Обзор ArXiv/astro-ph, 6-10 июля 2020

От Сильченко О.К.

NGC 474, SDSS

Она же, в системе Arp 227

ArXiv: 2007.01870

NGC 474 as viewed with KCWI: diagnosing a shell galaxy

Adebusola B. Alabi[1,2]★, Anna Ferré-Mateu[3], Duncan A. Forbes[2], Aaron J. Romanowsky[1,4], Jean P. Brodie[1,2]

[1] *University of California Observatories, 1156 High Street, Santa Cruz, CA 95064, USA*
[2] *Centre for Astrophysics & Supercomputing, Swinburne University, Hawthorn VIC 3122, Australia*
[3] *Institut de Ciencies del Cosmos (ICCUB), Universitat de Barcelona (IEEC-UB), E02028 Barcelona, Spain*
[4] *Department of Physics and Astronomy, One Washington Square, San José State University, San Jose, CA 95192, USA*

Accepted today

ABSTRACT

We present new spectra obtained using Keck/KCWI and perform kinematics and stellar population analyses of the shell galaxy NGC 474, from both the galaxy centre and a region from the outer shell. We show that both regions have similarly extended star formation histories although with different stellar population properties. The central region of NGC 474 is dominated by intermediate-aged stars (8.3 ± 0.3 Gyr) with subsolar metallicity ([Z/H]= −0.24 ± 0.07 dex) while the observed shell region, which hosts a substantial population of younger stars, has a mean luminosity-weighted age of 4.0 ± 0.5 Gyr with solar metallicities ([Z/H]=−0.03 ± 0.09 dex). Our results are consistent with a scenario in which

2 OBSERVATIONS AND DATA

We obtained spectroscopic data from the central and shell regions of NGC 474 with the KCWI during the nights of 2017 September 19 and October 18. We used the BM grating centred at λ_c = 4800 Å and the medium image slicer to obtain spectral data with nominal resolution R~4000. This configuration spans the spectral region 4360 – 5230 Å and has a 16.5″ × 20.4″ field-of-view. We therefore obtained data with spectral resolution FWHM = 1.2 Å or $\sigma_{\rm instr}$~32 km s^{-1} at λ_c. We observed the galaxy centre for 600 s and a region of the prominent eastern shell for a total of 4800 s, with both regions shown in Figure 1. Our observed shell region was chosen to have maximum brightness along the shell but free of compact, point sources such as globular clusters or foreground stars. We also observed a dedicated blank field for accurate sky subtraction.

