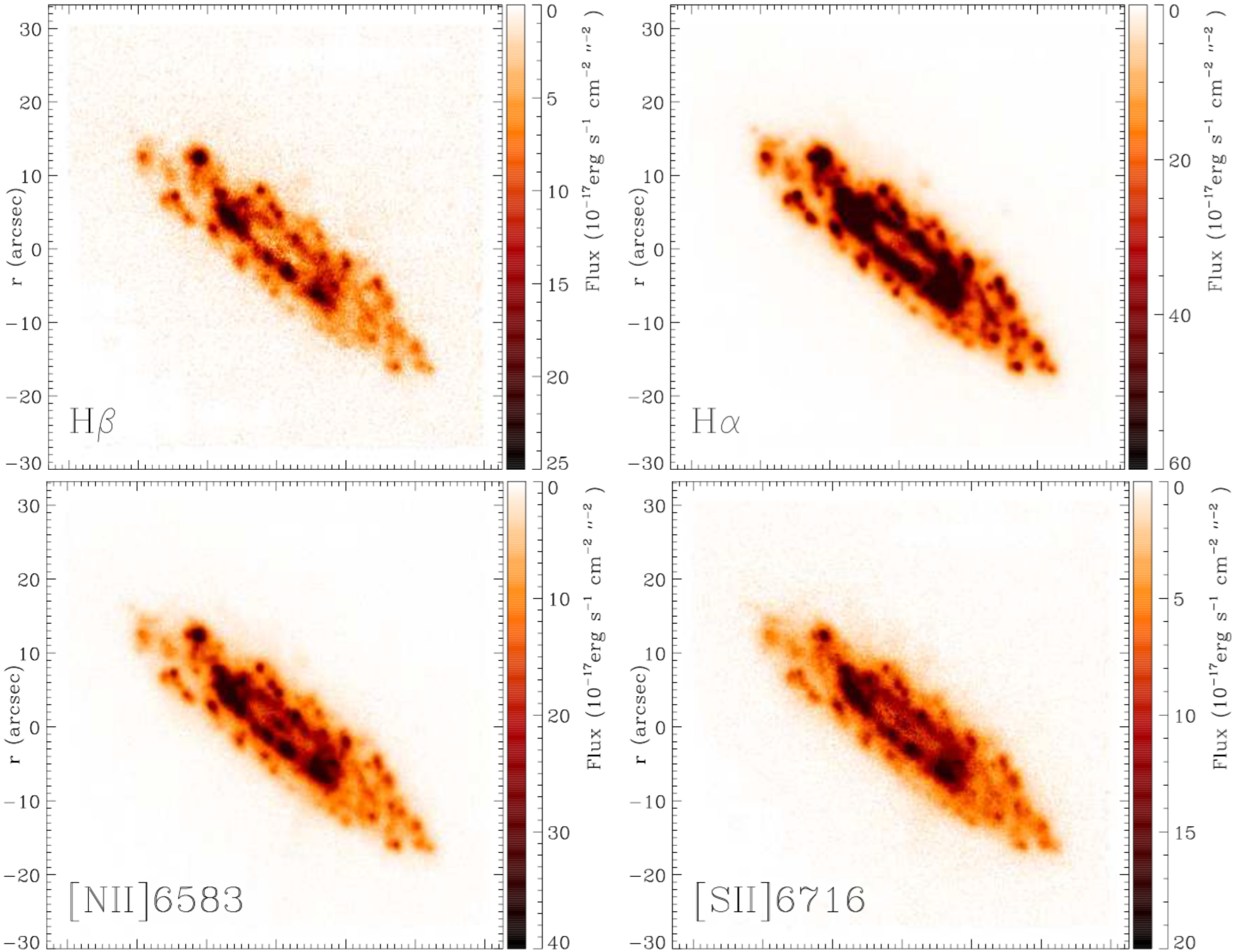




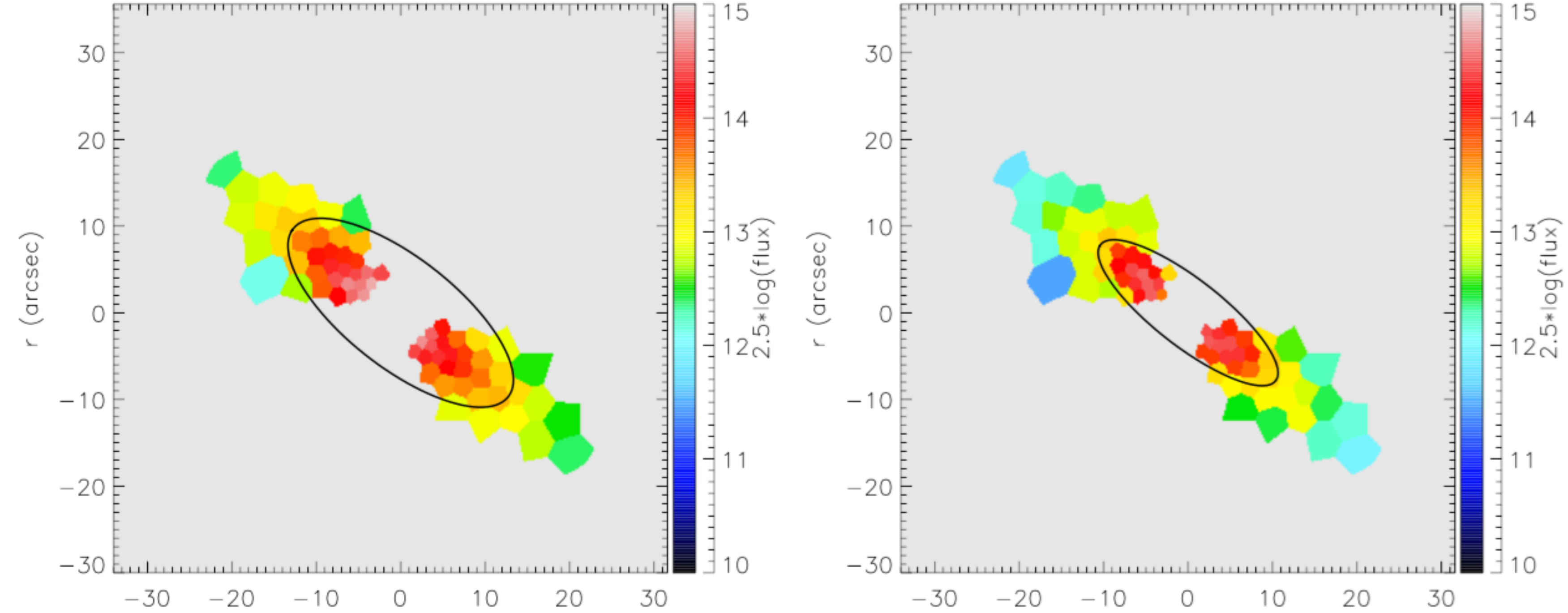




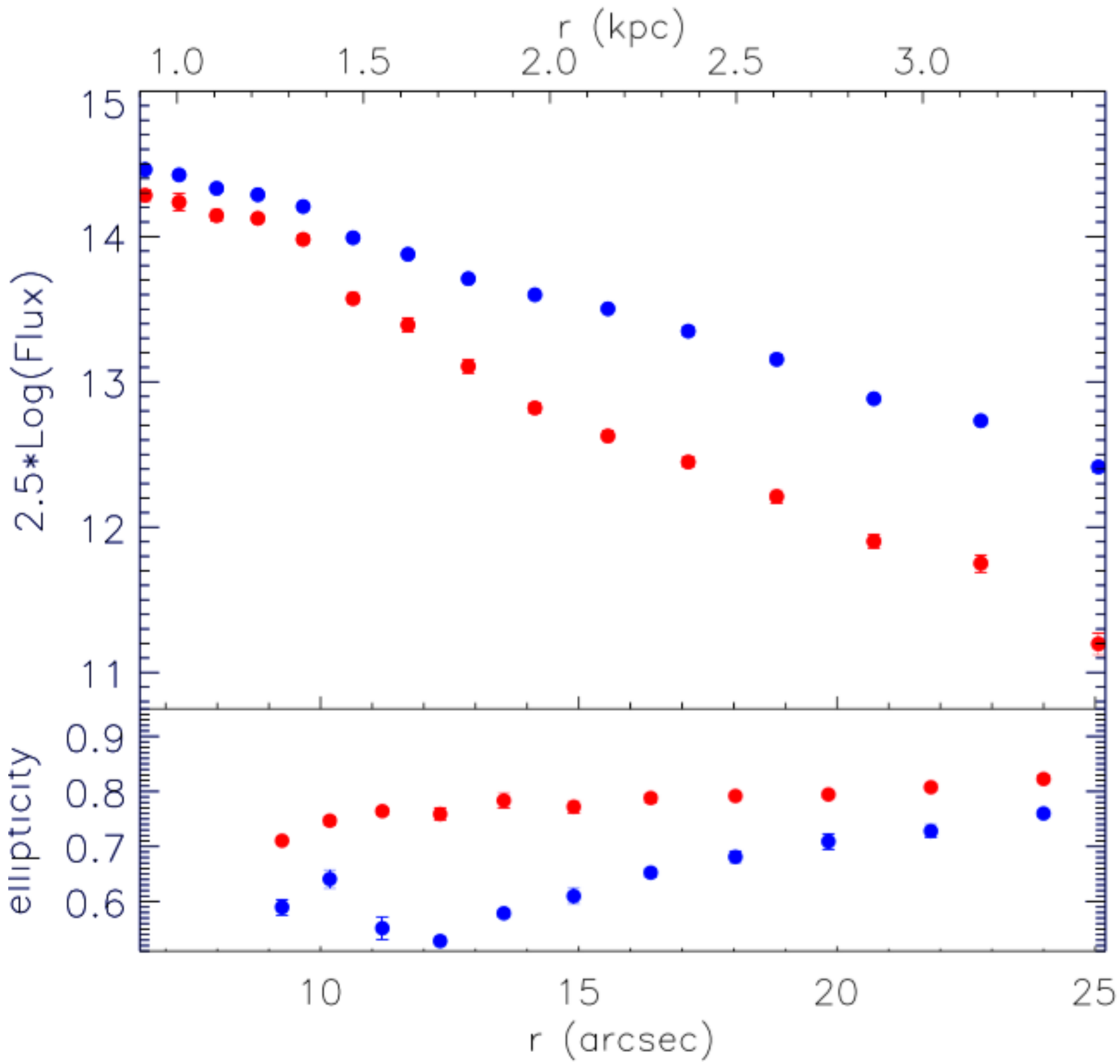
Main Component
Secondary Component
Ionized Gas
