# The MUSE Ultra Deep Field (MUDF). I. Discovery of a group of L nebulae associated with a bright z =3.23 quasar pair

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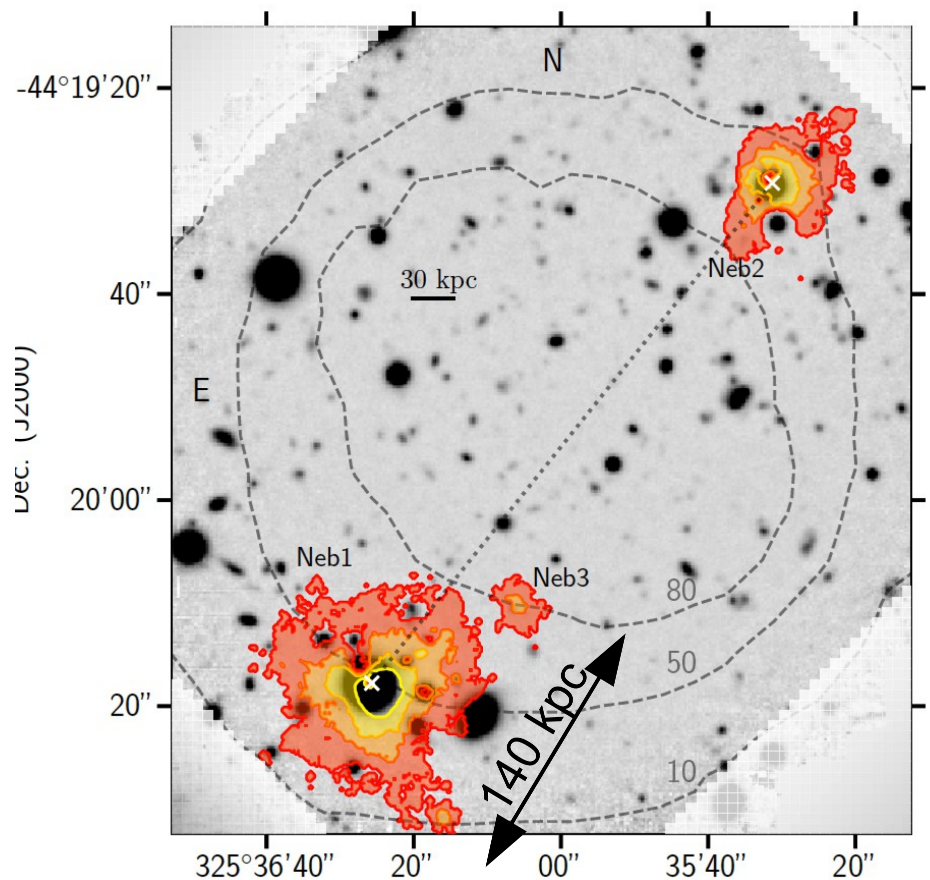
ArXiv:1903.00483

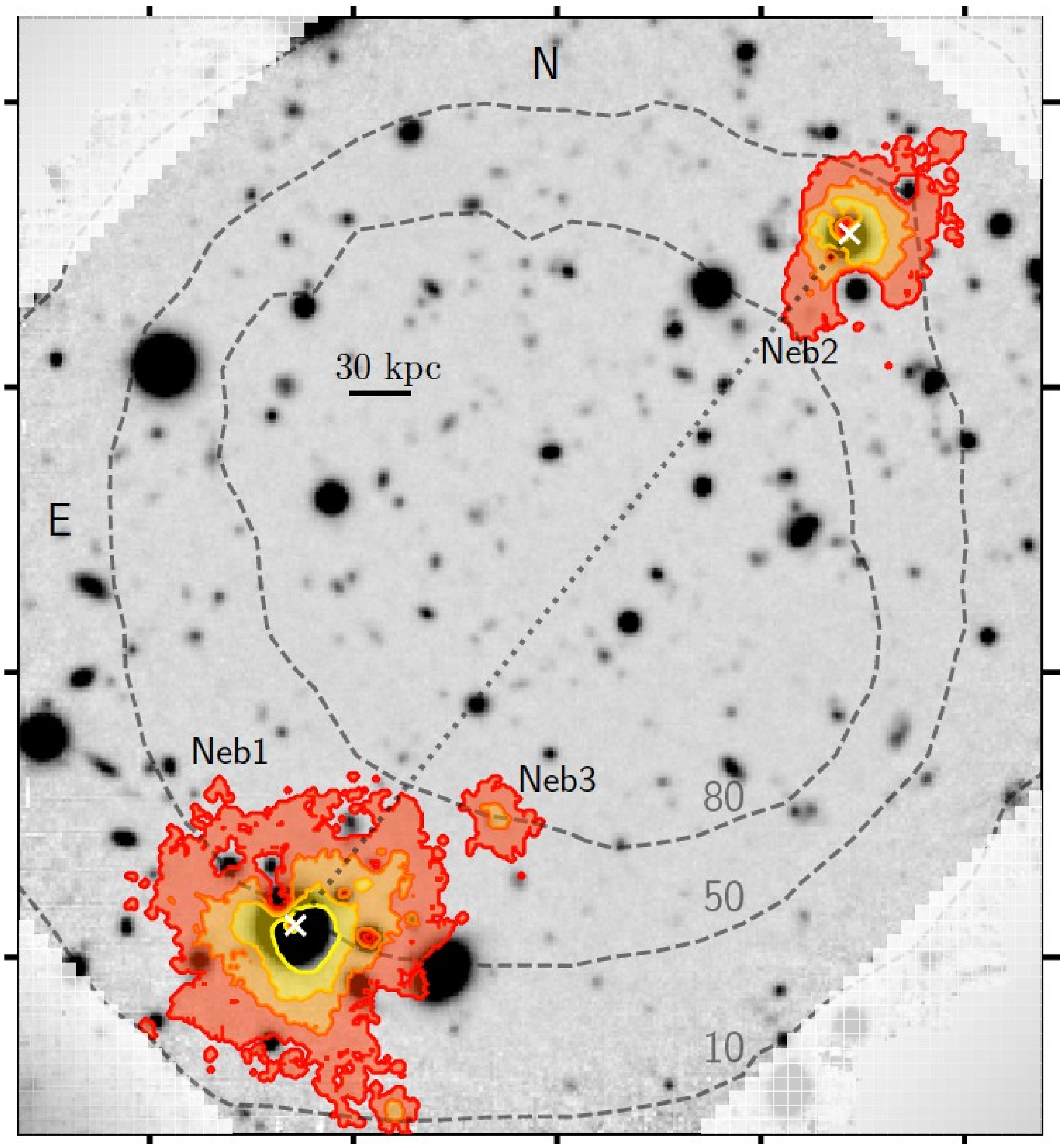
MUDF – 200 h(!) exposures in 1.2x1.4 arcmin
FWHM=0.60+/-0.01" (GALACSI AO)
+90 orbit HST WFC3/G141 slitless NIR

