

# Very Thin Disc Galaxies in The SDSS Catalog of Edge-on Galaxies

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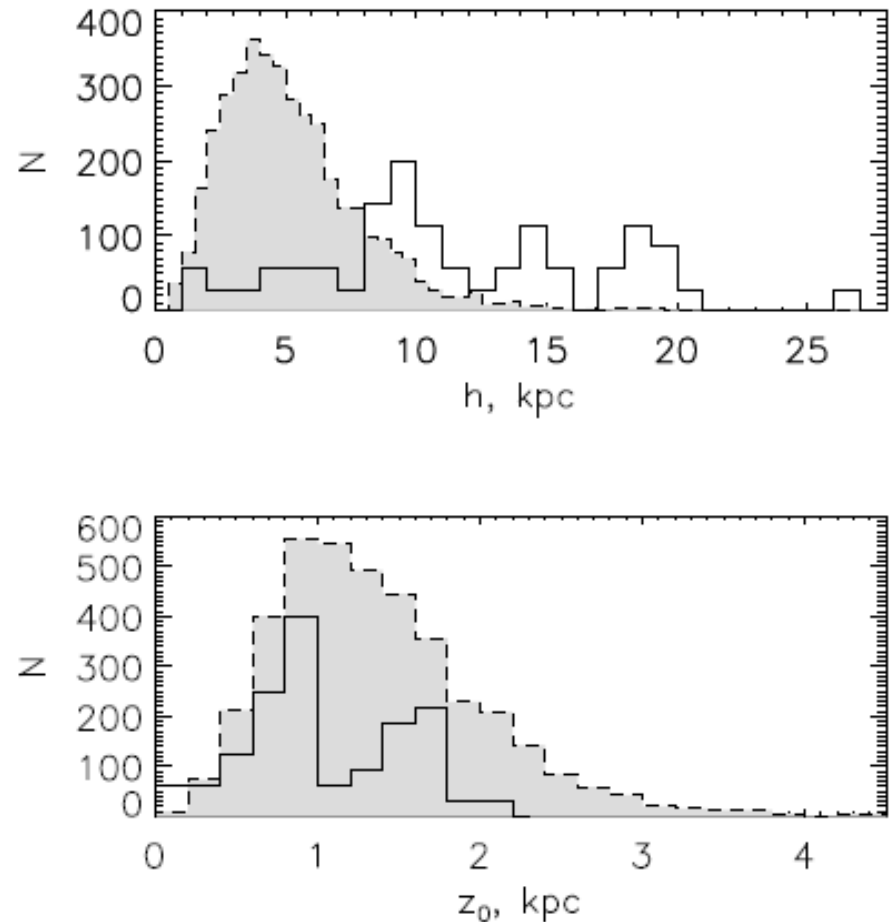
## ABSTRACT

We study the properties of galaxies with very thin discs using a sample of 85 objects whose stellar disc radial-to-vertical scale ratio determined from photometric decomposition, exceeds nine. We present evidences of similarities between the very thin disc galaxies (VTD galaxies) and low surface brightness (LSB) disc galaxies, and conclude that both small and giant LSB galaxies may reveal themselves as VTD, edge-on galaxies. Our VTD galaxies are mostly bulgeless, and those with large radial scale length tend to have redder colors. We performed spectral observations of 22 VTD galaxies with the Dual Imaging Spectrograph on the 3.5m telescope at the Apache Point Observatory. The spectra with good resolution ( $R \sim 5000$ ) allow us to determine the distance and the ionized gas rotation curve maximum for the galaxies. Our VTD galaxies have low dust content, in contrast to regular disc galaxies. Apparently, VTD galaxies reside in specific cosmological low-density environments and tend to have less connection with filaments. Comparing a toy model that assumes marginally low star formation in galactic discs with obtained gas kinematics data, we conclude that there is a threshold central surface density of about  $88 M_{\odot}/pc^2$ , which we observe in the case of very thin, rotationally supported galactic discs.