V (km s^{-1})
σ (km s^{-1})
r (arcsec)
r (kpc)

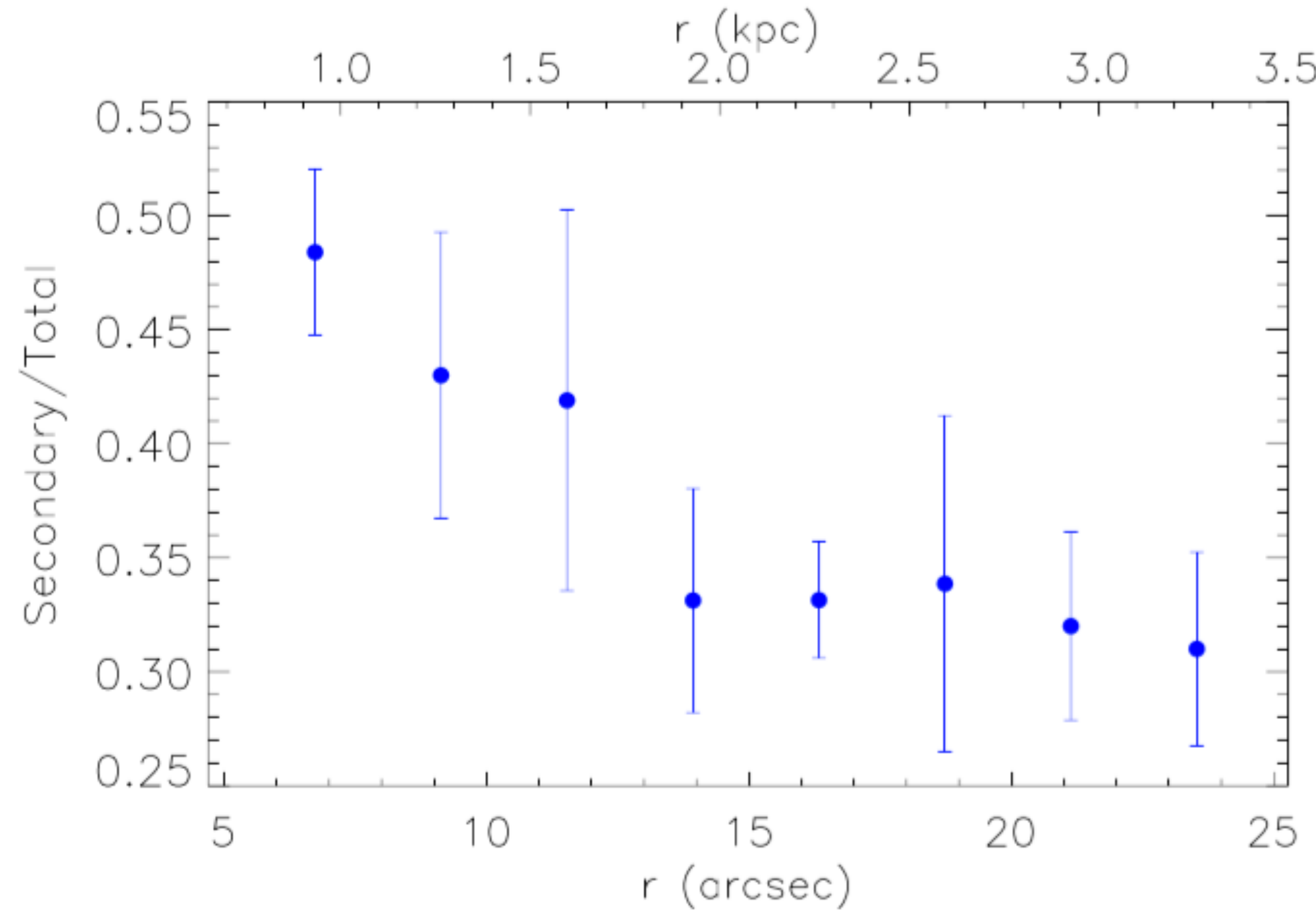


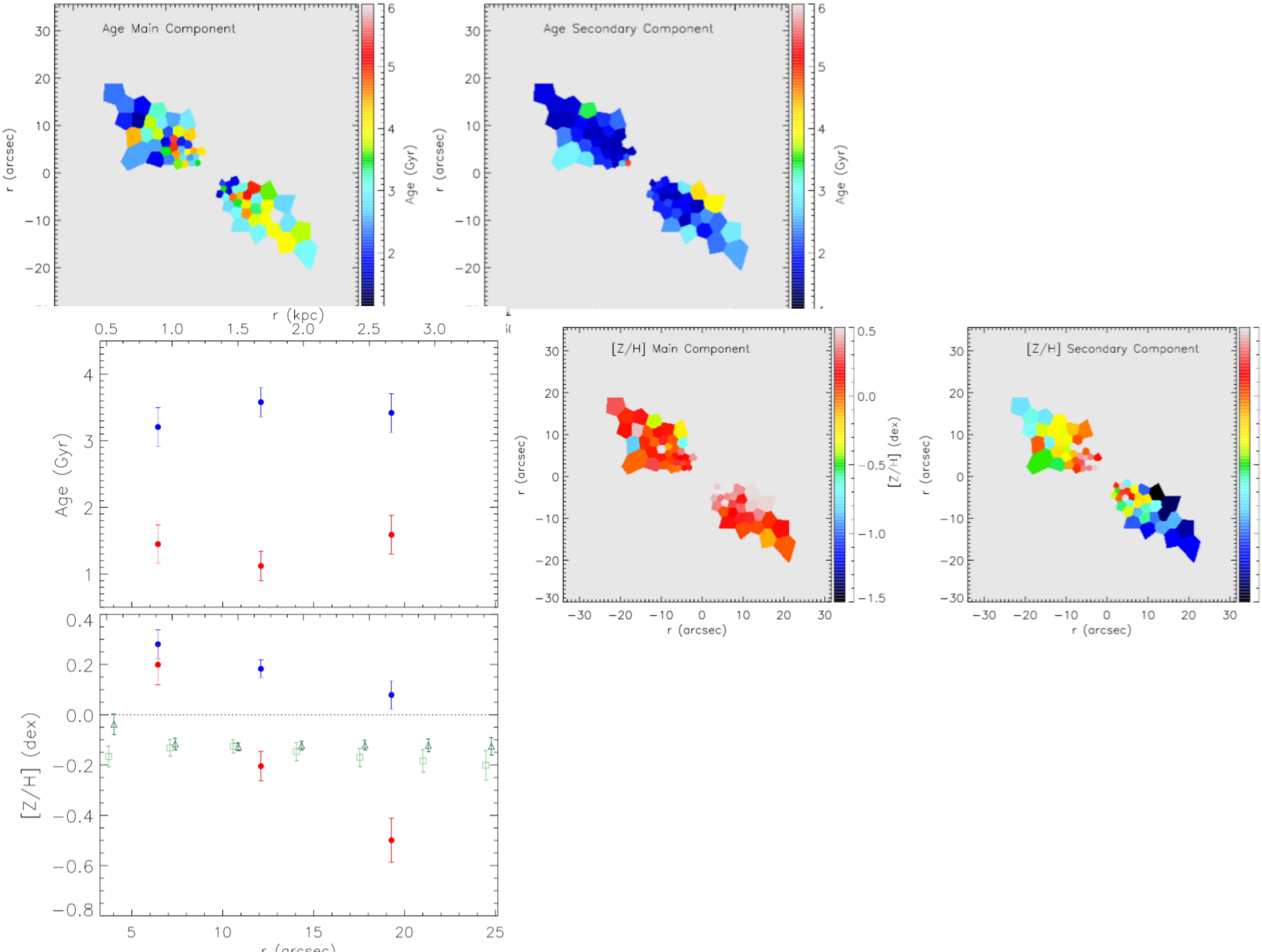
Hβ
Hα
[NII]6583
[SII]6716
r (arcsec)
