Features Of Disk Structure Of Lenticular Galaxies In Clusters

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ABSTRACT

We have obtained deep photometric data for a sample of **lenticular galaxies** in several **southern galaxy clusters**. We have analyzed structure of the disks: radial and vertical scalelength by applying **our original method**. We have compared the structural properties of the lenticular galaxies in clusters with those obtained for the S0 galaxies in rarified environments.

SAMPLE DATA

The observations were carried out in the service regime of the Las Cumbres Observatory Global Telescope (LCOGT).

By May 2013, the LCOGT consisted of two 2-m optical telescopes, dozens of 1-m telescopes, and one 83-cm telescope located at six observatories, three in the Northern and three in the Southern hemisphere. During our observations, all the LCOGT meter-class telescopes were outfitted with standard SBIG cameras for the acquisition of direct frames. Our observing program was carried out during the commissioning time of the LCOGT, when not all components of the service regime were fully operational.

As a result, for these work we have a sample of 29 lenticular galaxies in several southern galaxy clusters.

METHOD. FORMULA

We use our ***new photometric method*** enabling the derivation of the relative thickness of a galactic disk from the two-dimensional surface-brightness distribution of the galaxy in the plane of the sky. Our method allows us to calculate relative thicknesses of stellar disks not be viewed strictly face-on or strictly edge-on.

The key idea of our method is to derive galaxy inclination angle from distribution of exponential scalelength by azimuth.

In fact, for the plane-parallel disk with the same thickness at any distance from a center, the scalelength does not depend on thickness. It depends only on inclination to the plane of sky. The difference between ellipticities of isophote and scalelength allows us to calculate relative thickness of galaxy disc by formula:

$$q = \sqrt{1 - \frac{2e_I - e_I^2}{2e_h - e_h^2}} \qquad (1)$$

After some calibration of q our method allows us to evaluate relative thickness Q for galaxies with following brightness distribution:

$$I(r,z) = I_0 \mathrm{sech}^2\left(\frac{z}{d}\right) e^{-\frac{r}{h}}; \qquad Q = \frac{d}{h} \qquad (2)$$

METHOD STEP-BY-STEP

On the figure you can see how our method works on the sample galaxy NGC5750.

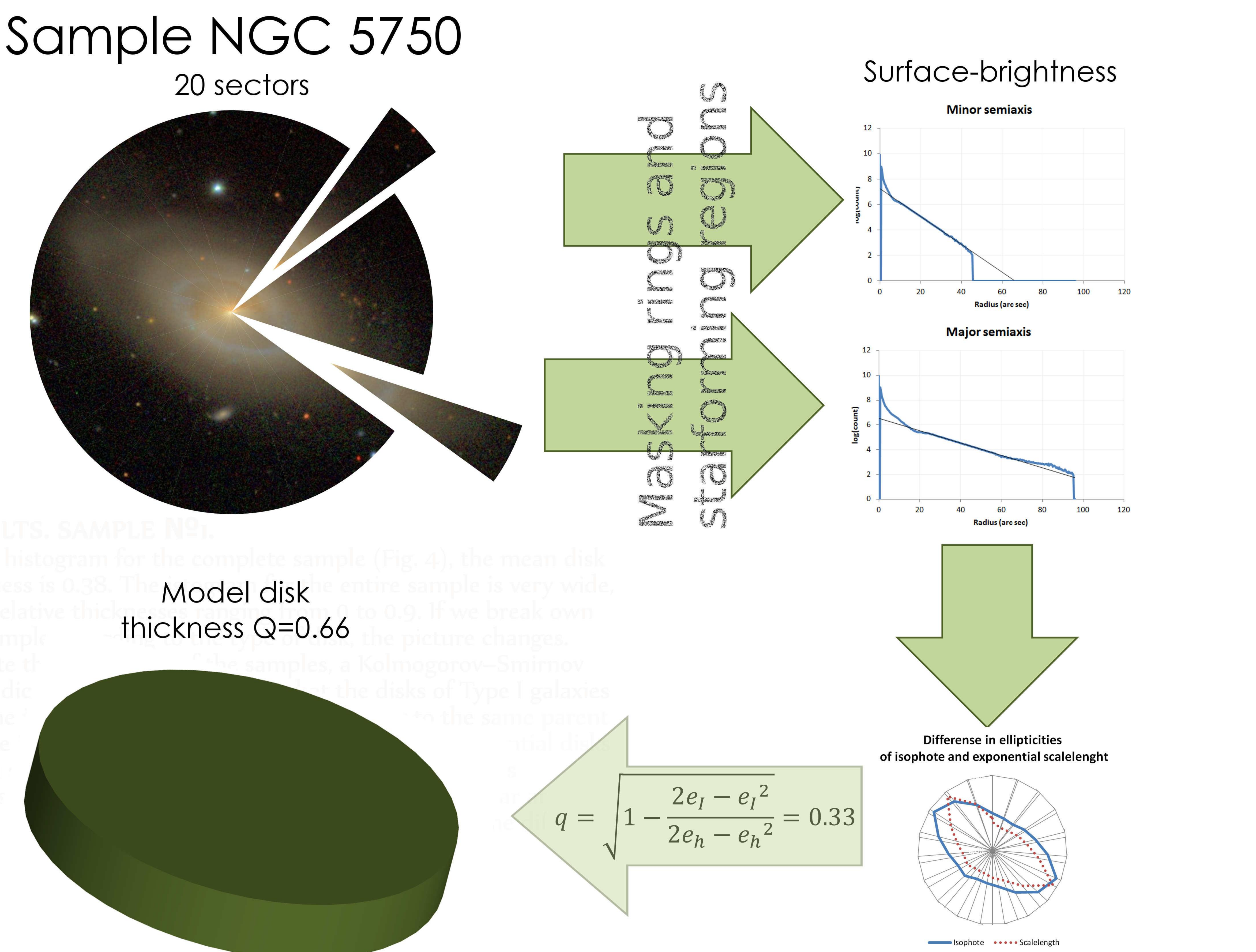
The key idea of method implementation is slicing galaxy into sectors. We divide galaxy image into 20 sectors, and plot surface brightness distribution for each sector. We calculate exponential scalelength for each sector.

