Обзор ArXiv/astro-ph, 7-11 сентября 2020

От Сильченко О.К.

ArXiv:2009.01852

Kinematic signatures of nuclear discs and bar-driven secular evolution in nearby galaxies of the MUSE TIMER project

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Проект TIMER на MUSE/VLT

The TIMER sample was drawn from the Spitzer Survey of Stellar Structure in Galaxies (S^4G, Sheth et al. 2010), which includes only galaxies at distances below 40 Mpc, brighter than 15.5 B-mag, and larger than $1'$. The TIMER galaxies are all barred, with stellar masses above $10^{10}\,M_{\odot}$, inclinations below $\approx 60°$, and nuclear stellar structures. The presence of the bar and nuclear structures was assessed from the morphological classifications of Buta et al. (2015), who used the S^4G images for their work. The TIMER sample is thus biased towards conspicuous bars and nuclear structures, and it is important to keep this in mind when considering the results discussed in this paper.

Most of the observations were performed during ESO Period 97 (April to September 2016) with a typical seeing of $0.8 - 0.9''$, mean spectral resolution of 2.65 Å (FWHM), and spectral coverage from 4750 Å to 9350 Å. MUSE covers an almost square $1' \times 1'$ field of view with a contiguous sampling of $0.2'' \times 0.2''$, which corresponds to a massive dataset of about 90 000 spectra per pointing. The spectral sampling is 1.25 Å per pixel. The total integration time on source for each galaxy was typically 3 840 s.

Выборка TIMER

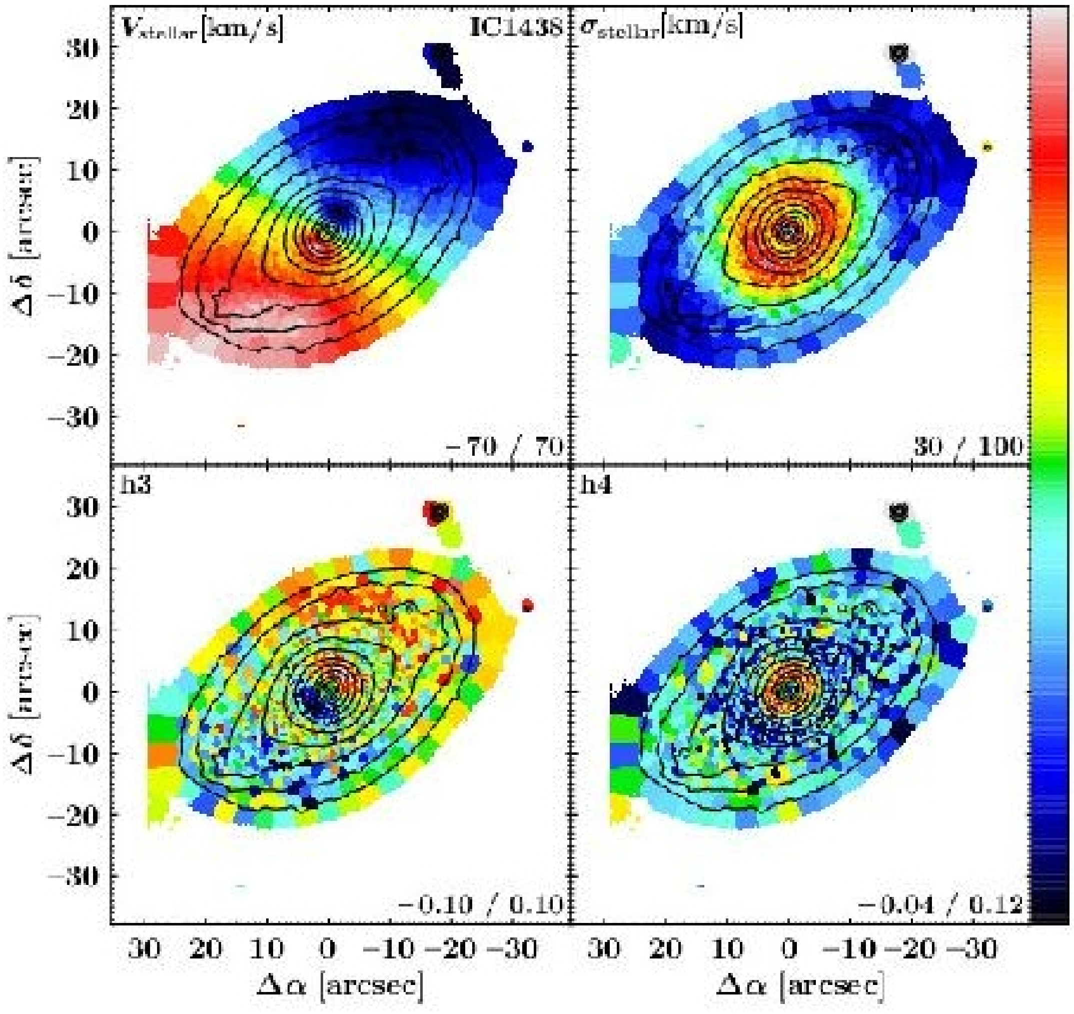
Table 1. Systemic velocities and central velocity dispersions. Column (1) gives the galaxy designation and column (2) shows their effective radii r_e as derived in Muñoz-Mateos et al. (2015). Columns (3) and (4) show, respectively, the tabulated values of systemic radial velocity and the corresponding errors as presented in the Lyon Extragalactic Data Archive (LEDA; `http://leda.univ-lyon1.fr/`), whereas our own measurements are presented in columns (5) and (6). In column (7) we show our measurements of the central velocity dispersions as measured within an aperture of $r_e/8$, with the corresponding errors shown in column (8). Column (9) shows again our measurements of the central velocity dispersions but now adapted to follow the same aperture corrections as in LEDA. Finally, columns (10) and (11) show the LEDA values of central velocity dispersions and their errors, respectively. See text for further details.

