Young circumnuclear disks in elliptical galaxies

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UV-upturn in old galactic spheroid spectra

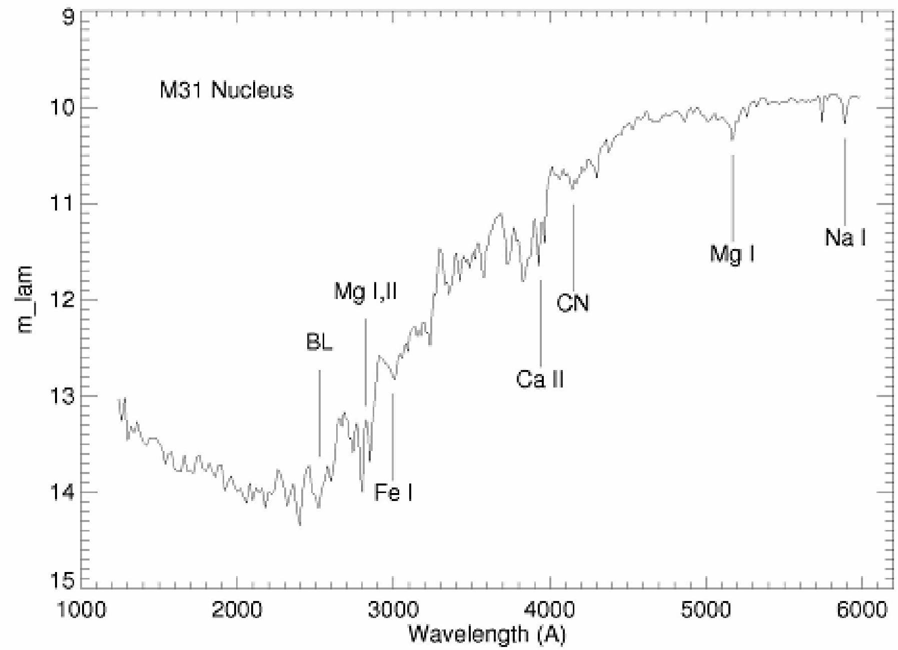


Fig. 1.— A composite UV-optical energy distribution for the center of the Sb galaxy M31. IUE data taken with a $10'' \times 20''$ aperture is plotted below 3200 Å, while a ground-based spectrum covering the same region is plotted above. Resolution is 20 Å below 2600 Å and 12 Å above. Irregularities in the UV spectrum below 2200 Å are mainly noise. Some of the stronger absorption line features are identified ("BL" corresponds to a strong blend of Fe and other metallic lines near 2538 Å). The "UV-upturn" is the rise in the spectrum at wavelengths shorter than 2000 Å. By simple extrapolation of the far-UV continuum slope, one finds that the upturn component contributes only about 0.3% of the V light of the galaxy. Spectrum courtesy of D Calzetti.

O'Connell 1999

UV-excess in elliptical galaxies

- Common view is that the origin of UV-excess in spectra of elliptical galaxies is due to old low-mass stars in late evolutionary stages: horizontal-branch extension, AGB-manque stars, etc.
- BUT the first FUV-imaging of a small sample of nearby elliptical galaxies with UIT has shown a strict difference of the FUV surface brightness distributions with respect to the optical-band ones. If the same old stars, why the different spatial distribution?