Экспозиция оболочки 80 минут

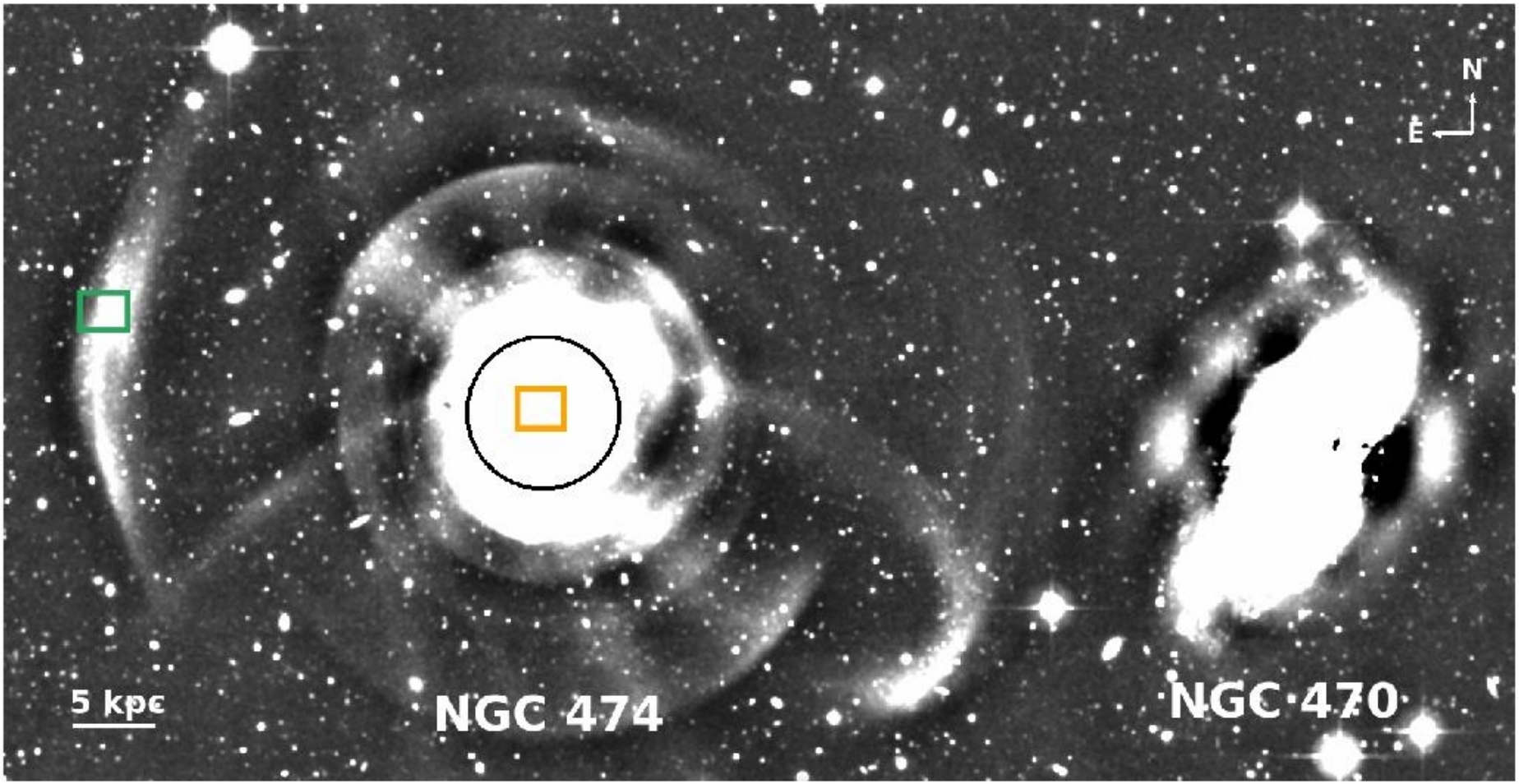
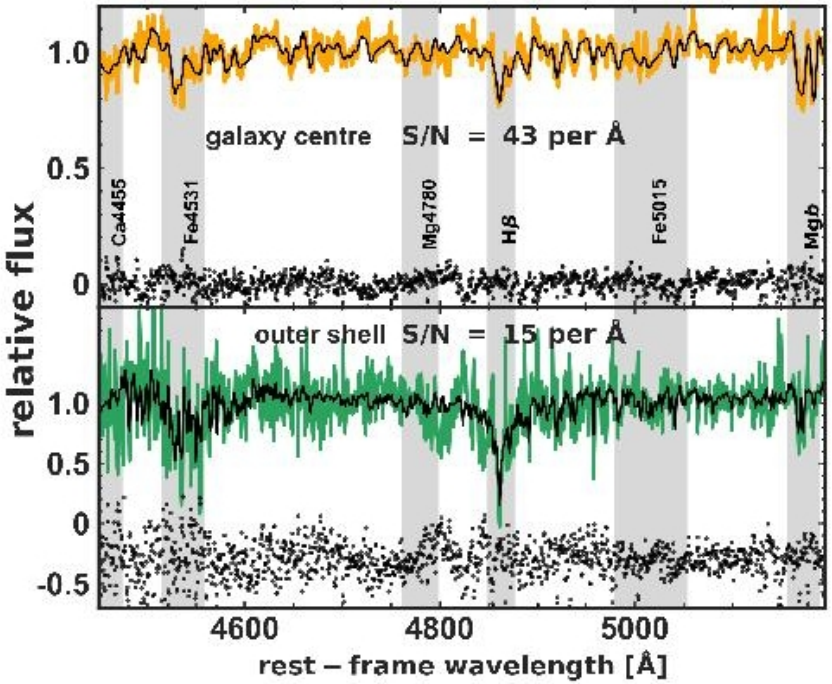


Figure 1. Combined image of NGC 474 from archival CFHT/MegaCam g, r and i images. The image shows the spectacular system of stellar shells and plumes in NGC 474 and covers $11' \times 5.5'$ which corresponds to 94×47 kpc at the distance of NGC 474. The spiral galaxy NGC 470 is at a projected distance of ~47 kpc away from NGC 474. The orange and green rectangles, each equivalent to 2.4×2.9 kpc, show the central and shell regions we have observed with Keck/KCWI, respectively. For reference, the black circle is the 1 effective radius isophote and the white horizontal line has a length of 5 kpc. The observed shell region is at a physical distance of ~30 kpc away from the centre of the galaxy.