Galaxy	r_e	v_{LEDA}	err(v_{LEDA})	v	err(v)	$\sigma_{r_e/8}$	err(σ)	σ_{corr}	σ_{LEDA}	err(σ_{LEDA})
	$''$	km s^{-1}	km s^{-1}	km s^{-1}	km s^{-1}	km s^{-1}	km s^{-1}	km s^{-1}	km s^{-1}	km s^{-1}
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
IC 1438	11.5	2616	5	2618	2	101	2	99		
NGC 613	51.6	1484	3	1506	2	125	3	128	122	18
NGC 1097	58.8	1269	7	1274	2	196	3	198		
NGC 1291	60.7	837	8	858	6	168	7	166	165	10
NGC 1300	71.9	1578	2	1579	5	100	8	102	218	29
NGC 1365	67.2	1638	4	1633	7	157	10	160	141	19
NGC 1433	67.5	1076	2	1086	4	95	13	94		
NGC 3351	64.5	778	1	791	4	98	8	98	116	10
NGC 4303	56.0	1567	2	1577	3	79	8	79	95	8
NGC 4371	33.5	913	4	972	8	132	12	131	129	2
NGC 4643	24.2	1328	2	1341	2	133	3	131	147	3
NGC 4981	29.9	1678	2	1688	2	95	3	95		
NGC 4984	18.1	1215	10	1271	2	113	3	109		
NGC 5236	145.9	508	2	527	2	75	6	75		
NGC 5248	45.7	1152	2	1168	4	91	7	90	99	9
NGC 5728	28.8	2788	4	2773	5	160	7	161	197	14
NGC 5850	49.4	2546	3	2558	2	123	3	128	140	4
NGC 6902	24.0	2793	4	2799	2	119	2	120		
NGC 7140	38.1	2978	4	2982	2	98	3	100		
NGC 7552	12.2	1609	5	1612	3	84	6	81	98	19
NGC 7755	32.2	2960	3	2952	2	114	3	116		

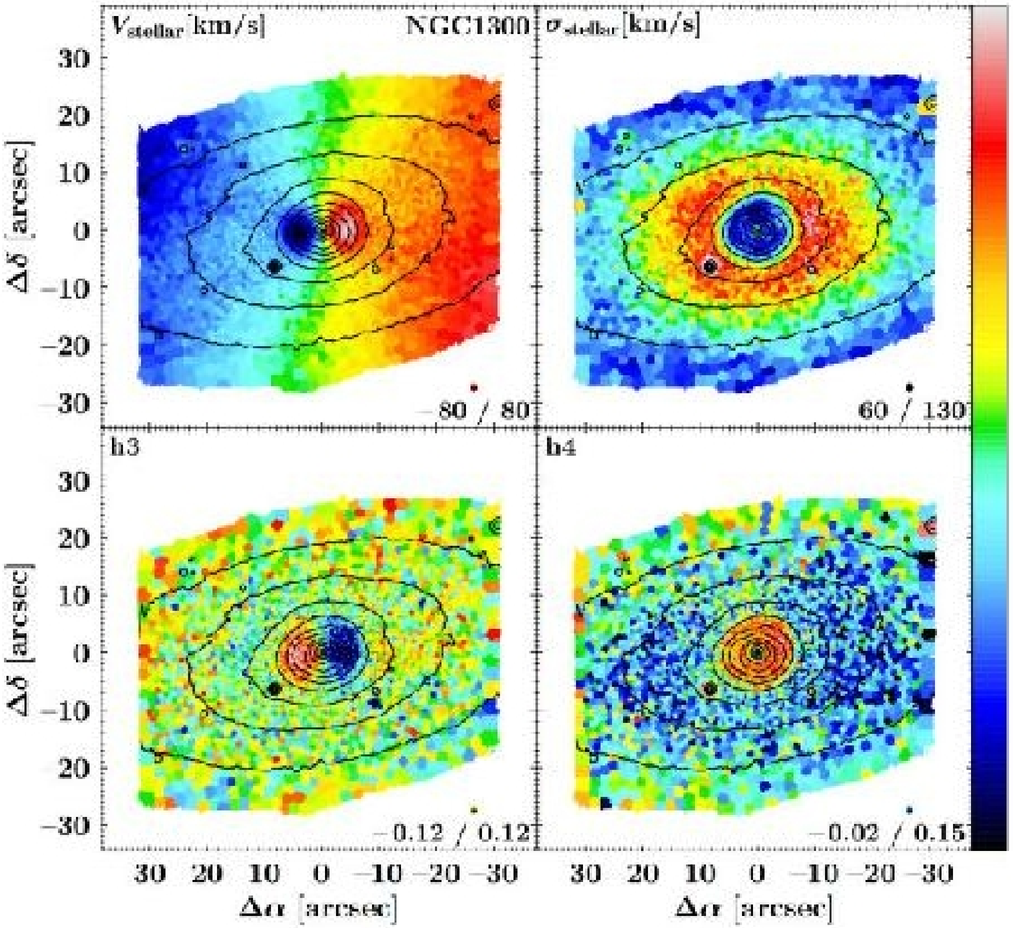
Что ищем по звездной кинематике?

- Ядерные диски: быстрое вращение, малая дисперсия скоростей, спин – как у большого диска, антикорреляция v и h3. Нашли: в 18 из 21.
- А в барах v и h3 должны коррелировать.
- Когда наложение нескольких структур – большой h4.
- Peanut/boxy балджи: минимум h4 (13).
- Они же, когда видны не с ребра, - бар-линзы (5).