В поле = два квазара на одном z, для них:
Q1: X-SHOOTER Q2: Magellan/FIRE

Q1-Q2: 500 kpc

В данной работе – первые 40 часов
Хитрое сложение, sigma-clipping, разное
число экспозиций по полю (контуры)






tours represent the extended Ly$\alpha$ emission of the three nebulae detected within $\approx 2000$ km s$^{-1}$ of the two quasars, with contours of SB levels at 0.6, 3.2, 10, and $31.6\times10^{-18}$ erg s$^{-1}$ cm$^{-2}$ arcsec$^{-2}$. The "holes" in the nebulae are caused by the subtraction of continuum sources. The dashed lines represent the contours at 10, 50 and 80 exposures/pixel from the combined mean optimally extracted image. The alignment and morphology of these nebulae

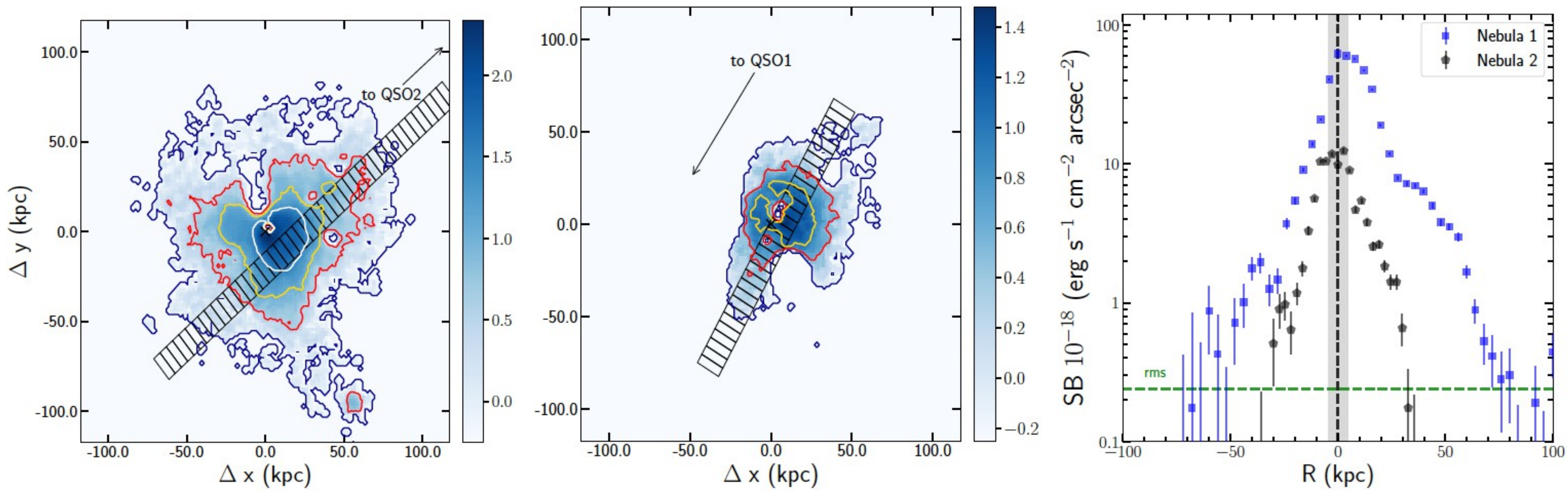
Туманности вытянуты вдоль соединияющей линии:

tribution $\Phi$ as in Arrigoni Battaia & et al. (2019), finding $\alpha \approx 0.80$ and $\Phi \approx -56.8$ deg for Nebula 1 and $\alpha \approx 0.91$ and $\Phi \approx -48.1$ deg for the Nebula 2. Within uncertainties (see