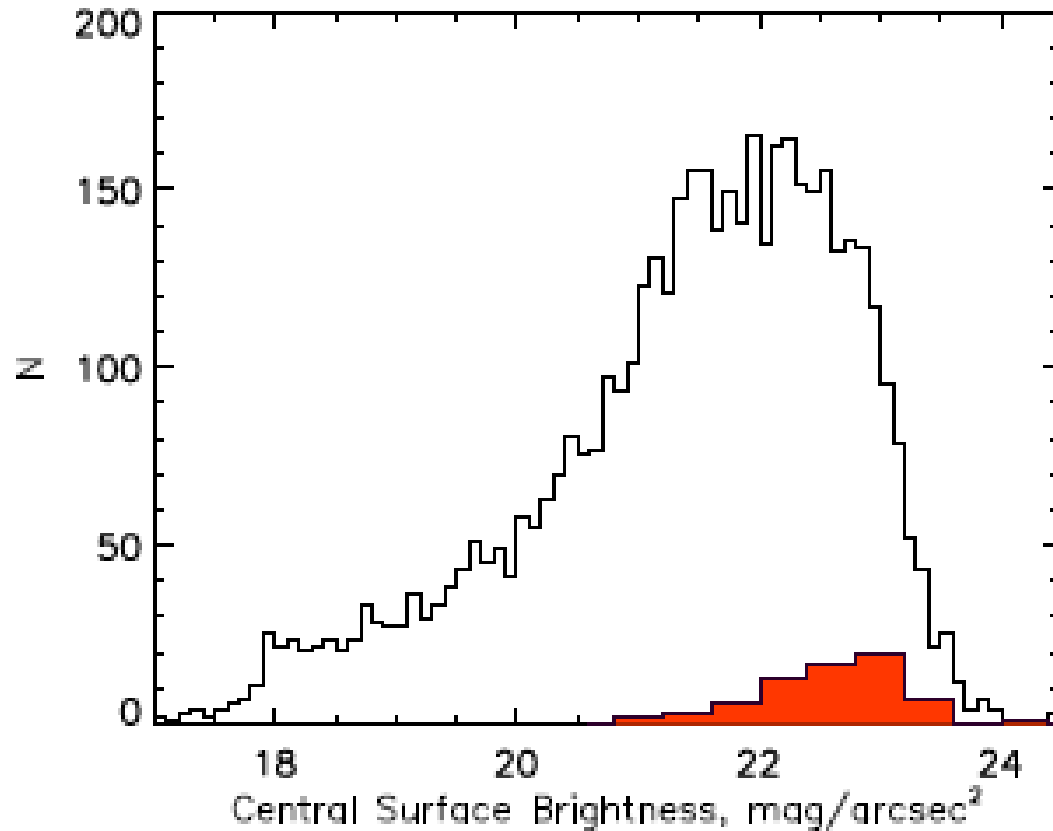
**Key words:** galaxies: structure, galaxies: edge-on, galaxies: LSB

- Обзор EGIS ("Edge-on disk Galaxies In SDSS")
- Bizyaev+, 2014
- Обзор VTD:  $h/z_0 > 9$  (некоторые с балжжами)
- Отобрано 85 объектов.
- Для 24 получены спектральные данные на 3.5м Apache Point.

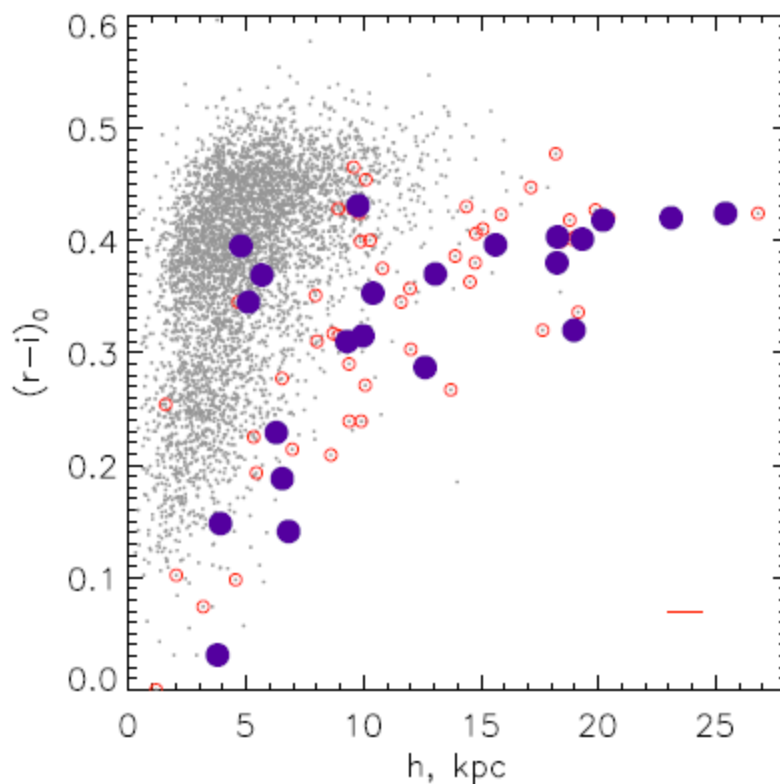
- Шкала  $h$  для EGIS – 5.2 кpc  
VTD- 11.6 кpc  
(у голубых VTD  $h$  меньше).