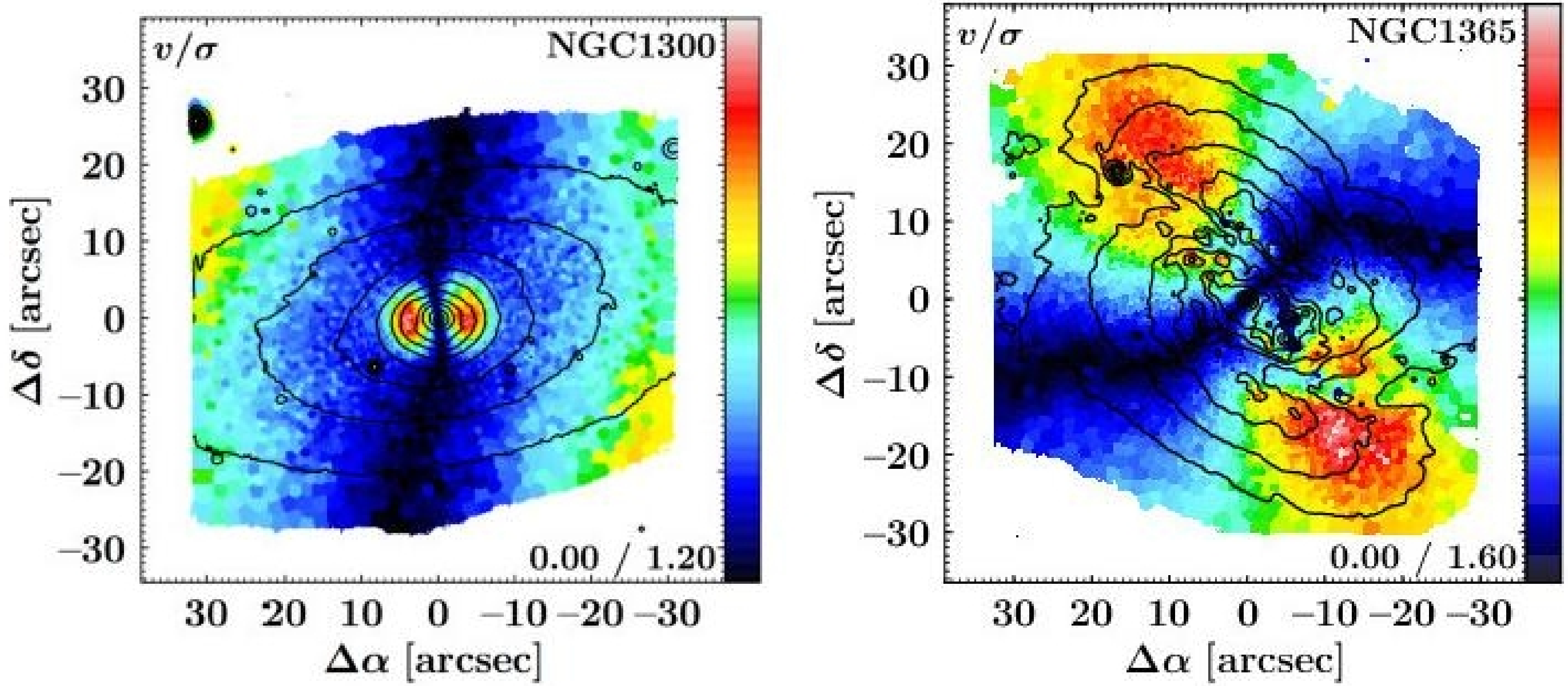
Что увидели? IC1438



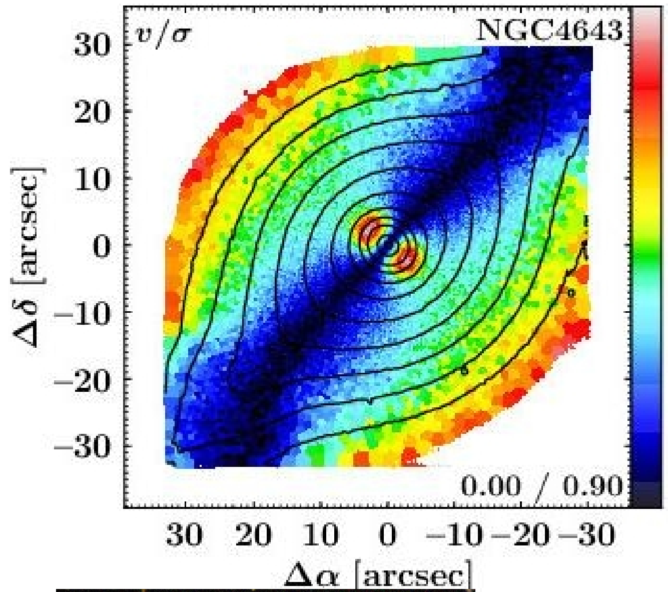
На мой взгляд, NGC 1300 лучше

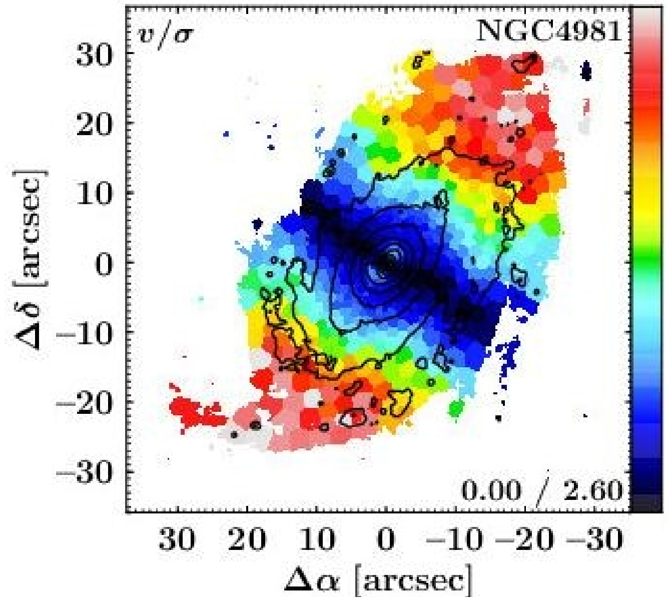


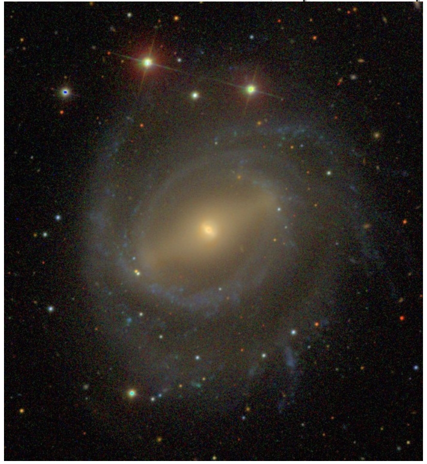
Как мерять радиус ядерного диска?