UV-excess in elliptical galaxies

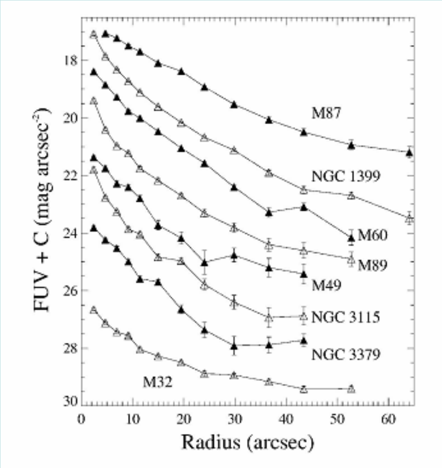
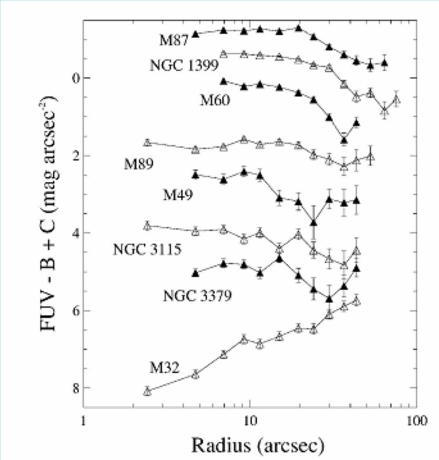


FIG. 1.—FUV surface brightness profiles for eight E/S0 galaxies. One sigma error bars are shown. In these units, exponential profiles are straight lines. For clarity, the profiles are given zero-point offsets; from the top down, these are $C = -3.0$, -2.0, -1.0, 0.0, $+1.0$, $+2.0$, $+3.0$, and $+6.5$ mag arcsec^{-2}.



Several regular elliptical galaxies – e.g. NGC 3379, M49, M60 – having de Vaucouleurs' brightness profiles in the optical light, have shown exponential profiles in FUV. Exponential brightness profiles are typical for disks. Moreover, there are FUV-B colour breaks at the end of the exponential profile segments. Embedded structures? They are FUV-bright so may be young?

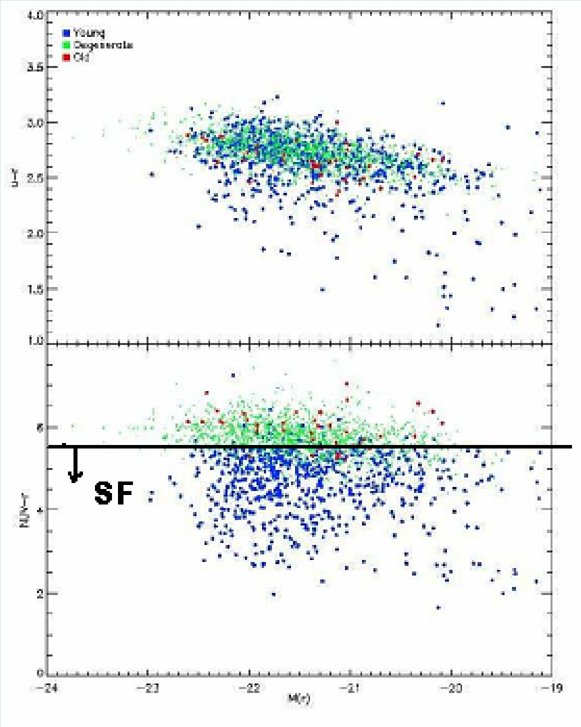
TWO-DIMENSIONAL WELL-EXPOSED IMAGING IS STRICTLY NEEDED!

Ohl et al. 1998

UV-excess=SF in elliptical galaxies?

- Old stars (giants) lose their masses
- Minor merging/satellite accretion is frequent in dense environments
- Gas without large momentum concentrates in the center of spheroid
- SO there may be gas reservoir and star formation in the centers of elliptical galaxies

UV-excess=SF in elliptical galaxies?



- GALEX colour data for ~2100 early-type galaxies from the SDSS: 30% of them may experience star formation within the last Gyr

Kaviraj et al. 2007

Fuel for star formation in elliptical galaxies?