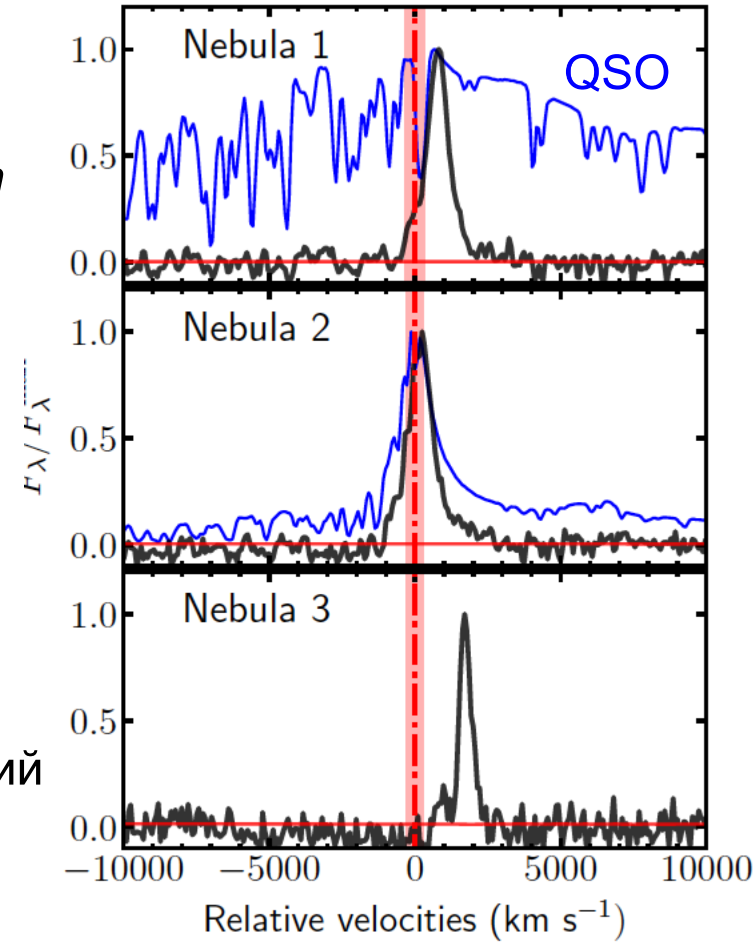
over, the probability of the nebulae to be randomly oriented can be estimated as the ratio between the subtended angle of the nebulae ($\approx 50$ degrees) and $2\pi$, $(50/360)^2$, which is only 2%. The alignment of the nebulae thus likely reflects the presence of an underlying structure not currently detected.

В Neb3 - есть источник, но слабоват(?) m(r)=27.1 mag,
Several obscured AGN coexist?
Need X-ray!

| Object | $z_{\rm neb\,Ly\alpha}$ | $z_{\rm qso}$ | $m_r^a$ | FWHM$^b_{\rm Ly\alpha}$ km s$^{-1}$ | $F_{\rm Ly\alpha}$ $10^{-18}$ erg s$^{-1}$ cm$^{-2}$ | $L_{\rm Ly\alpha}$ $10^{43}$ erg s$^{-1}$ | Size$^c$ kpc |
|---|---|---|---|---|---|---|---|
| Neb1 | 3.230 | 3.221±0.004 | 17.9±0.02 | 1124±23 | 748.9±3.5 | 6.81±0.03 | 140 |
| Neb2 | 3.229 | 3.229±0.003 | 20.5±0.03 | 1153±24 | 276.7±1.8 | 2.52±0.02 | 100 |
| Neb3 | 3.254 | – | 27.1±0.20 | 513±25 | 35.5±0.6 | 0.32±0.01 | 35 |




Neb3: +1550 km/s: → d < 5 Mpc (proper)
*and hence it is likely to be associated with the same large scale structure hosting the quasars and within the region in influenced by the quasars' radiation field*




Нет резкого обрыва яркости →
не вся имеющаяся газовая структура подсвечена квазарами.

Основной посыл работы – подсвечена часть общего филамента.

Кинематика пока не описывается, как и отношение линий (ждут накопления всех экспозиций)

# A treatment procedure for GMOS/IFU data cubes: application to NGC 2835

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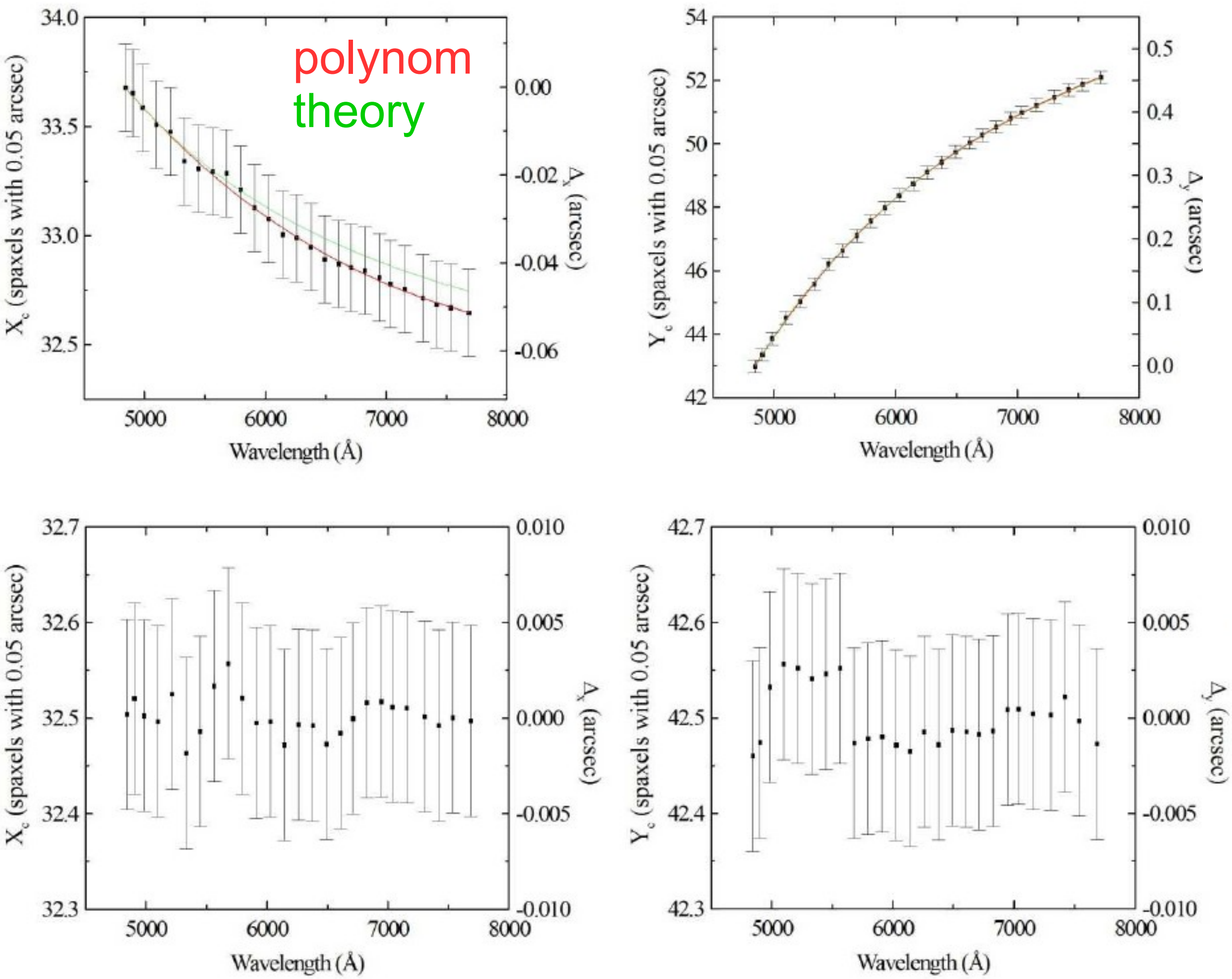
GMOS (FOV 5x7 arcsec, 1000 lenslets, 0.2"):
- differential atmospheric refraction;
- Butterworth spatial filtering, to remove high spatial-frequency noise;
- instrumental fingerprint removal (W-PCS Tomography;
- Richardson-Lucy deconvolution