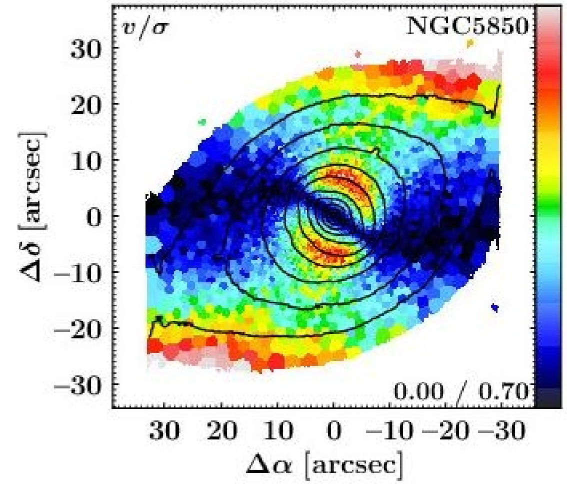


Но, вообще говоря, картина довольно пестрая…

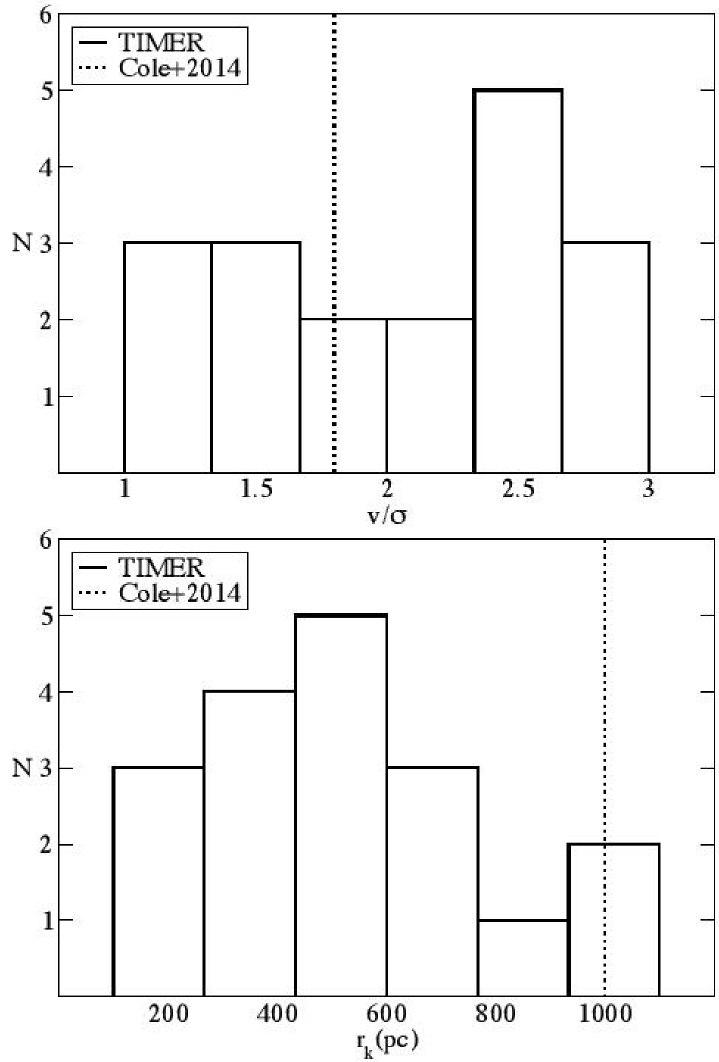








Характеристики ядерных дисков



Ну как бы и правда – динамически холодные (хотя изофоты - не обязательно их)

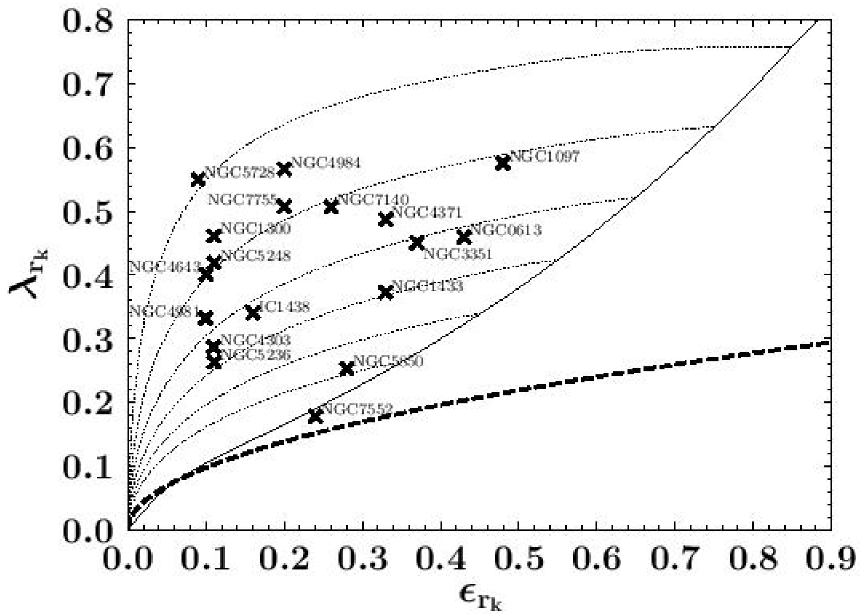
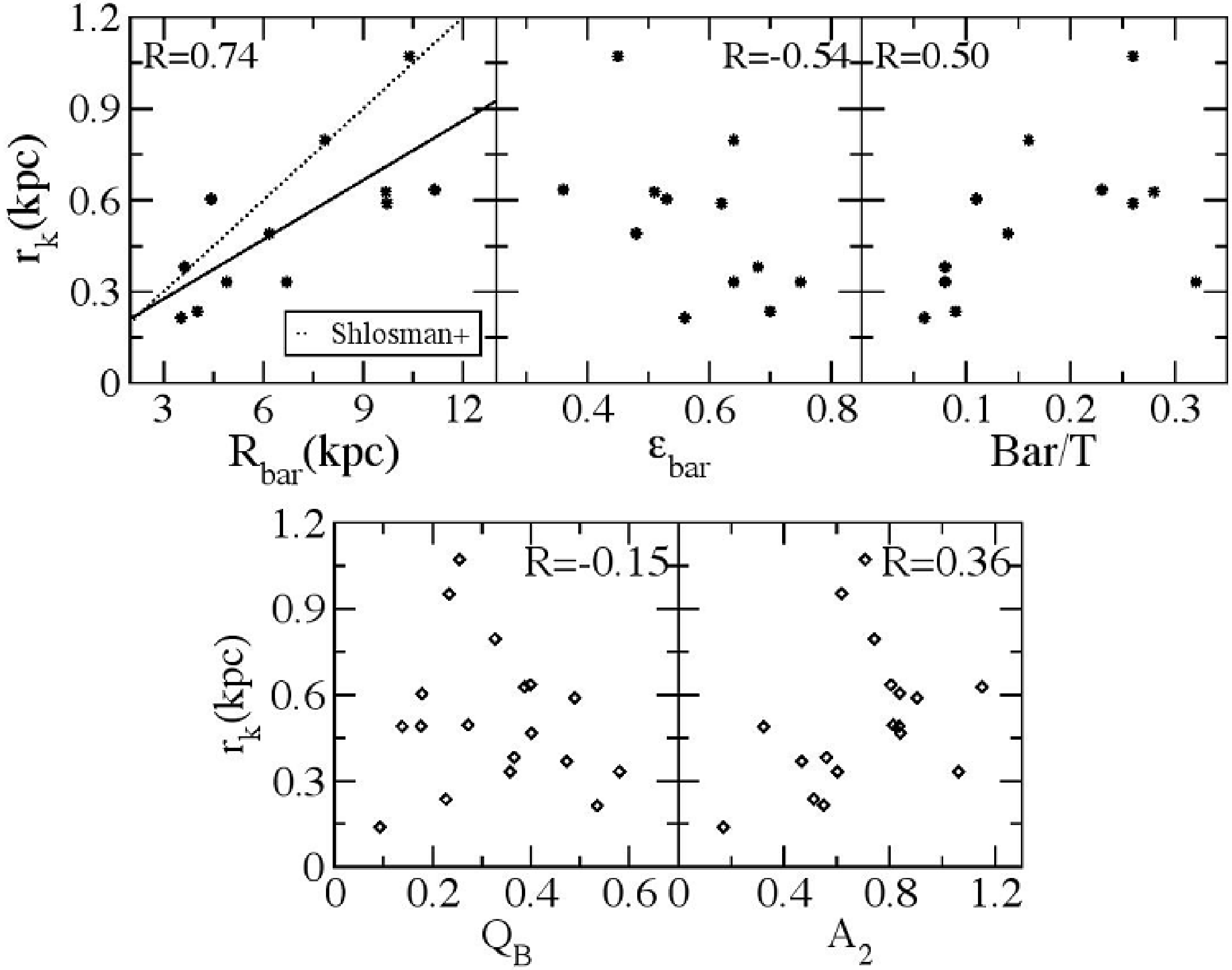