Flux (10^-17 erg s^-1 cm^-2 ″^-2)



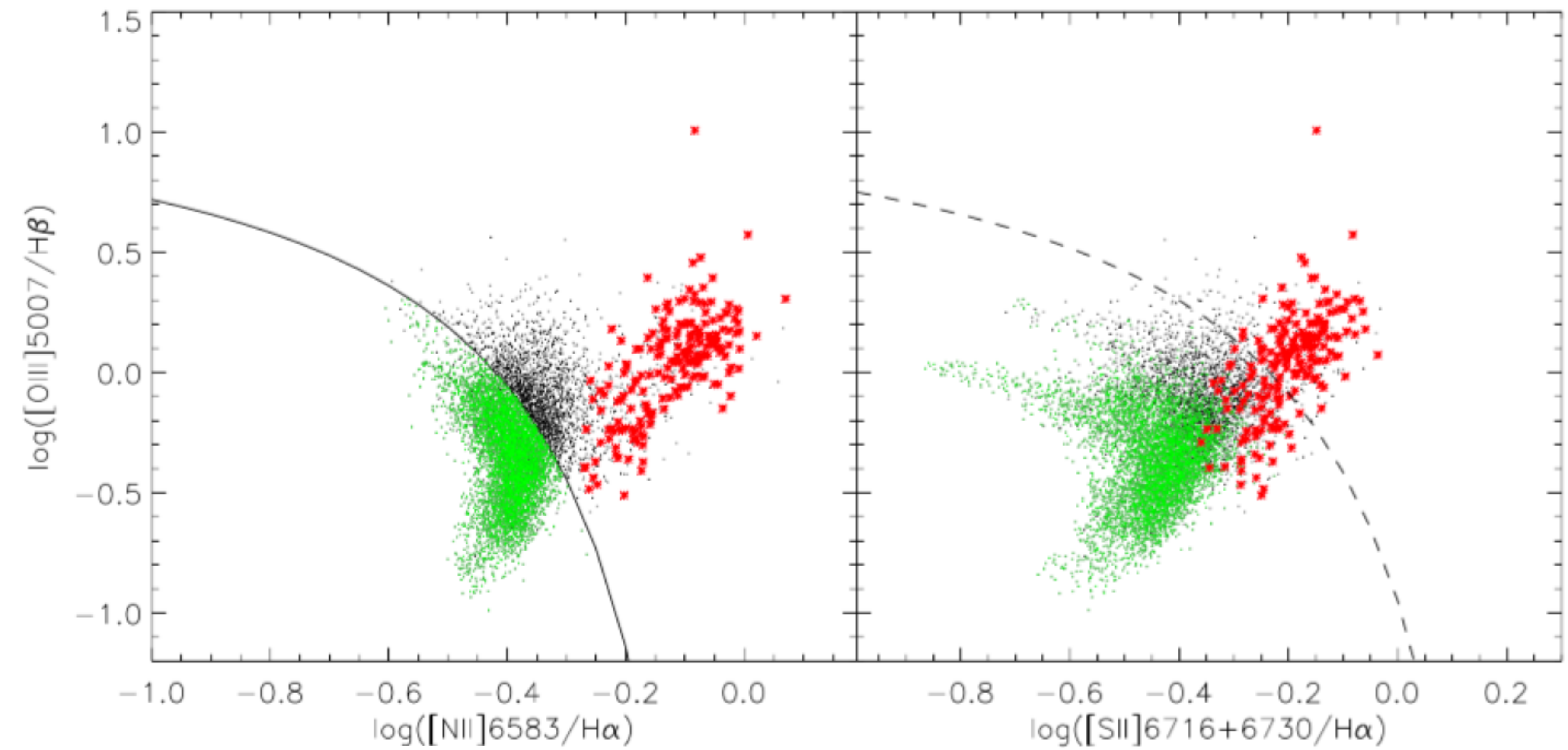
of the *IRAF*[1]. The main component has an exponential profile with scale length of ~ 1.5 kpc; the