Table 2. Observed molecular properties

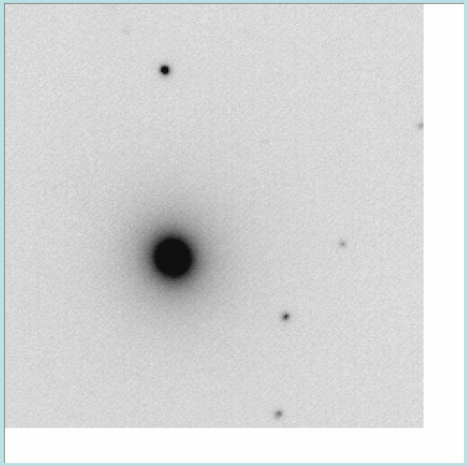
Name		$V_{CO}^{a)}$ $km\ s^{-1}$		$\Delta V_{CO}^{b)}$ $km\ s^{-1}$		I_{CO} $K\ km\ s^{-1}$		$\Re^{c)}$	$RMS^{d)}$ mK		$\delta v^{e)}$ km s^{-1}	
		(1–0)	(2–1)	(1–0)	(2–1)	(1–0)	(2–1)		(1–0)	(2–1)	(1–0)	(2–1)
NGC	83	6240	6262	403	400	4.7	3.2	0.7	3.7	6.0	27.3	26.0
NGC	741								4.1	6.5	27.4	26.0
NGC	759	4665	4666	386	385	11.8	15.2	1.3	6.4	8.4	21.3	23.4
UGC	1503	5070	5073	298		6.1			4.3	2.9	27.3	26.0
NGC	807	4724	4720	492	472	7.5	5.8	0.8	2.7	6.1	27.4	26.0
NGC	855	600	604	26	36	0.8	0.6	0.8	3.8	6.5	12.1	11.7
NGC	1052								6.5	10.8	26.0	26.0
NGC	2328	1093		280		3.5			3.8		26.0	
NGC	2320	5584		320		2.2			2.5	5.8	27.3	26.0
NGC	2534								8.0	14.2	27.3	26.0
NGC	2768	1466	1479	136	146	0.8	1.2	1.5	3.0	4.2	27.4	28.6
NGC	2783								6.4	8.9	27.3	26.0
NGC	2831	5168		300		3.3			5.9	18.0	31.2	31.2
NGC	3597	3457		330		6.9			5.0		27.3	
NGC	3656	2865	2882	505	447	23.4	24.2	1.0	10.8	11.1	27.4	26.0
NGC	3837								9.1	18.4	27.3	28.6
NGC	3842								3.2	7.6	27.3	26.0
NGC	4125	1106		400		2.5			4.4	6.0	27.3	26.0
NGC	4374								7.8	15.3	27.3	26.0
NGC	4406								5.1	11.3	27.3	28.6
NGC	4406a								7.7	8.9	27.3	26.0
NGC	4476	1973	2003	215	144	5.4	5.4	1.0	4.7	4.5	33.4	36.4
NGC	4589								12.7	13.6	27.3	26.0
NGC	4581								11.7	14.7	33.4	31.2
NGC	5666	2209	2200	180	173	12.9	10.5	0.8	12	10	27.4	26.0
NGC	6702								3.5	4.4	27.4	26.0
IC	5063	3349		163		1.1			3.4		18.4	
NGC	7052								3.6	3.4	27.4	26.0
NGC	7464								5.8	7.1	27.3	26.0
NGC	7468	2302		665		6.7			5.9	8.4	33.4	32.5

a) Intensity weighted mean velocity.
b) Width at the half intensity level.
c) $\Re = I_{CO}(2-1)/I_{CO}(1-0)$, measured in T_{mb}.
d) Channel–to–channel noise rms.
e) Channelwidth used when deriving the RMS and plotting the spectra.