Fig. 6. λ_{r_k} plotted against the observed (projected) ellipticity at the radius of the nuclear disc. The dashed line is the upper envelope of slow rotators in Emsellem et al. (2011). The solid line shows the relation for a model of oblate stellar systems viewed edge-on (see Binney 2005; Cappellari et al. 2007; Emsellem et al. 2007). The dotted lines correspond to the location of the same model for varying edge-on ellipticity (intrinsic flatness), from top (0.85) to bottom (0.35) in steps of 0.1, with edge-on systems on the relation and face-on systems towards the origin, as in Emsellem et al. (2011). NGC 1291, 1365 and NGC 6902 are not included.

Корреляции с характеристиками больших баров



ArXiv:2009.01856

The inside-out formation of nuclear discs and the absence of old central spheroids in barred galaxies of the TIMER survey

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Как честные люди, проверили: разный фиттинг дает разный результат

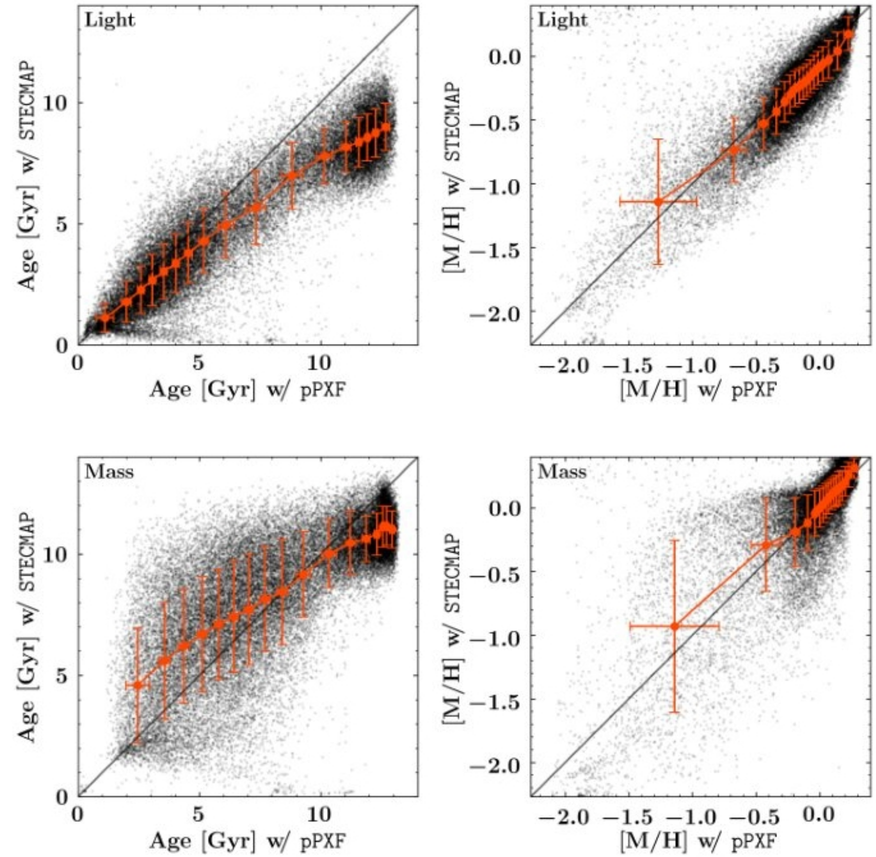


Fig. 3. Same as Fig. 2, but showing mean stellar population propertie:

Цель:

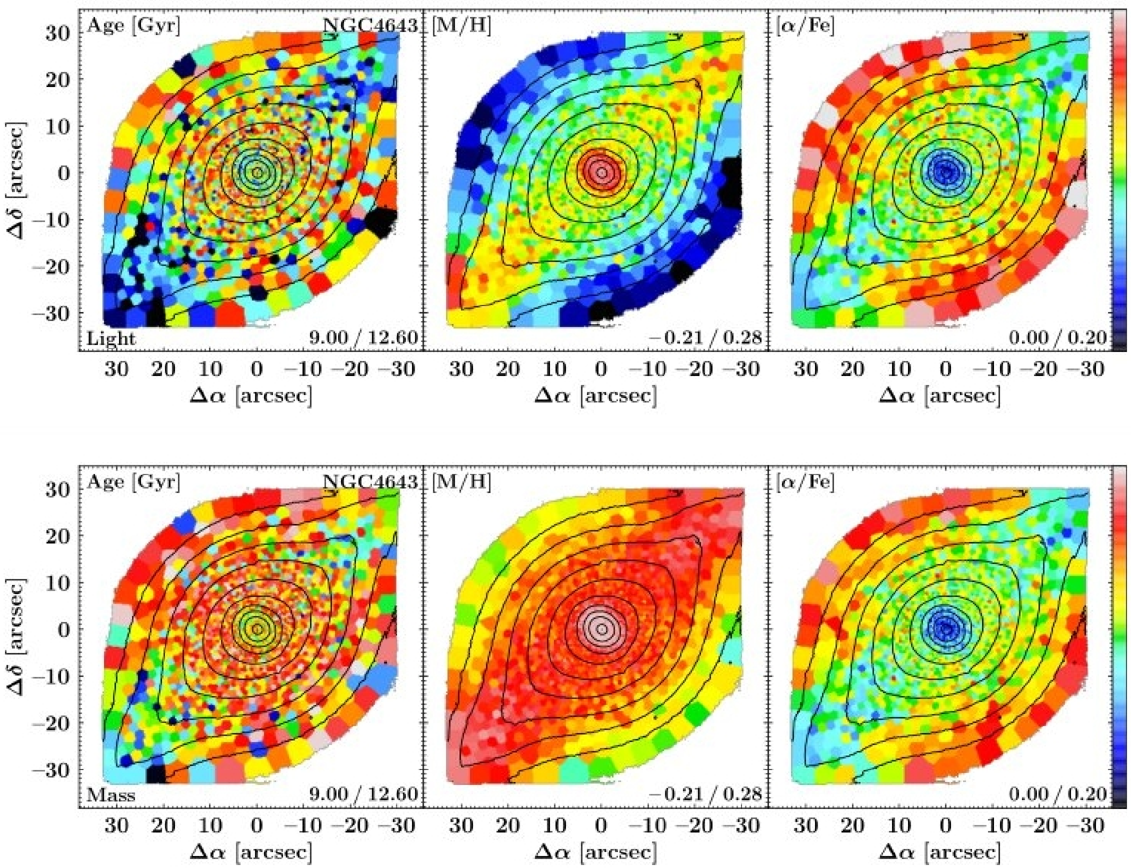
- Характеристики звездного населения (возраст, металличность, альфа-элементы) в ядерных дисках.
- Сравнение радиусов ядерных звездных дисков с околоядерными кольцами эмиссии H-alpha.

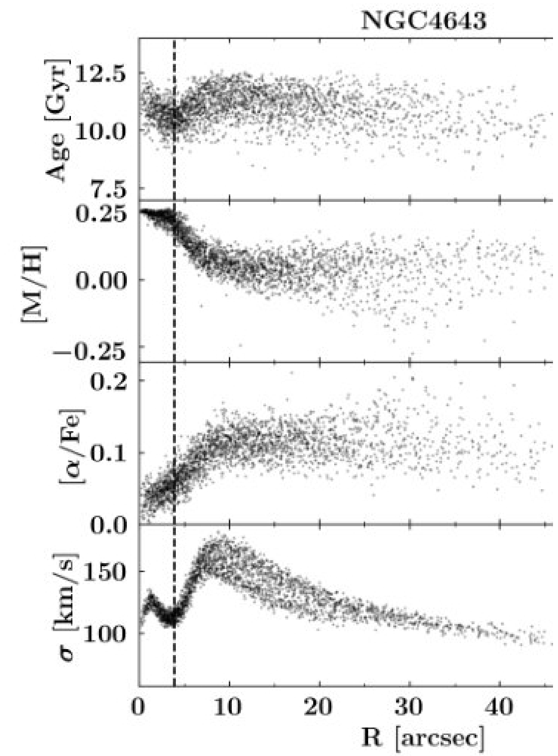
Две подвыборки: с кольцами и без

Galaxy (1)	i deg (2)	PA deg (3)	$M_{\rm stellar}$ 10^{10} $M_\odot$ (4)	Spatial scale pc/arcsec (5)	R_{kin} pc (6)	Hα morphology (7)	Central emission (8)	Age gradient (9)
Non-star-forming nuclear rings								
IC 1438	24	-25.4	3.1	164	604	NR	LINER	SYM
NGC 1291	11	-8.9	5.8	42	—	IRR	LINER	—
NGC 1300	26	-45.9	3.8	87	332	NR	LINER	FLAT
NGC 1433	34	18.2	2.0	49	381	IRR	LINER	FLAT
NGC 4371	59	88.1	3.2	82	952	NO	NO	—
NGC 4643	44	55.5	10.7	125	495	C	LINER	SYM
NGC 5248	41	-75.6	4.7	82	489	U	SF/LINER	SYM
NGC 5850	39	-26.5	6.0	112	796	C	NO	SYM
NGC 7140	51	4.1	5.1	180	634	NR	SF	FLAT
NGC 7755	52	23.9	4.0	153	466	NR	LINER	SYM
Star-forming nuclear rings								
NGC 613	39	-50.1	12.2	120	590	NR	LINER	—
NGC 1097	51	-52.1	17.4	100	1072	NR	LINER	—
NGC 3351	42	11.2	3.1	49	236	NR	SF	—
NGC 4303	34	-36.7	7.2	80	214	NR	LINER	—
NGC 4981	54	-28.2	2.8	120	139	NR	LINER	—
NGC 4984	53	29.6	4.9	103	491	NR/C	AGN	—
NGC 5236	21	47.0	10.9	34	368	IRR	SF	—
NGC 7552	14	54.9	3.3	83	332	NR	SF	—
Peculiar nuclear regions								
NGC 1365	52	42.0	9.5	87	—	NR/IRR	AGN	—
NGC 5728	44	1.1	7.1	149	628	NR/C	AGN	—
NGC 6902	37	-49.6	6.4	187	—	PECULIAR	NO	—