**Figure 1.** The radial scale length (top) and the vertical scale height (bottom) of all EGIS galaxies (dashed curve and grey shaded histogram) and of VTD subsample (solid curve). The histogram for VTD galaxies is arbitrary scaled in the Y-direction in order to better show the plot (the tallest bins have 6 and 13 objects in the top and bottom panels, respectively).

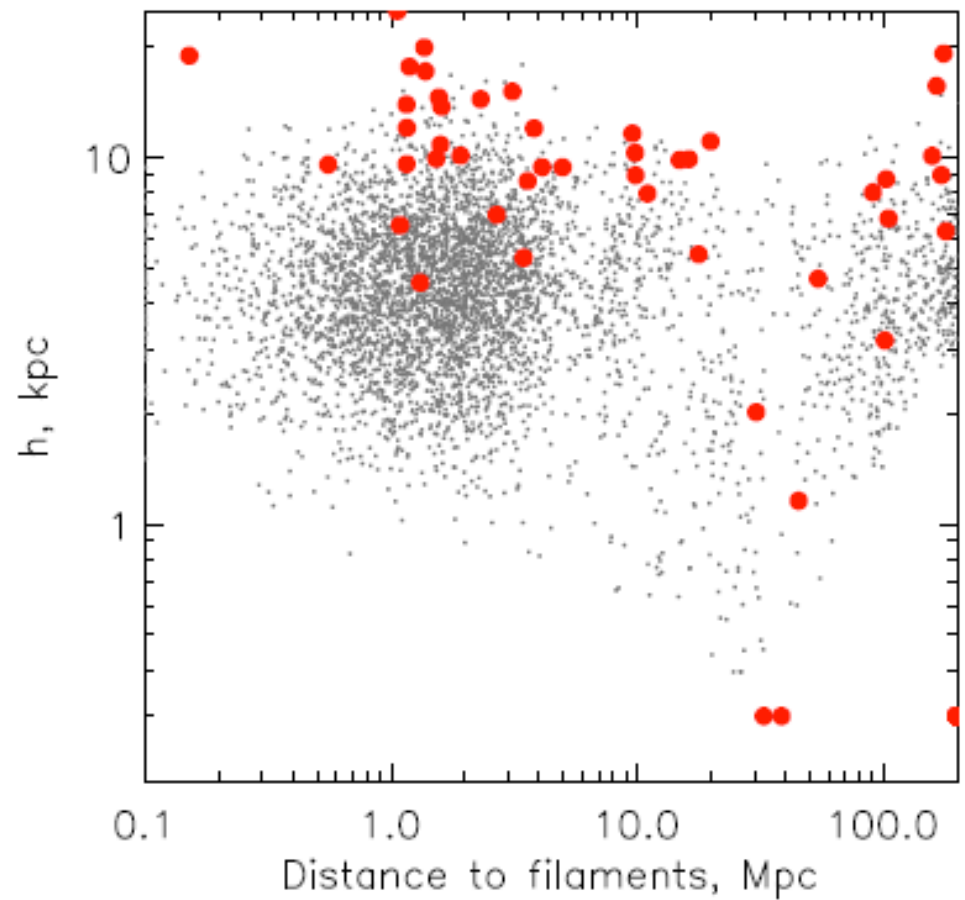


**Figure 2.** The central face-on surface brightness in the  $r$ -band for all EGIS galaxies (open histogram) and for the VTD subsample (filled histogram). The VTD galaxies are mostly LSB galaxies with about 1.5 mag dimmer surface brightness than regular galaxies in the EGIS catalog.