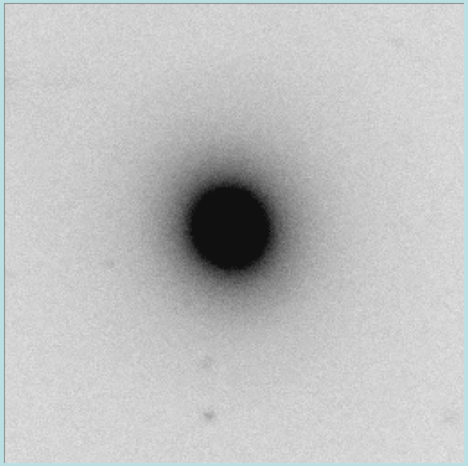
Wiklind et al. (1995): among IRAS-bright ellipticals more than 50% contain molecular gas

Sage et al. (2007): in a volume-limited sample of non-cluster ellipticals there are 33% with the molecular gas

We have taken two regular E0-galaxies from the sample of Wiklind et al. (1995) for our two-dimensional spectroscopy



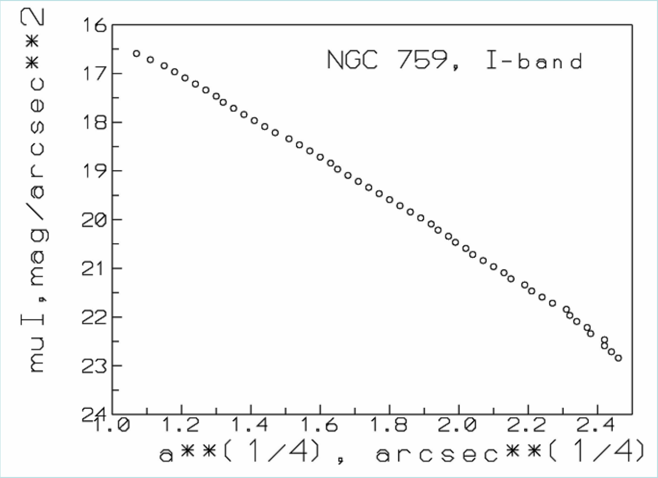
- NGC 759 (E0, the member of A262 cluster): $M_B = -20.8$, $(B\text{-}V)_e = 1.05$, $(U\text{-}B)_e = 0.53$, Vlasyuk & Sil'chenko (2000)



- NGC 83 (E0, the rich group of NGC 80): $M_B=-21.6$, $(B\text{-}V)_e =1.12$, $(U\text{-}B)_e = 0.60$,

The paper in preparation

The global surface brightness profiles are quite normal de Vaucouleurs' ones



Vlasyuk & Sil'chenko 2000

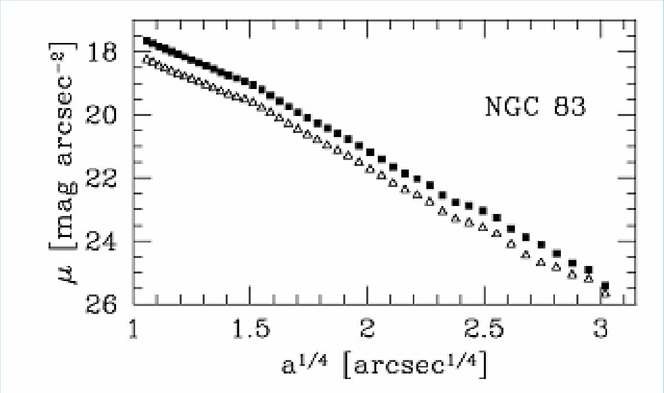


FIG. 1.—Surface brightness profiles of NGC 83, where *R*-band data are shown with filled squares and *V*-band data are shown with open triangles. The break in slope at $a^{1/4} \sim 1.5$ arcsec$^{1/4}$ is due to the dust disk.