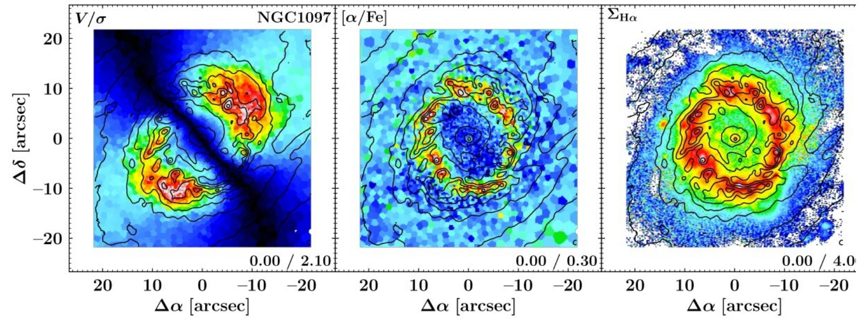
'erview of the different subsamples and some general properties of nuclear rings, nuclear discs, and their host galaxies.

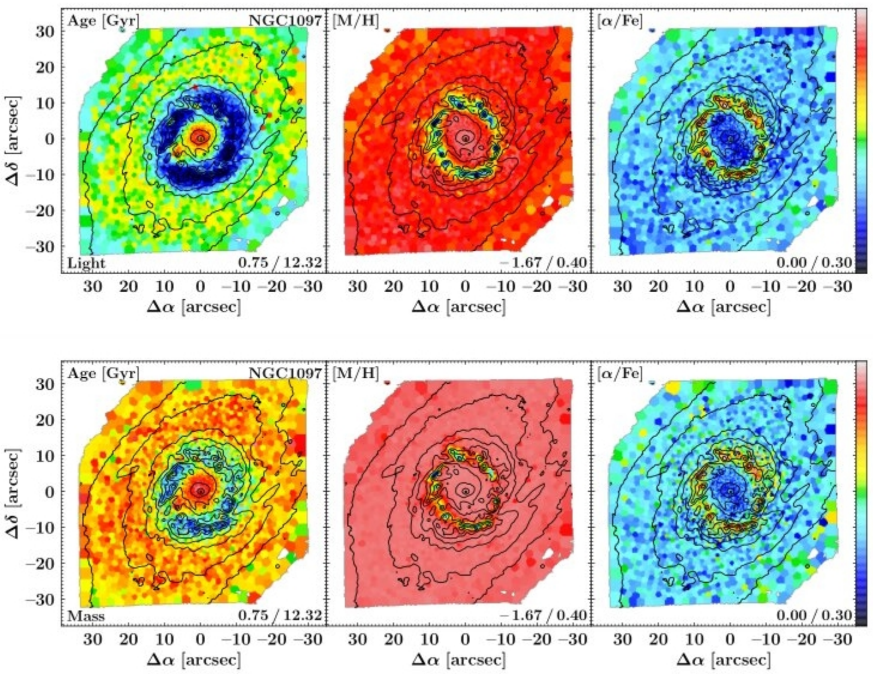
Когда нет кольца – все замечательно: «молодой» диск, строился inside-out