3- я работа в серии (NIFS, Menezes+2014; SINFONI, Menezes+2015)
IDL codes: http://www.astro.iag.usp.br/~pcatomography/
(ссылку пришлось уточнять,  там пока только томография, хотя обещали всё)

| Target | Programme ID | Name of PI | Observation date | Grating | Exposure time (s) | Number of exposures | Seeing (arcsec) |
|---|---|---|---|---|---|---|---|
| HZ 44 | GN-2012A-Q-12 | H. -Y. Shih | 2012 April 24 | B600+G5307 | 300.0 | 1 | 0.73 |
| LTT 1020 | GS-2012B-Q-52 | R. B. Menezes | 2012 November 28 | B600+G5323 | 900.5 | 1 | 1.16 |
| LTT 1020 | GS-2013B-Q-20 | T. V. Ricci | 2013 September 25 | B600+G5323 | 900.5 | 1 | 0.75 |
| LTT 2415 | GS-2014B-Q-30 | J. E. Steiner | 2014 November 28 | R831+G5322 | 300.0 | 1 | 0.55 |
| LTT 3218 | GS-2014A-Q-5 | J. E. Steiner | 2014 March 14 | R831+G5322 | 300.5 | 1 | 1.37 |
| LTT 7379 | GS-2013A-Q-82 | R. B. Menezes | 2013 July 31 | R831+G5322 | 901.0 | 1 | 2.12 |
| LTT 9239 | GS-2008B-Q-21 | J. E. Steiner | 2008 July 29 | B600+G5323 | 180.5 | 1 | 1.12 |
| NGC 157 | GS-2014B-Q-30 | J. E. Steiner | 2014 December 23 | R831+G5322 | 930.0 | 3 | 0.49 |
| NGC 1313 | GS-2012B-Q-52 | R. B. Menezes | 2012 December 4 | B600+G5323 | 589.5 | 3 | 0.52 |
| NGC 1316 | GS-2013B-Q-20 | T. V. Ricci | 2013 October 7 | B600+G5323 | 1800.5 | 1 | 1.06 |
| NGC 1399 | GS-2008B-Q-21 | J. E. Steiner | 2008 August 4 | B600+G5323 | 1800.5 | 1 | 1.13 |
| NGC 2835 | GS-2015A-Q-3 | J. E. Steiner | 2015 May 12 | R831+G5322 | 865.0 | 3 | 0.40 |
| NGC 5236 | GS-2014A-Q-5 | J. E. Steiner | 2014 February 23 | R831+G5322 | 815.5 | 3 | 0.63 |
| NGC 7424 | GS-2013A-Q-82 | R. B. Menezes | 2013 September 23 | R831+G5322 | 808.5 | 3 | 0.54 |

# Дифференциальная рефракция



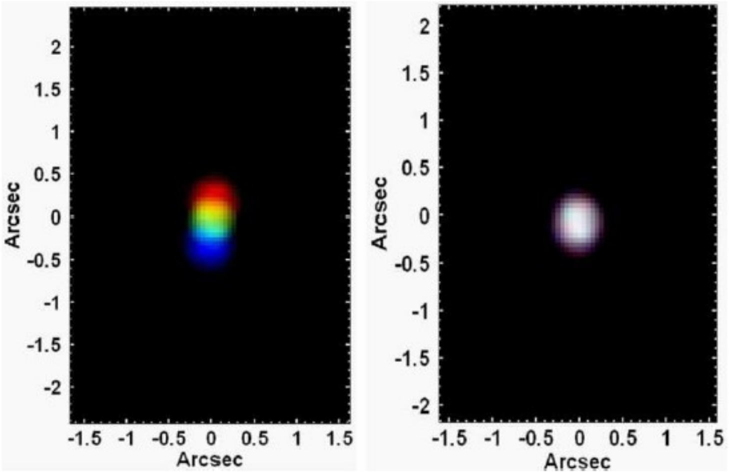




**Figure 3.** RGB composite images of the data cube of the star HZ 44 (left) before and (right) after the correction of the DAR