**Figure 6.** The integral  $(r-i)_0$  color of EGIS galaxies (grey) in the comparison with their radial scale length expressed in kpc. VTD galaxies from our spectroscopic sample with detected H $\alpha$  emission are designated by the blue bullets. The red circles mark all other VTD galaxies from our list in Table 2. The red bar in the lower right corner shows the average uncertainty of the radial scale length for the sample of VTD galaxies. The colors are corrected for the reddening in the Milky Way.

- VTD в среднем дальше от филаментов (3D анализ), особенно голубые



# Toy model

- Минимальная дисперсия скоростей 6 км/с, весь диск газовый
- Чем больше относительная масса гало, тем тоньше может быть диск (при маргинальной устойчивости и  $Q_T = \text{const}$ ).

$$M_t/M_d \gtrsim 1.1 (h/z_0) (Q/1.4)^2 .$$

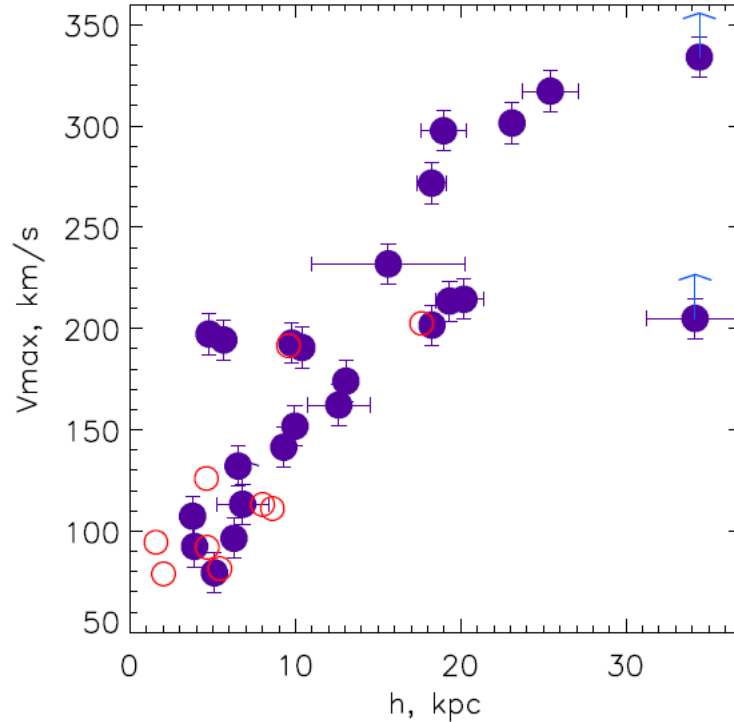
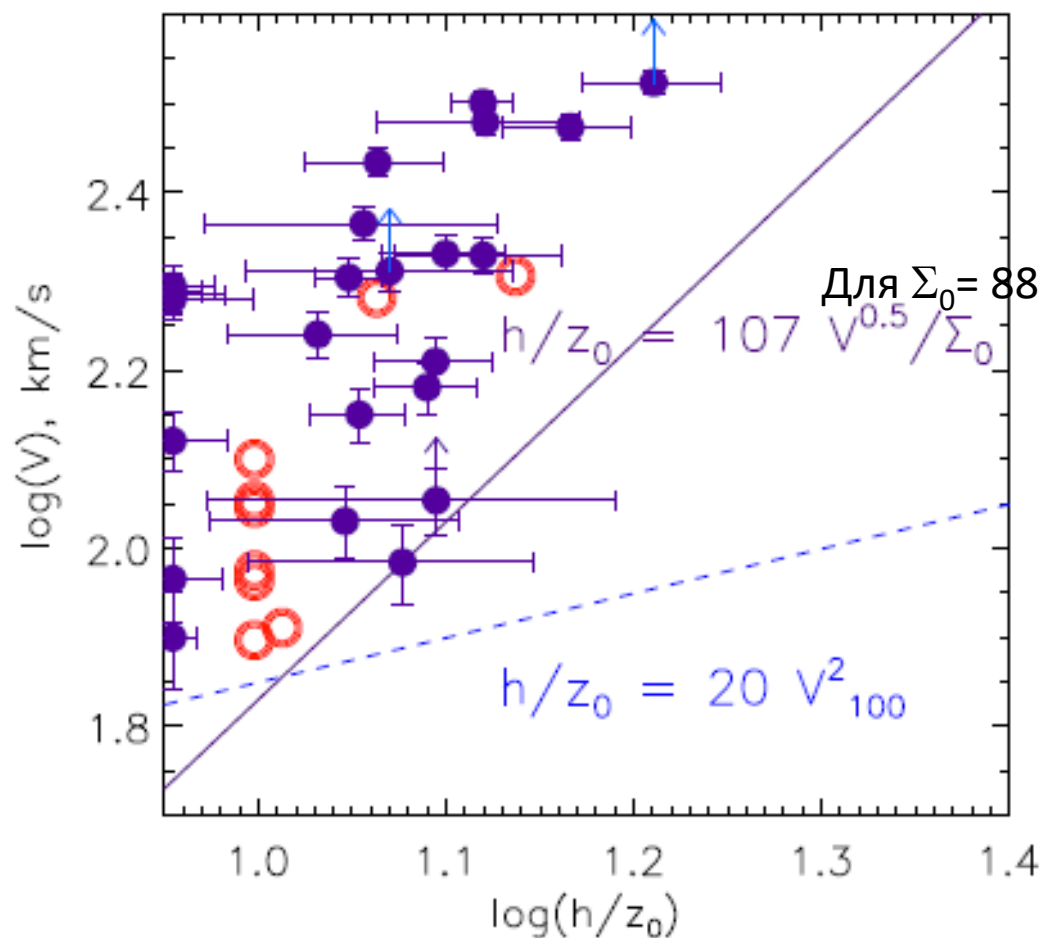