Звездные населения – ОТДЕЛЬНЫЙ фит; зато дисп. Скоростей в оболочке 18 км/с



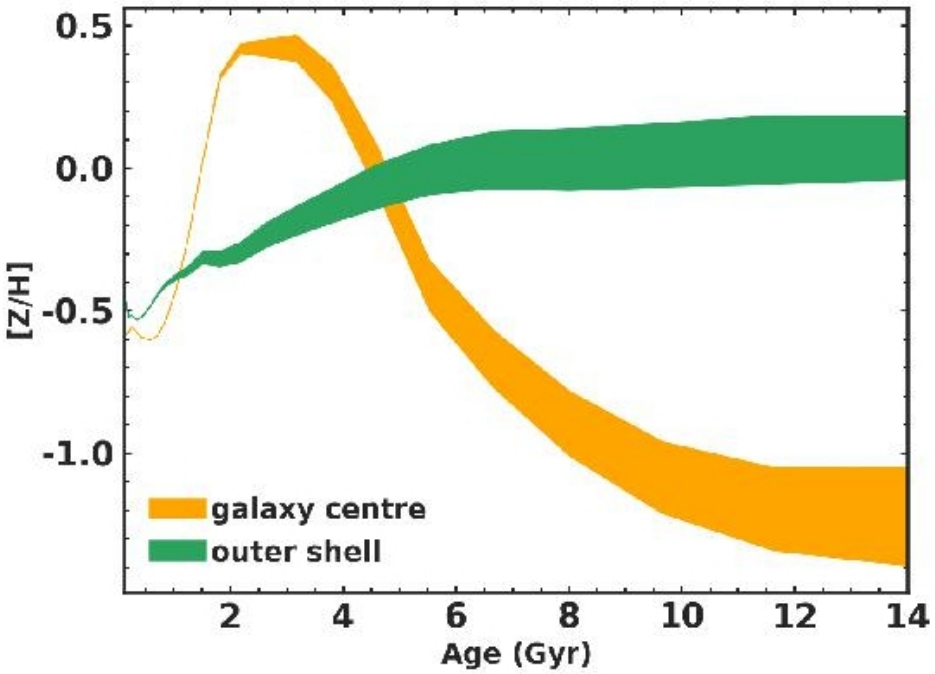


Figure 2. Left: Sky subtracted, median normalized Keck/KCWI spectra from the galaxy central region (*upper panel*) and the outer shell region (*lower panel*) of NGC 474, with best-fit STECKMAP models shown as black spectra in both panels. Residuals from the best-fit are shown in the lower part of each panel (shifted by −0.3 in the lower panel for display purpose only), and the prominent absorption features within the rest-frame spectral range have been identified and labelled. Note the relative strength of the Hβ feature in the *lower panel* compared to the *upper panel*, hinting at the presence of a substantial, younger stellar population in the outer shell region. Right: Age–metallicity relations from the galaxy centre and the outer shell region. The width of each band corresponds to the stellar mass fractions at different ages. The bands highlight the different chemical evolutionary histories of the galaxy centre and the outer shell region.