In the next step we approximate isophote with 20 dots of equal brightness from each of our sectors. Also we plot the scalelength in each sector on isophote radius. We'll fit ellipses into our approximation of isophote and scalelength.

It is important, that scalelength ellipse is flatter than the isophote. The difference between ellipticities of isophote and scalelength enables us to calculate relative thickness of galaxy disc.

As we said, for the plane-parallel disk with the same thickness at any distance from center, scalelength does not depend on thickness. It depends only on inclination to the plane of sky. So the reason of rounding isophote is finite thickness of the disk. Formula (1) shows the expression for relative thickness according to ellipticities of isophote and scalelength.

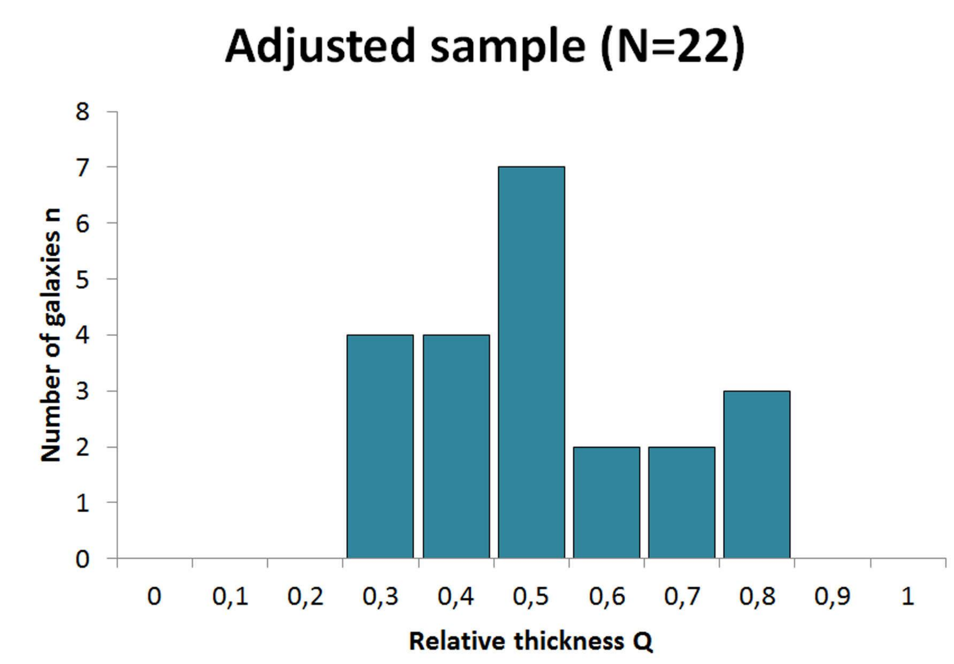
For the sample galaxy NGC 5750 the q from the equation (1) is 0.33. We calibrated our evaluations with model images of galaxies with brightness distribution (2). It make our results comparable with known thickness of edge-on galactic disks.
After calibration we can say, that relative thickness Q of galaxy NGC5750 is 0.66.



RESULTS

We applied our method to the described sample of the 29 galaxies. For 5 galaxies the method did not work for some reasons. But 5 of the remaining 24 galaxies showed piecewise-exponential disks, so our sample of 24 galaxies contains 29 disks. After the main part of calculations made, before calibration we noticed that the distribution of galaxies in q is bimodal. It means that in our sample of the lenticular discs some spheroidal galactics are included. After exclusion of these objects and calibration we have result statistics on the figure.