Young 2005

BUT

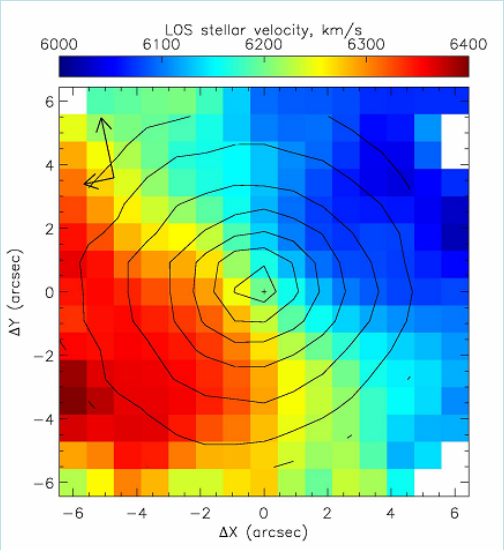
- NGC 759: the tiny brightness excess=exponential stellar disk is seen within the radius of 15 arcsec

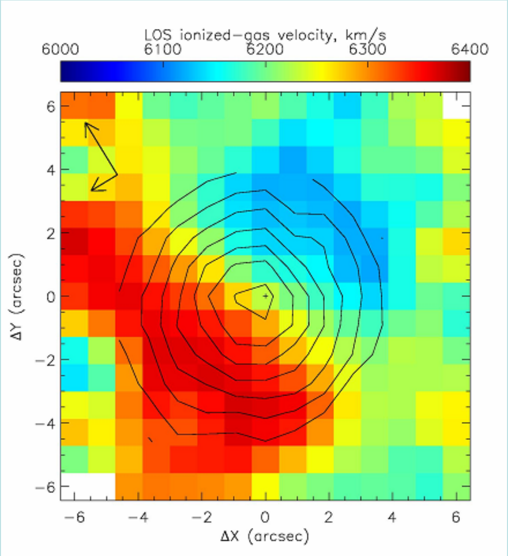
- NGC 83: the brightness deficit=a dust disk is seen within the radius of 5 arcsec

Observations with the Multi-Pupil Spectrograph of the 6-m telescope

- MPFS (“Multi-Pupil Field Spectrograph”, later “Multi-Pupil Fiber Spectrograph”) is an integral-field spectrograph at the 6-m telescope of the Special Astrophysical Observatory of the Russian Academy of Sciences.
- NGC 759 was observed in 1998: two spectral ranges, green and red, spectral resolution of 5 A, the frame of 8x9 square elements with 1.3-1.4” per lens.
- NGC 83 was observed in 2003-2004: two spectral ranges, green and red, spectral resolution of 3 A, the frame of 16x16 square elements with 1” per lens.