И, несмотря на низкий сигнал/шум, восстановили историю SF

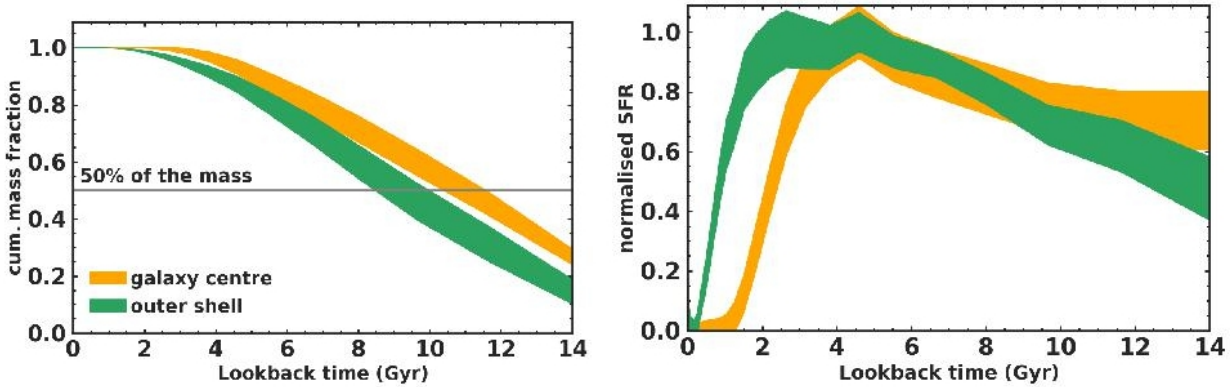
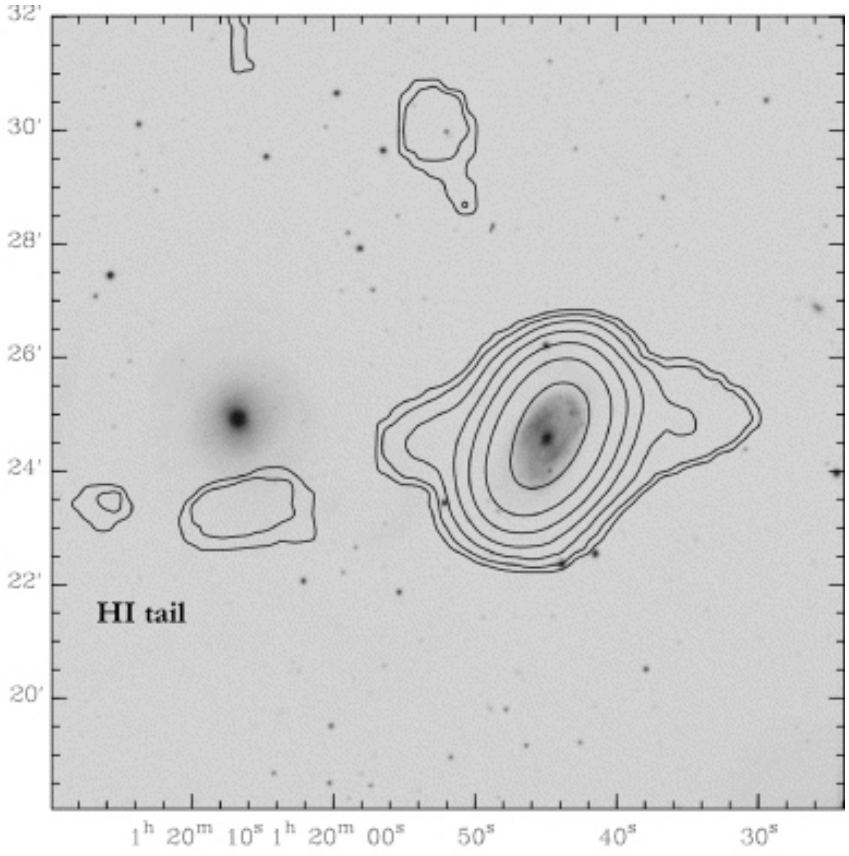


Figure 3. Star formation history from the galaxy centre (orange color) and the outer shell region (green color). Both regions of NGC 474 experienced extended star formation but peak star formation at different epochs. The *left panel* shows cumulative mass fraction as a function of lookback time. The orange and green bands show the standard errors around the mean values obtained from Monte Carlo simulations. The horizontal line shows how long it takes to build up 50 per cent of the total stellar mass. The *right panel* shows the normalised star formation rate. The outer shell region experienced a more recent peak of star formation rate (in the last ~2 Gyr) than the central region of the galaxy.

Parameter	centre	Shell
V_{los} [km s^{-1}]	2324 ± 6	2325 ± 8
σ [km s^{-1}]	134 ± 6	18 ± 9
Age $_{mass}$ [Gyr]	8.3 ± 0.3	7.1 ± 0.5
[Z/H] $_{mass}$ [dex]	−0.24 ± 0.07	−0.03 ± 0.09
Age $_{lum}$ [Gyr]	7.2 ± 0.4	4.0 ± 0.5
[Z/H] $_{lum}$ [dex]	−0.14 ± 0.08	−0.16 ± 0.06

Table 1. Summary of results from kinematics and stellar population analyses from both central and shell regions. Parameters with mass and lum subscripts are mass- and luminosity-weighted, respectively.

Вывод? Радиальное падение спутника в ¼ от хозяина, 4 млрд лет назад



- И это не взаимодействие с NGC 470, характерное время которого 0.3 млрд лет

Rampazzo+(2006): HI

ArXiv: 2007.03318

Revealing the formation mechanism of the shell galaxy NGC474 with MUSE⋆

Jérémy Fensch[1,2], Pierre-Alain Duc[3], Sungsoon Lim[4], Éric Emsellem[2,5], Michal Bílek[3], Patrick Durrell[6], Chengze Liu[7], Éric Peng[8,9], and Rory Smith[10]