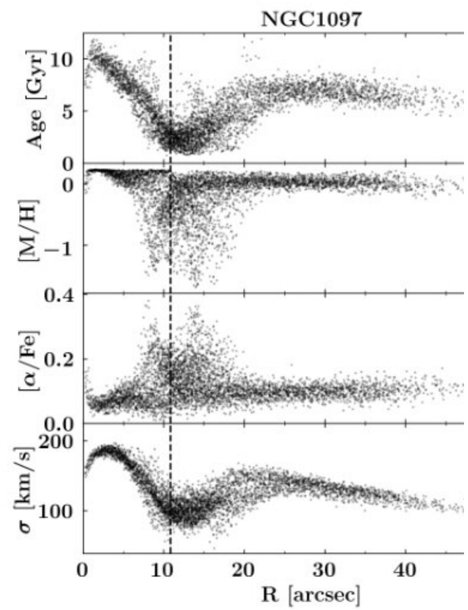




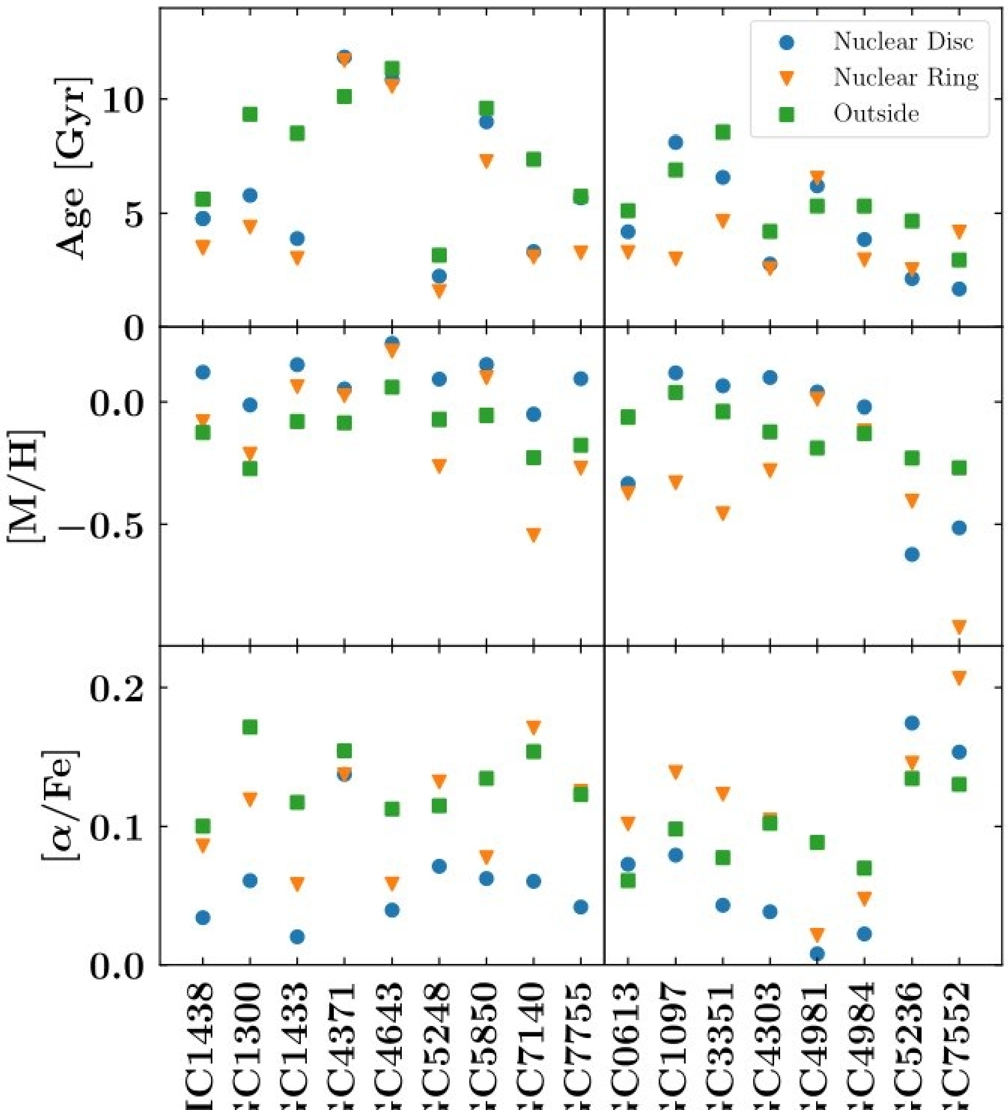
Когда есть эмиссионное кольцо, результатам верить нельзя, но очень хочется.



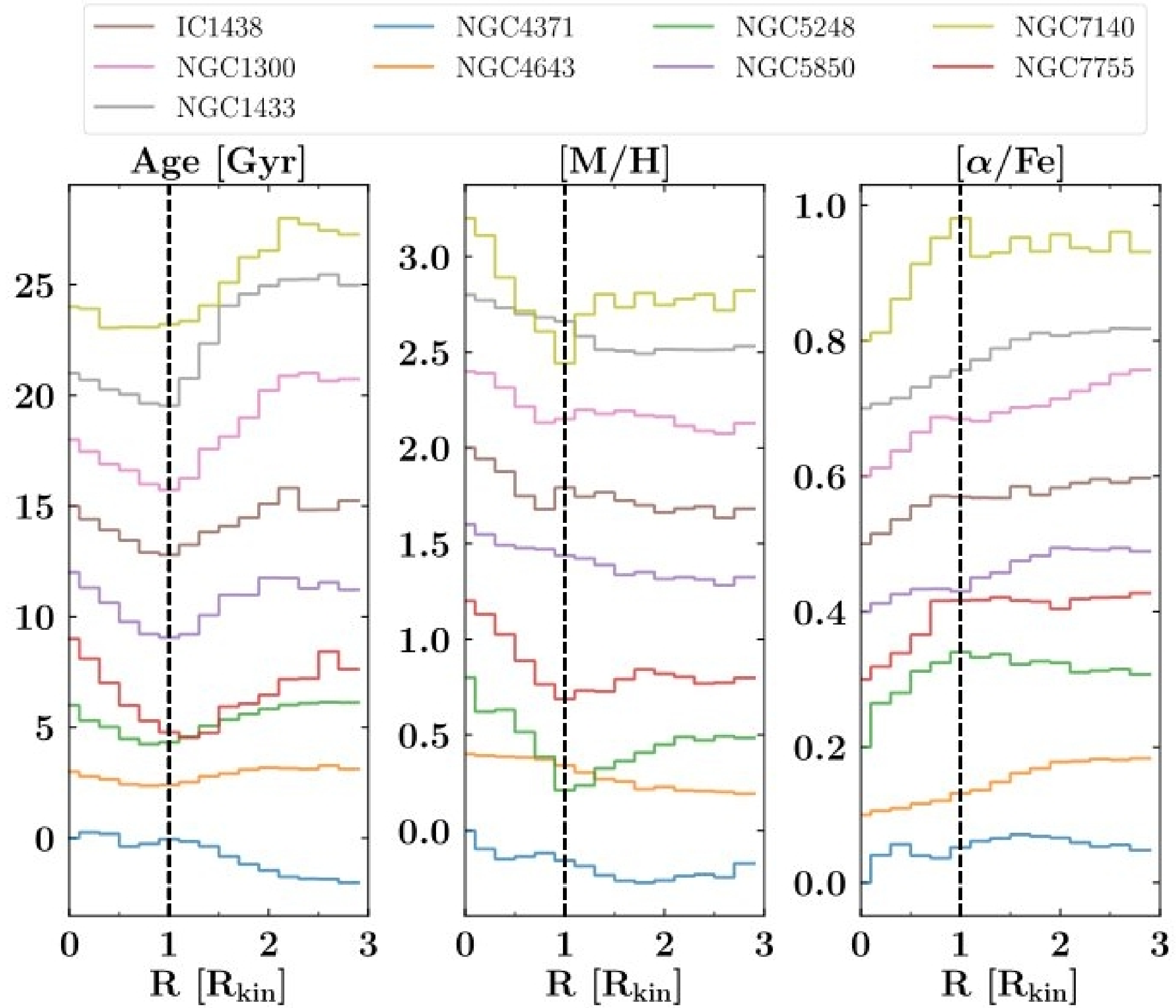




Результат: статистика возрастов и всего остального



Градиенты галактик без колец: inside-out?



Идея (пока не модель?)

- Бар растет со временем (в течение многих миллиардов лет).
- И вместе с ним сдвигается радиус околоядерного кольца, которое всегда 10% от длины бара.
- И таким образом «заметается» полный диапазон радиусов околоядерного звездного диска: позднее всего формируется его внешний край.