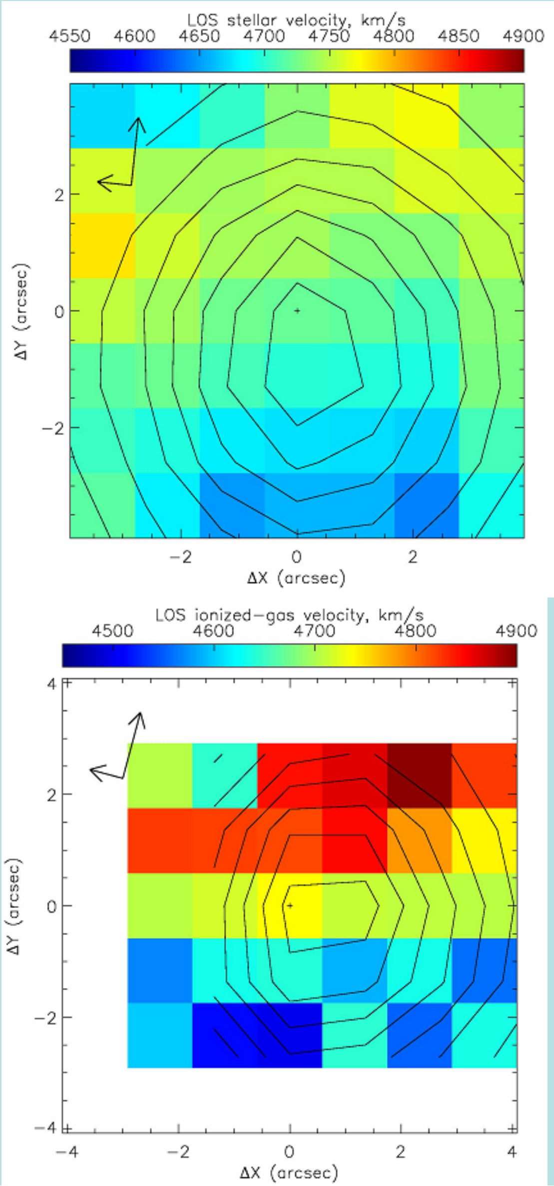
Kinematical results





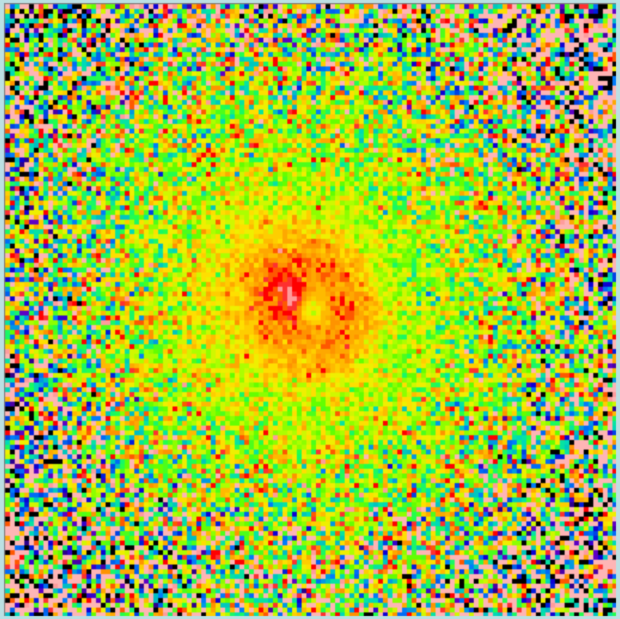
- NGC 83: stars rotates fastly, +/-200 km/s in 5 arcsec (2 kpc) from the center; the ionized gas rotates with the same speed within R=5”.
- Both rotations are coupled (the directions of the kinematical major axes coincide).

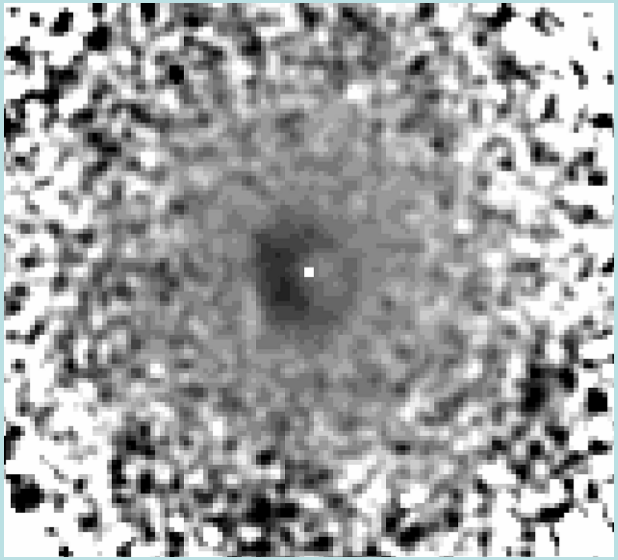
Kinematical results



- NGC 759: stars rotates slightly, ionized gas rotates VERY fastly, +/-200 km/s in 3 arcsec (1 kpc) from the center.
- Both rotations are coupled (the directions of the kinematical major axes coincide).