secondary component follows an exponential profile with a possible truncation beyond 4 kpc. Its scale length is ~ 1 kpc and therefore smaller than the primary disk. We also used the reconstructed images to derive the

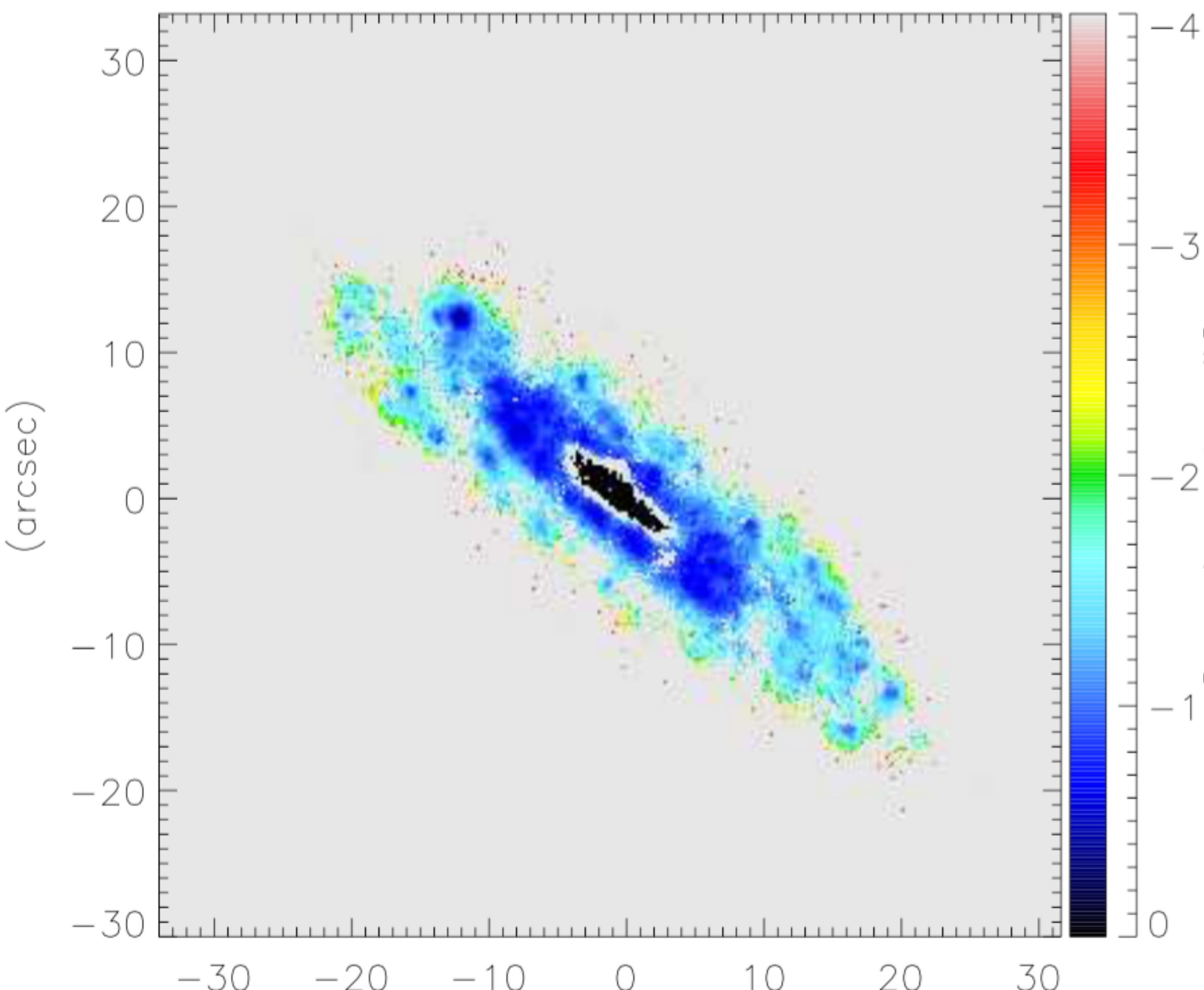


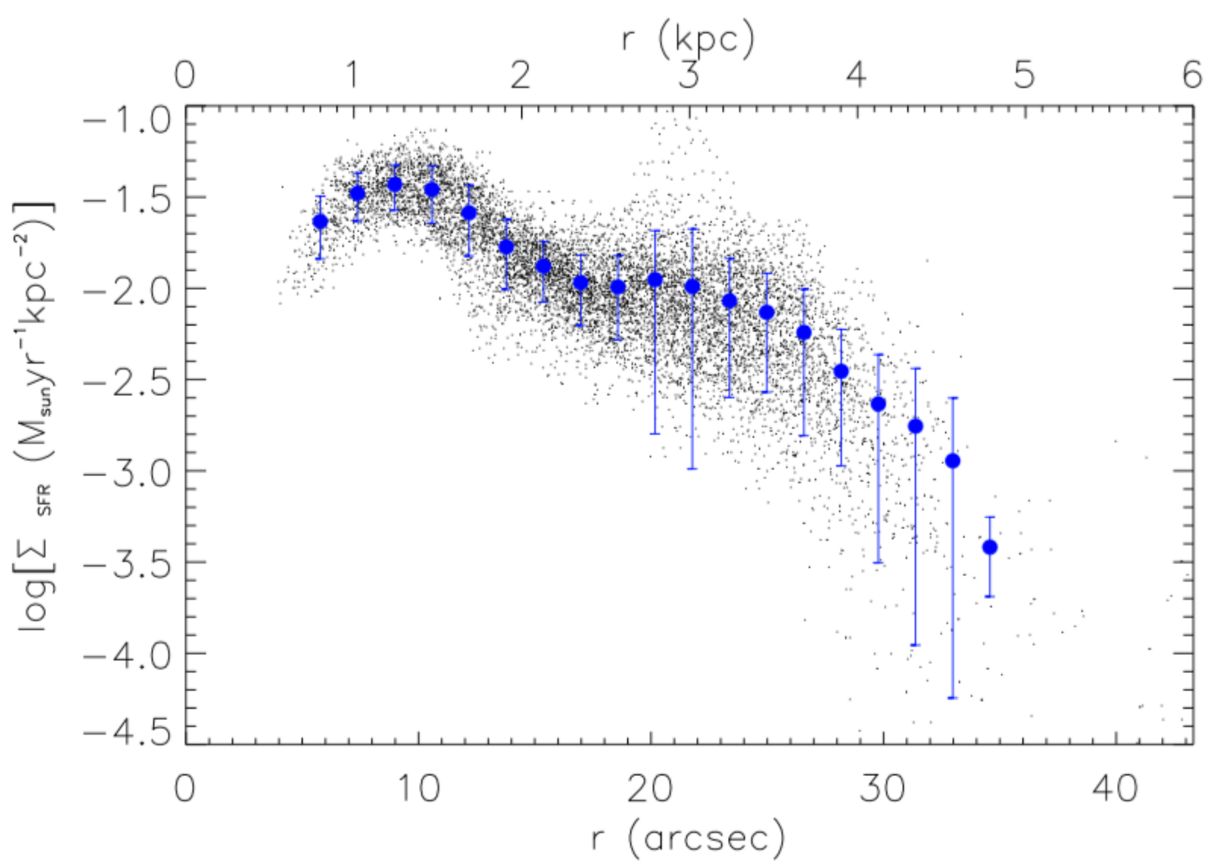


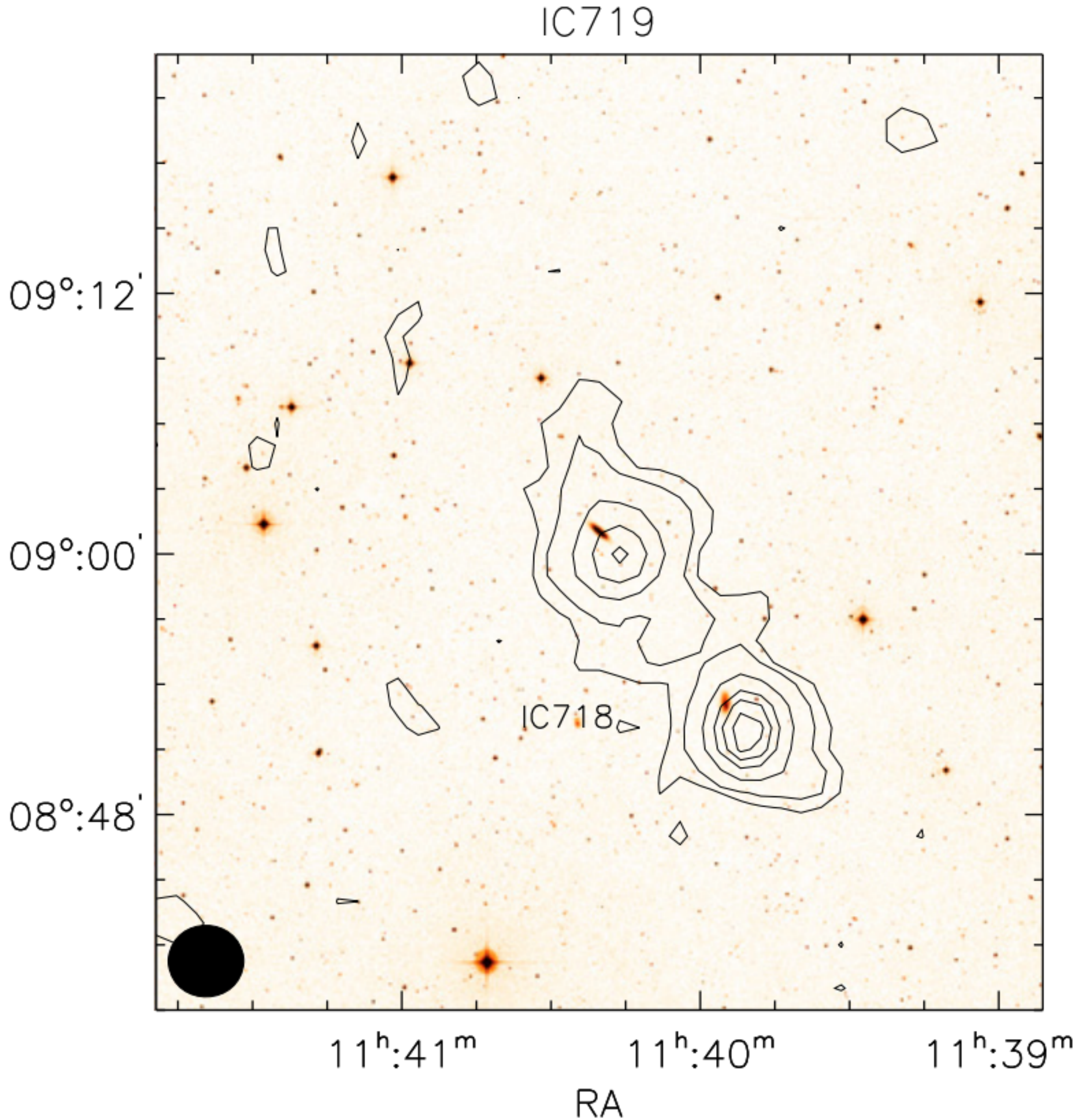


Age Main Component
Age Secondary Component
r (arcsec)
Age (Gyr)
r (kpc)
Age (Gyr)
[Z/H] (dex)
[Z/H] Main Component
[Z/H] Secondary Component
r (arcsec)
[Z/H] (dex)


log([OIII]5007/Hβ)
log([NII]6583/Hα)
log([SII]6716+6730/Hα)
1.5
1.0
0.5
0.0
−0.5
−1.0
−1.0 −0.8 −0.6 −0.4 −0.2 0.0
−0.8 −0.6 −0.4 −0.2 0.0 0.2


(arcsec)
30
20
10
0
−10
−20
−30
−30 −20 −10 0 10 20 30
−4
−3
−2
−1
0


r (kpc)
0 1 2 3 4 5 6
log[Σ SFR (Msun yr−1 kpc−2)]
−1.0
−1.5
−2.0
−2.5
−3.0
−3.5
−4.0
−4.5
0 10 20 30 40
r (arcsec)



ALFALFA HI map
Grossi+09