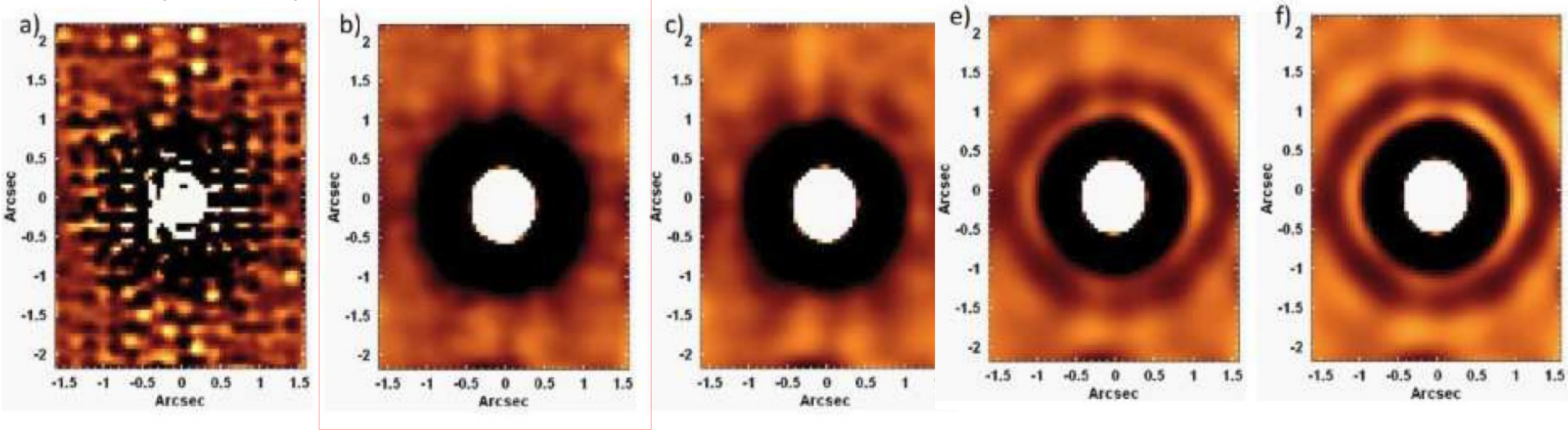
Интересно, что теоретическая кривая (Bonsch & Potulski 1998) хорошо описывает данные

Земля – плоская: *the curvature of the atmosphere are entirely compatible with those obtained with a plane-parallel atmosphere.* :)

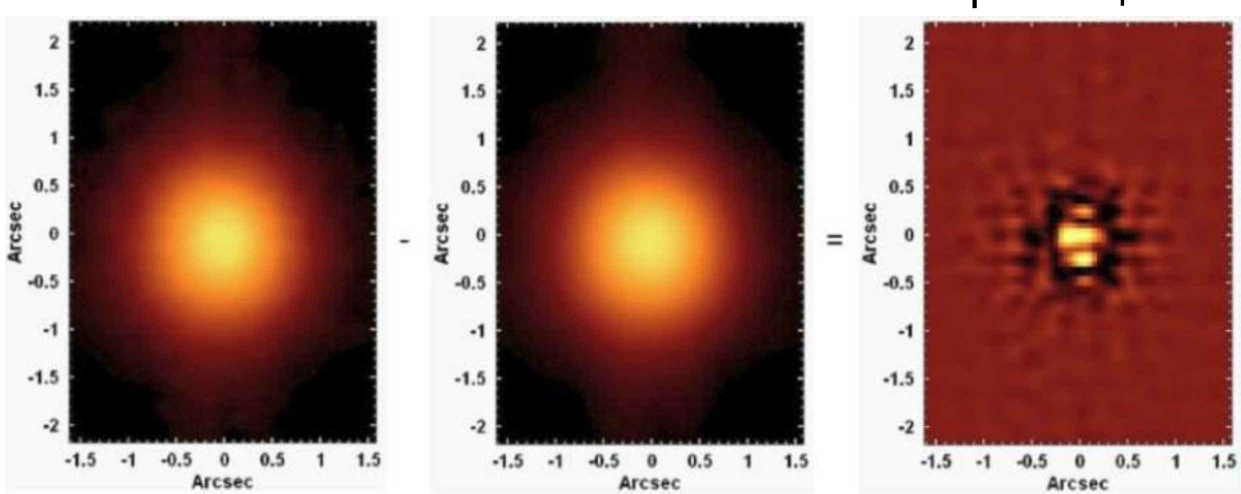
*Семинар VOLGA 11/03/2019, Моисеев*

Высокочастотные помехи – частично, инструментальный эффект (плотная упаковка фиберов?), частично – из-за resampling 0.2'' (hexagonal) → 0.05'' (square)

W0 (wavelet) n=2 n=3 n=5 n=6

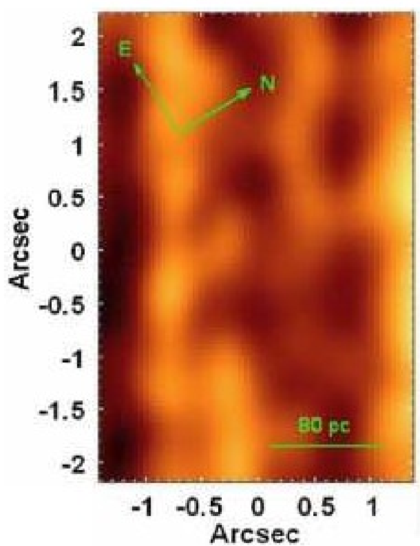


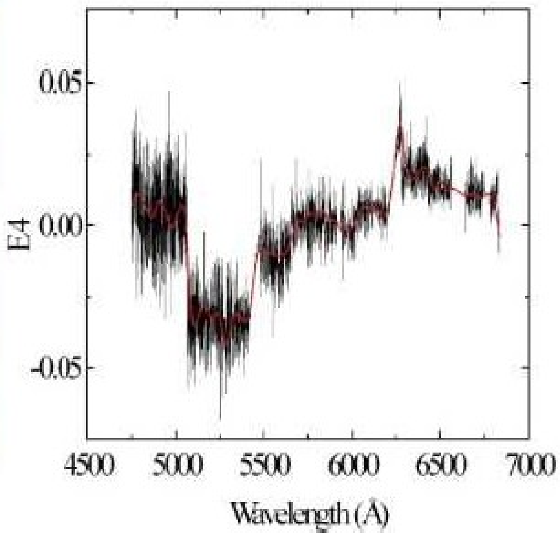

Было стало разница




Не уверен, что поток сохраняется ….