[1] Univ. Lyon, ENS de Lyon, Univ. Lyon 1, CNRS, Centre de Recherche Astrophysique de Lyon, UMR5574, F-69007 Lyon, France
email: jeremy.fensch@ens-lyon.fr
[2] European Southern Observatory, Karl-Schwarzschild-Str. 2, D-85748 Garching, Germany
[3] Observatoire Astronomique de Strasbourg (ObAS), Université de Strasbourg - CNRS, UMR 7550 Strasbourg, France
[4] University of Tampa, 401 West Kennedy Boulevard, Tampa, FL 33606, USA
[5] Univ. Lyon, Univ. Lyon1, ENS de Lyon, CNRS, Centre de Recherche Astrophysique de Lyon UMR5574, F-69230, Saint-Genis-Laval, France
[6] Department of Physics & Astronomy, Youngstown State University, Youngstown, OH 44555
[7] Department of Astronomy, School of Physics and Astronomy, and Shanghai Key Laboratory for Particle Physics and Cosmology, Shanghai Jiao Tong University, Shanghai 200240, China
[8] Department of Astronomy, Peking University, Yi He Yuan Lu 5, Hai Dian District, Beijing 100871, People's Republic of China
[9] Kavli Institute for Astronomy & Astrophysics and Department of Astronomy, Peking University, Yi He Yuan Lu 5, Hai Dian District, Beijing 100871, People's Republic of China
[10] Korea Astronomy and Space Science Institute (KASI), 776 Daedeokdae-ro, Yuseong-gu, Daejeon 34055, Korea