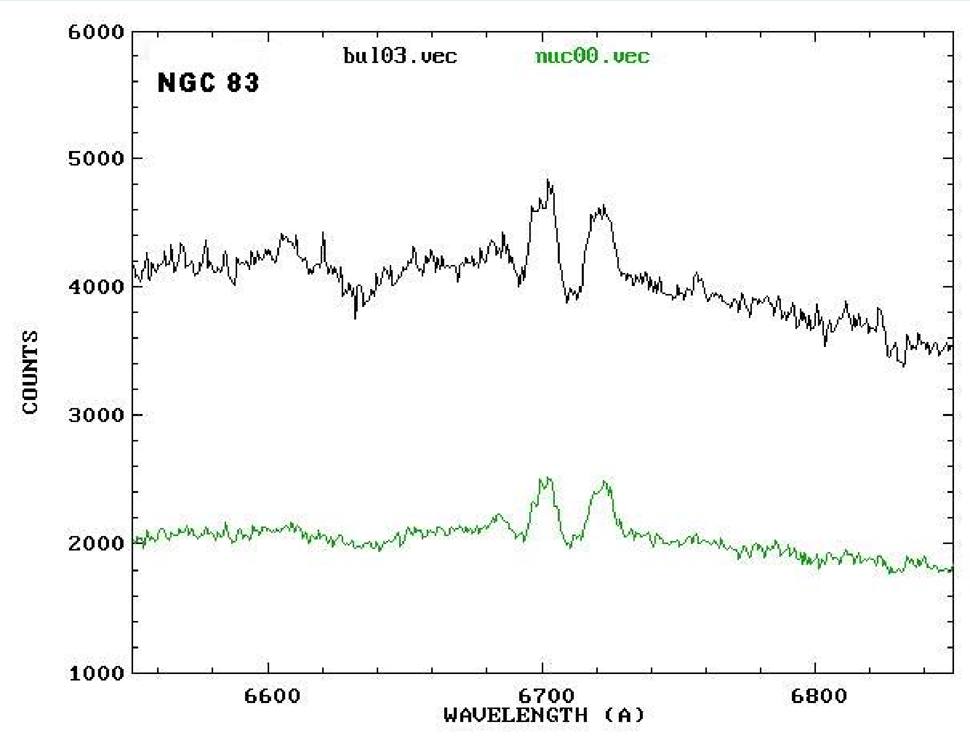
Dust rings coupled with the ionized gas

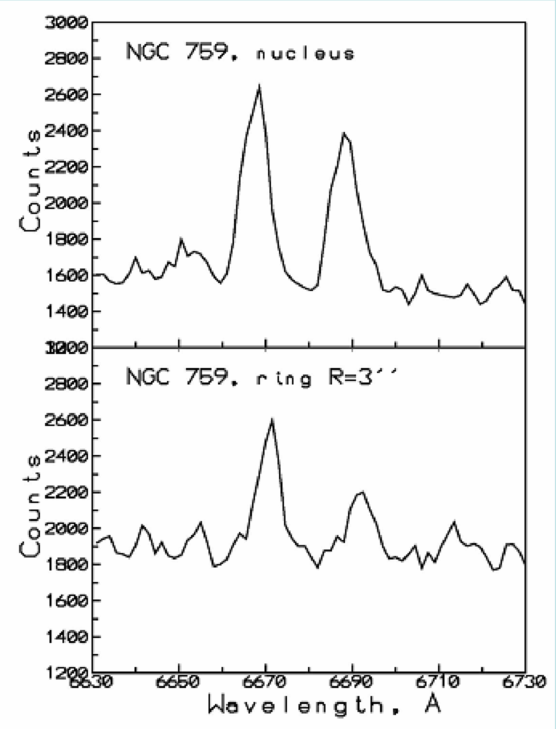




- The V-I colour maps for NGC 83 (left) and NGC 759 (right): inclined dust rings with the same radii, 2 kpc and 1 kpc respectively

Star formation rings?





- The intensity ratio of emission lines H_{α}/[NII]6583 rises from the nucleus to the borders of the rings – the transition from the LINER nuclei to the star-forming rings?

Summary

- In two REGULAR ROUND RED LUMINOUS elliptical galaxies which are however known to possess molecular gas we have found central stellar disks being formed just now.
- In fact, secondary star formation bursts in the centers of luminous elliptical galaxies hidden within stellar spheroids may be a common phenomenon which may be responsible for the UV radiation excess in massive elliptical galaxies.