Не до конца ясный инструментальный эффект.
Рассеянный свет + эффект от замены ПЗС!
Вычитают линии (и эмиссии и асборбции!), а в континууме потом выделяют собственный вектор E4, в котором сплайном убирают помехи и строят обратное преобразование




We are conducting the Deep IFS View of Nuclei of Galaxies ($DIVING^{3D}$) survey (PI: J. E. Steiner), whose purpose is to observe, using the GMOS/IFU, the central region of all southern galaxies brighter than B = 12.0. The methodologies described in the previous sections are being used in the treatment of all data cubes obtained for this sur-

было стало разница

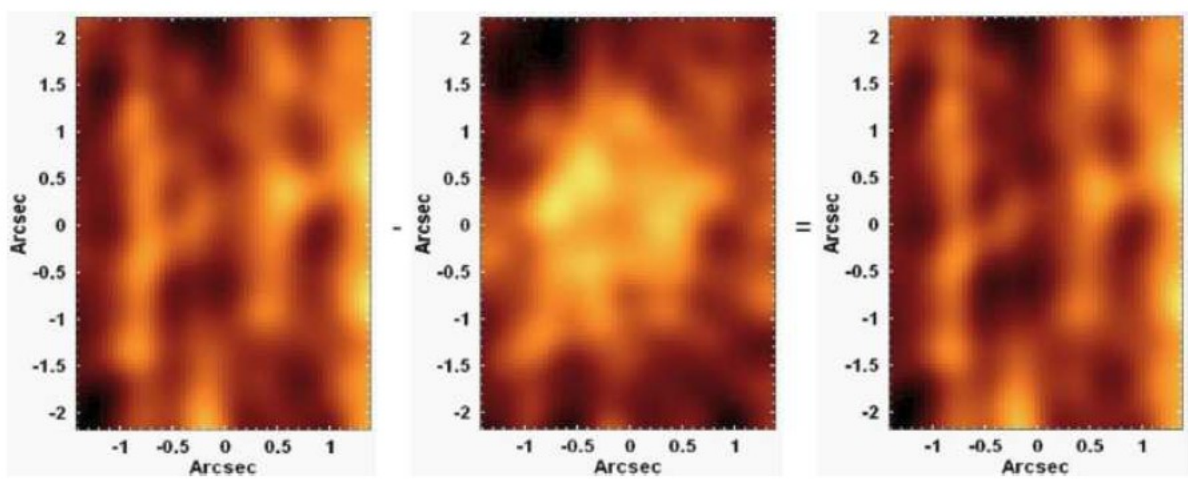
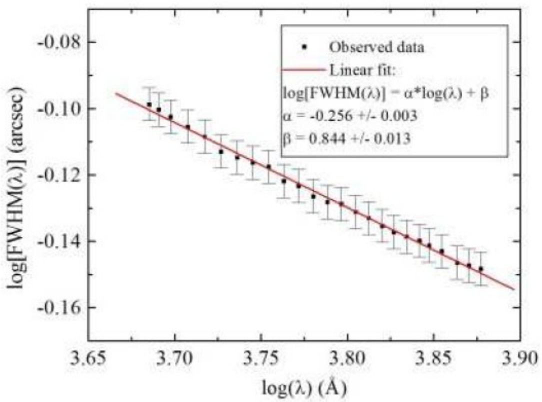


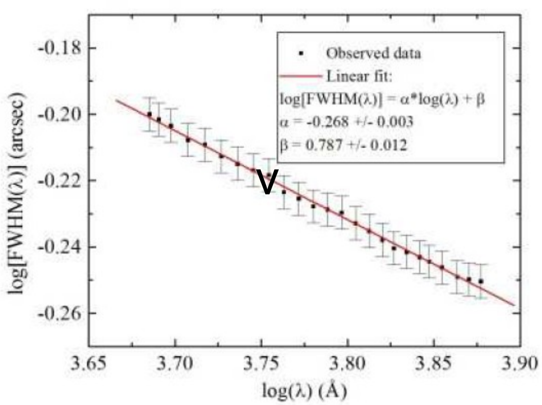

**Figure 13.** Left: image obtained, from the data cube of the central region of the galaxy NGC 157 before the instrumental fingerprint removal, by subtracting the image of the wavelength interval 5304 – 5401 Åfrom the image of the wavelength interval 6383 – 6480 Å.

Улучшение ~70%: 0.74 → 0.5''