MUSE! Экспозиция 5 часов

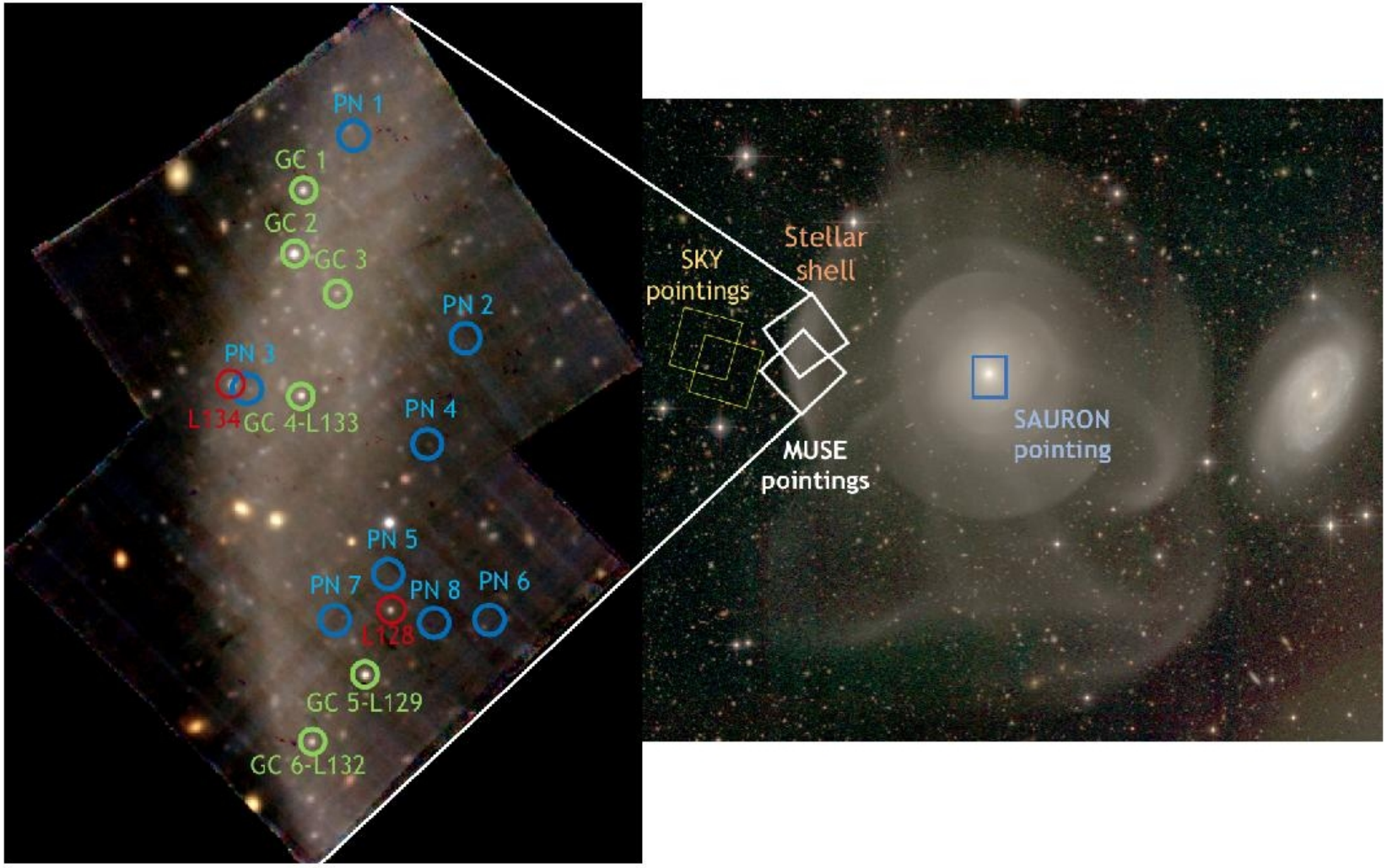
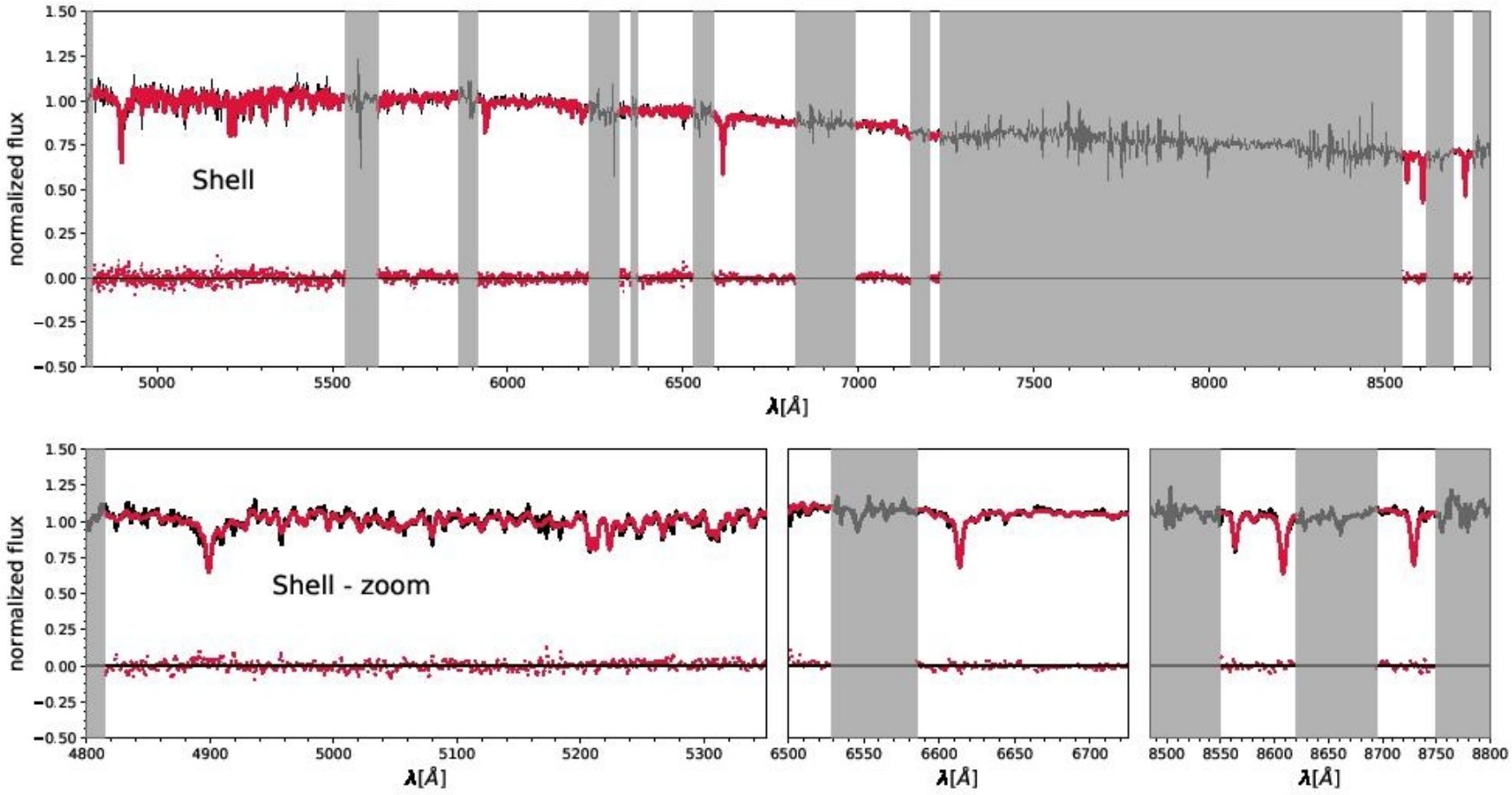


Fig. 1. *Left*: True color image constructed from the MUSE data using as colors the g,r and i filters of Megacam@CFHT. The locations of the detected PNe are shown with blue circles. In green are shown the detected GCs. GC 4, 5 and 6 were part of L17 sample, their number in that

Совсем другая модель звездного населения

- eMILES → оценка отношения магния к железу. Но ниже спектральное разрешение.
- Опять отдельно кинематика и звездное население; РАЗНЫЕ наборы параметров: для кинематики И аддитивный, И мультипликативный полином Лежандра, а для звездных населений – только мультипликативный.
- И только средние параметры, НИКАКОЙ истории звездообразования, хотя отношение сигнал/шум для оболочки 65!