Figure 10. The rotation curve maximum  $V$  versus the scale length diagram for nine galaxies with published data (the red open circles) and for the sample from Table 2 (the blue bullets). The diagram suggests that the majority of the galaxies follow the same trend. The three galaxies with the lower limit estimations for  $V$  (see text) are marked with asterisks. One of these galaxies

- Используя эмпирическое соотношение  $h \sim V^{1.5}$ , прокалиброванное по VTGs, получаем после простых преобразований
- $h/z = 107 V^{0.5} / \Sigma_{0,c}$





**Figure 11.** The rotation curve maximum  $V$  versus the inverse stellar disc thickness  $h/z_0$ . The two lines, solid and dashed, correspond to the cases of a surface density threshold, and no threshold, respectively. The red open circles show the data available for several VTD galaxies from literature. The blue bullets designate our sample with APO/DIS spectral observations.

# Самые главные выводы

- The VTD galaxies have larger scale lengths and shorter scale heights than regular EGIS objects
- VTD galaxies are mostly LSB stellar systems with low dust extinction.
- VTD galaxies from our sample avoid large-scale filaments twice as frequent than regular EGIS objects, thus suggesting that the VTDs are located in more isolated environment.
- VTD galaxies possess the dark-to-luminous mass ratio several times greater than that in regular spiral galaxies.
- Correlation between  $h/z_0$  and  $V_{\max}$ , as well as the lack of very thin and low-massive galaxies, suggests that the formation of the disc in galaxies is regulated by a threshold surface density.

Using kinematic data available for a sample of VTD observed at the Apache Point Observatory, we conclude that the minimum central surface density in the VTD galaxies is  $88 M_{\odot}/\text{pc}^2$ .

# От себя:

- Положение галактик на диаграмме
- «скорость вращения –  $h/z_0$ » показывает, что VTD галактики действительно ограничены условием маржинальной устойчивости на стадии газового диска, но в среднем имеют сплюснутость, меньшую предельной. Отсюда вывод: реальная центральная плотность дисков даже в VTD в б-ве случаев в 1.5 – 3 раза выше  $88 \text{ Мс/рс}^2$ . Но все равно это сильно меньше, чем в нормальных галактиках.