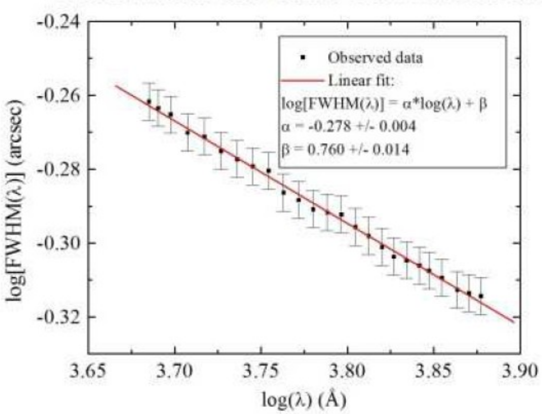
Non-deconvolved



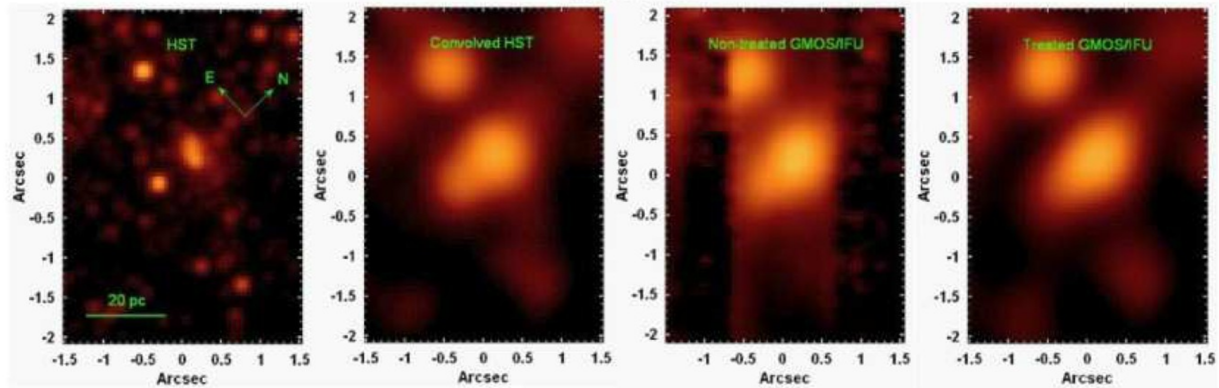

Deconvolved with 6 iterations



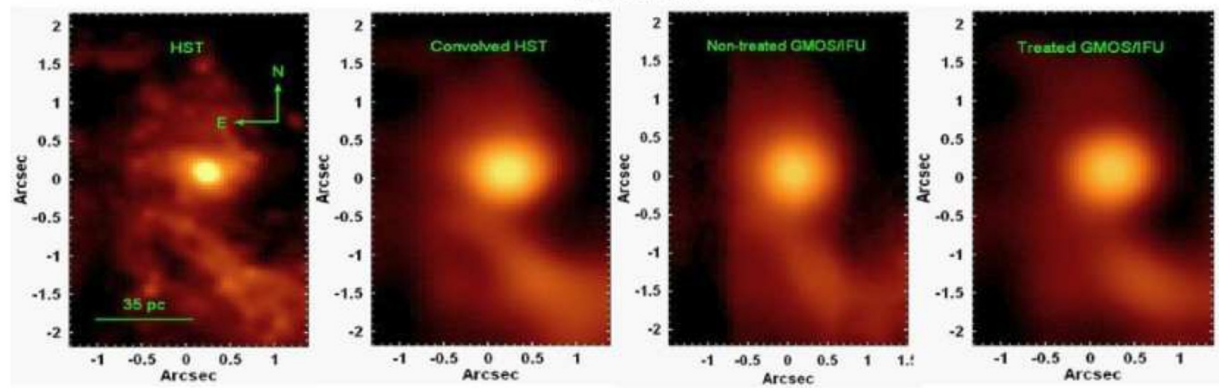

Deconvolved with 10 iterations



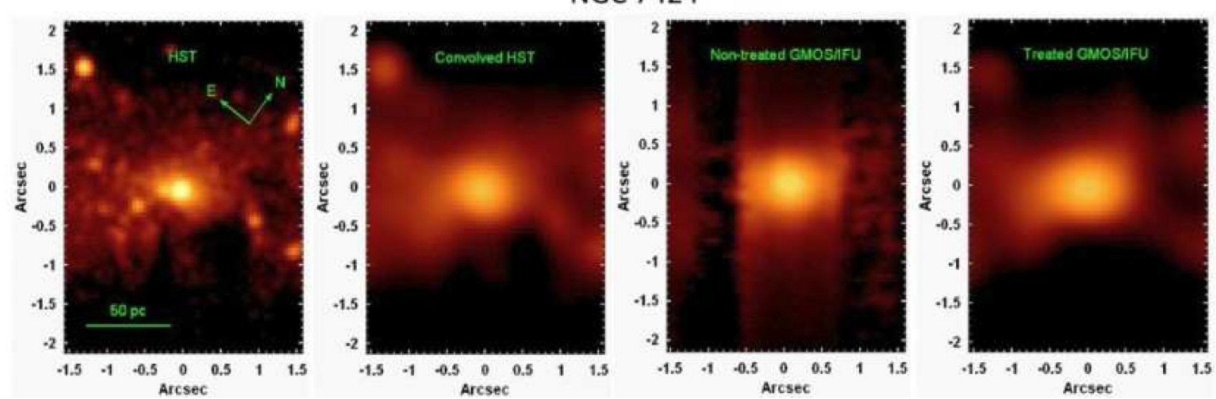

NGC 1313




NGC 5236




NGC 7424



# A SCIENTIFIC EXAMPLE: NGC 2835

[NII]6583:

original treated

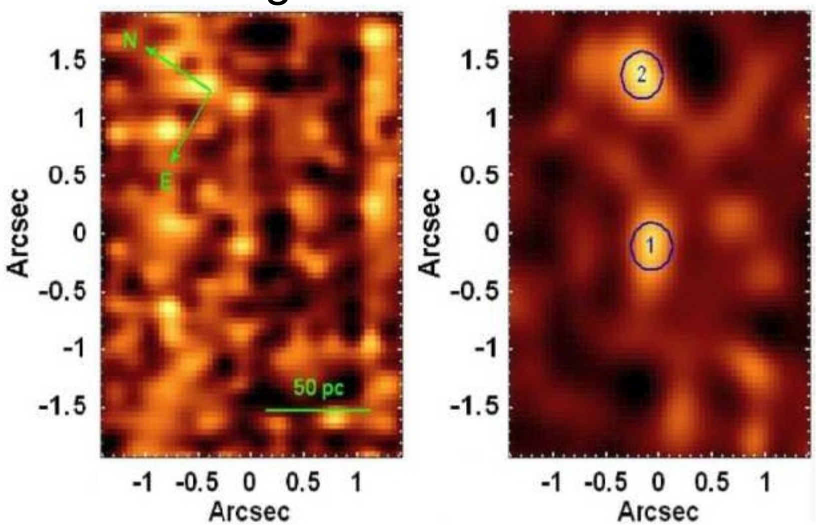
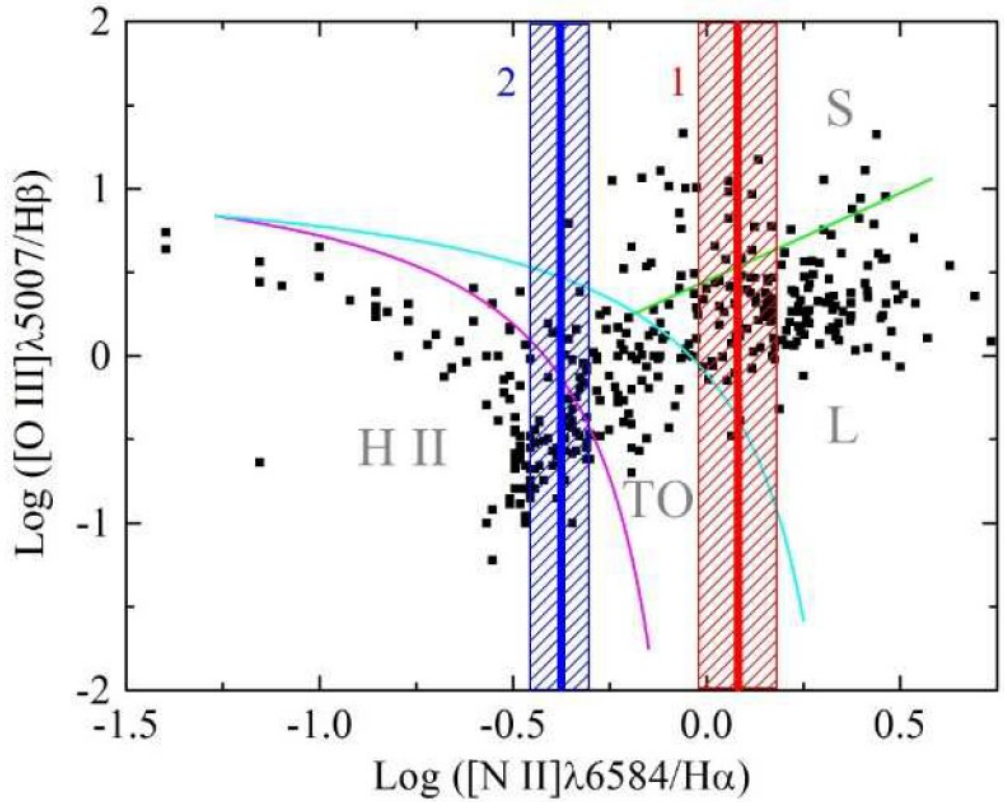
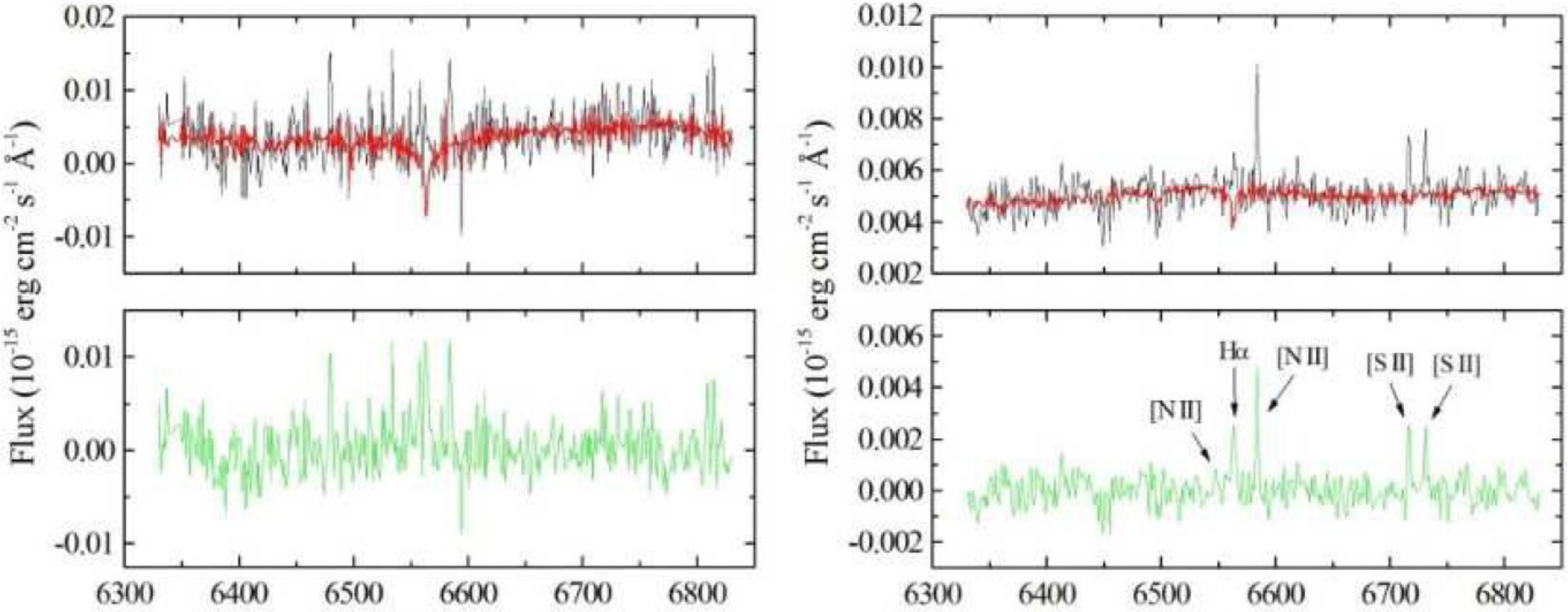



**Figure 20.** Left: images of the wavelength interval 6581 – 6587 Å(corresponding to the [N II] λ6584 emission line), after the subtraction of an image of the underlying stellar continuum, from the non-treated data cube of the central region of NGC 2835. Right: the same image shown on the left, but from the treated data cube of NGC 2835. The non-treated image shows essentially noise. However, the treated image shows two compact line-emitting re-




is much lower. The calculated emission-line ratios for the spectra of Region 2 from the treated and non-treated data cubes are [N II] $\lambda6584/\mathrm{H}\alpha(2)_{treated} = 0.42 \pm 0.07$ and [N II] $\lambda6584/\mathrm{H}\alpha(2)_{non-treated} = 0.40 \pm 0.17$, respectively. The two values are compatible, at a $1\sigma$ level, but, as expected, the reduced noise in the spectrum from the treated data cube resulted in a lower uncertainty for the emission-line ratio.

# Region 1 (nucleus)




# Region 2