Ну, и другой спектральный диапазон

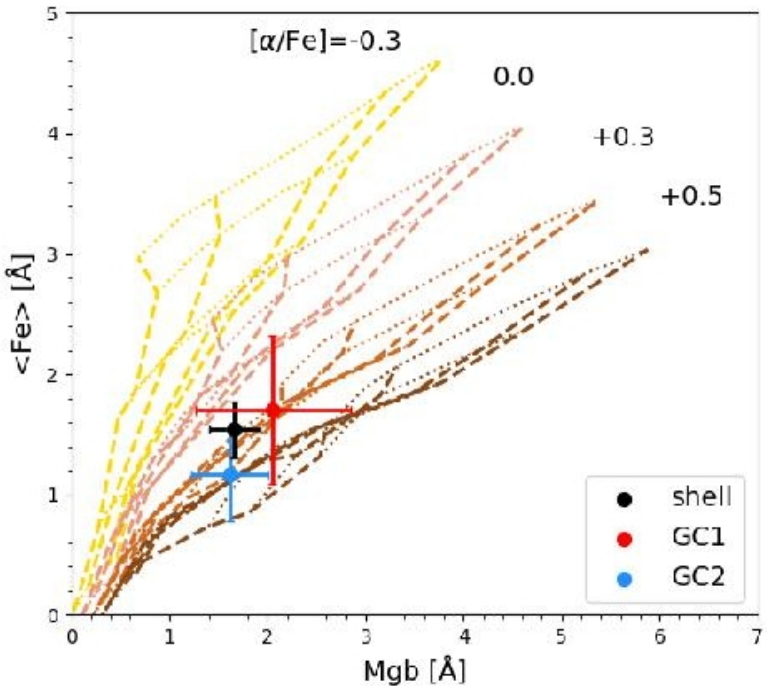


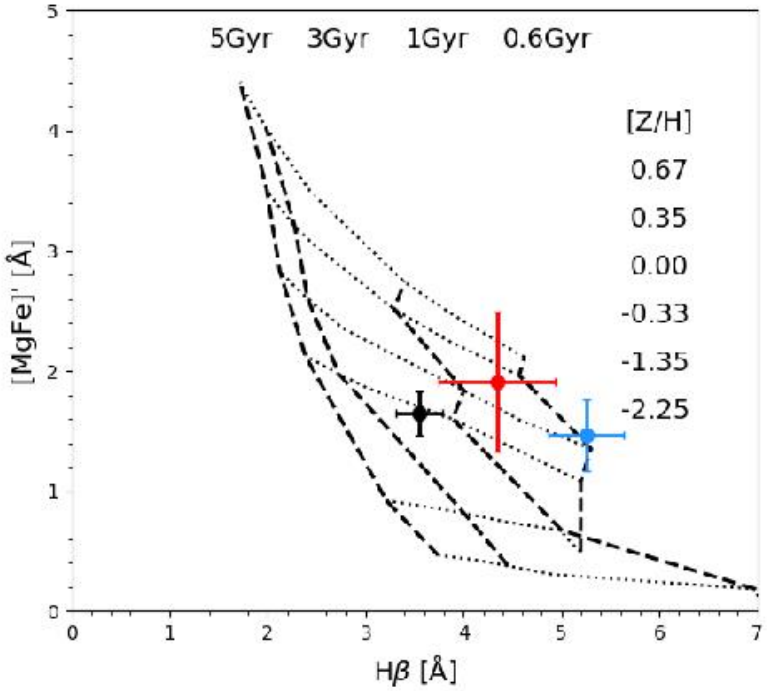
Получился возраст оболочки тот же, а металличность на порядок ниже!

Table 1. Results of the full spectra fitting procedure.. For the GCs, the S/N is measured in the neighborhood of the Hα line and given in units of pix^{-1}. For the PNe, the S/N is integrated over the [OIII]$_{5007}$ line.