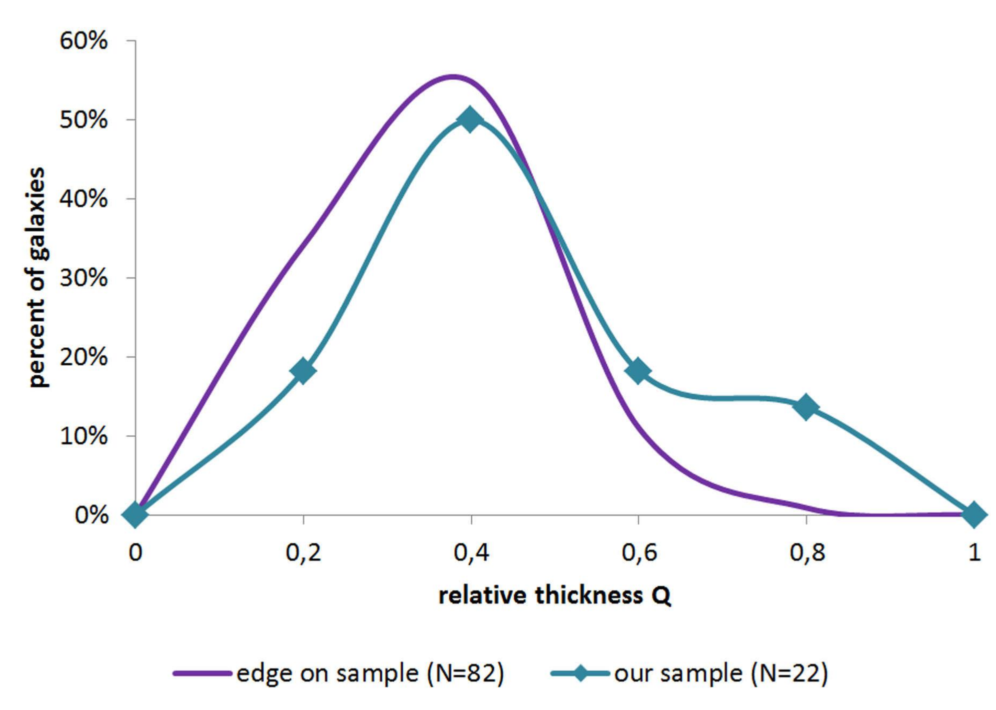
The relative thickness Q of the lenticular galaxies in clusters have a broad distribution with a mean of 0.42



COMPARISON

Calibration and formula (2) enable us to compare our results with earlier statistics using the sample of edge-on galaxies, compiled by Mosenkov et al. (2010)
On the figure we can see, that the distributions are very similar.

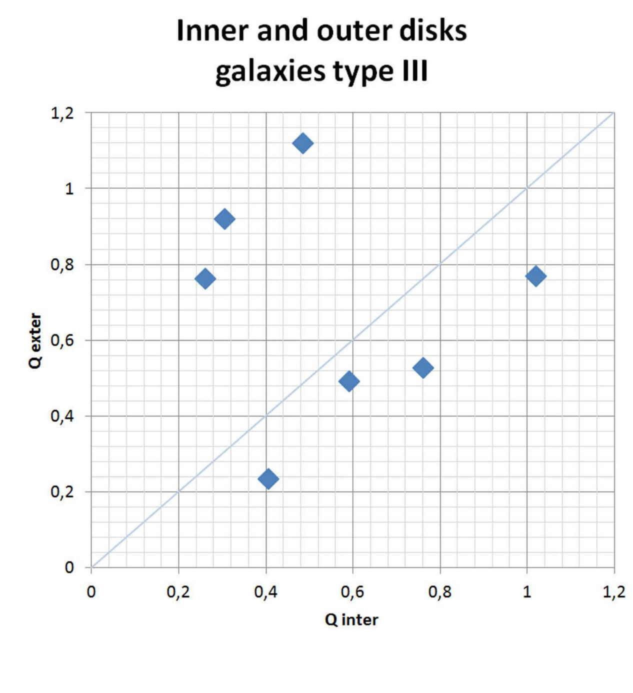
So we can conclude that the galaxies in the cluster does not differ by the thickness of the disks from the field S0.



PIECEWISE-EXPONENTIAL DISKS

5 of galaxies in our sample were piecewise exponential disks and allowed to determine the thickness of the two discs. We have added information on two previously known antitruncated objects to be able to compare the thickness of the inner and outer disks. On the figure we can see that piecewise exponential disks can be of two different types.

Three objects shows us thin inner disk and thicker spheroid (***III-s*** type by P.Erwin).
And four galaxies contain pseudo bulge and normal outer disk (***III-d*** type).



CONCLUSIONS

Density of the environment does not affect the thickness of the galactic disk

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