Name	RA (J2000) [h:m:s]	DEC (J2000) [h:m:s]	S/N	Velocity [km.s^{-1}]	Age [Gyr]	M/H	GC: Mass [$M_\odot$] PNe: M_{5007} [mag]
Shell	-	-	65.0	2307.6 ± 2.7	$3.55^{+0.61}_{-0.39}$	$-0.83^{+0.12}_{-0.12}$	-
GC1	01:20:19.1987	03:25:49.4674	13.9	2294.7 ± 5.4	$1.41^{+0.4}_{-0.22}$	$-1.07^{+0.17}_{-0.17}$	$2.50 \times 10^4 \pm 5.89 \times 10^3$
GC2	01:20:19.2836	03:25:40.4404	26.9	2298.0 ± 4.8	$0.56^{+0.07}_{-0.06}$	$0.22^{+0.22}_{-0.22}$	$5.91 \times 10^4 \pm 2.24 \times 10^3$
GC3	01:20:18.8817	03:25:34.9047	6.6	2307.6 ± 17.4	-	-	-
GC4	01:20:19.2141	03:25:20.0695	17.5	2304.0 ± 8.7	$12.59^{+2.17}_{-4.84}$	$-1.69^{+0.1}_{-0.18}$	$1.21 \times 10^5 \pm 2.21 \times 10^4$
GC5	01:20:18.6095	03:24:40.3496	19.4	2267.5 ± 28.4	$8.91^{+3.83}_{-2.78}$	$-1.73^{+0.13}_{-0.16}$	$1.35 \times 10^5 \pm 3.51 \times 10^4$
GC6	01:20:19.1119	03:24:30.7437	9.4	2320.0 ± 49.5	-	-	-
PN1	01:20:18.7024	03:25:57.4425	4.1	2287.5 ± 6.6	-	-	-3.87 ± 0.09
PN2	01:20:17.6471	03:25:28.4427	4.1	2275.6 ± 6.5	-	-	-4.10 ± 0.08
PN3	01:20:19.7309	03:25:21.2427	4.8	2317.2 ± 6.3	-	-	-3.42 ± 0.10
PN4	01:20:18.0078	03:25:13.2424	3.7	2294.5 ± 7.8	-	-	-3.32 ± 0.11
PN5	01:20:18.3818	03:24:54.6427	4.2	2302.5 ± 6.8	-	-	-3.99 ± 0.11
PN6	01:20:17.4201	03:24:48.0424	6.9	2286.0 ± 4.6	-	-	-4.46 ± 0.07
PN7	01:20:18.8894	03:24:48.0424	2.8	2350.7 ± 8.3	-	-	-3.98 ± 0.12
PN8	01:20:17.9410	03:24:47.6425	6.8	2316.8 ± 4.0	-	-	-4.51 ± 0.08

Не побрезговали и Ликскими индексами





[Mg/Fe]=+0.3!

Возраст стоит, а металличность поползла...

Ну, и на закуску…

SAURON-sum

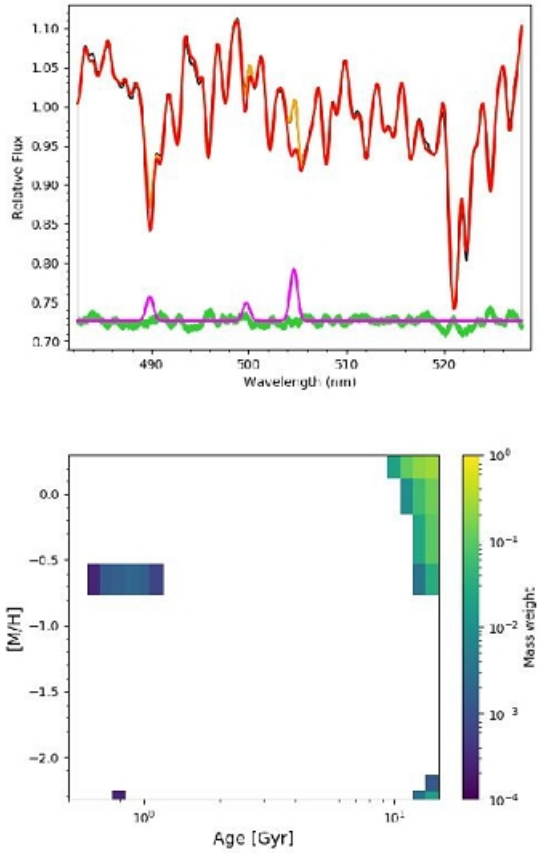


Fig. 8. Upper panel: Best fit for the SAURON data of NGC 474 (central kpc), from the pPXF procedure. The data is in black, the fit in red for the star component and yellow for the gas component. The green points show the residuals and the pink line highlight the ionized gas component fit: from left to right Hβ and the [OIII] doublet. Lower panel: weights of the different templates used by the regularized fit. Regions in white were not used during the fit. See text for details.

- Чтобы сделать аккрецию 1.5 млрд лет назад (потому что оболочки короткоживущие), нашли молодую вспышку звездообразования в ЦЕНТРЕ NGC 474.
- Но остаются вопросы к массе упавшего спутника…