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# A Search for Pure Disk Galaxies

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# A SEARCH FOR PURE DISK GALAXIES

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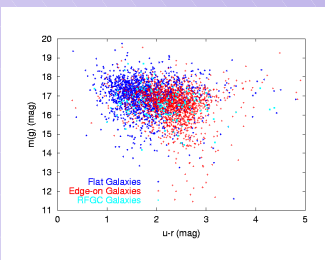


## MOTIVATION

The existence of pure disk galaxies is of high interest because recent hierarchical models do not explain the formation of pure disk galaxies. For that reason we started an extensive search for edge-on galaxies in the Sloan Digital Sky Survey (SDSS) Data Release 1 (DR1)\* in order to compile a uniform sample and to study their properties. An area of 2099 square degrees was searched. Here we present first results of our investigation.

## FLAT GALAXIES

Flat (or superthin) galaxies are late-type edge-on spiral galaxies that exhibit large axial ratios, small stellar disk scale heights and no distinct spheroidal bulge component (Matthews *et al.* 1999a). This type of galaxy appears to be a pure disk system with an extended blue stellar disk embedded in a red thick layer (Dalcanton & Bernstein 2002). Flat galaxies are very common objects with low star formation rates, low metallicities and low optical surface brightness, but high neutral gas fractions (Matthews *et al.* 1999b). Their rotation curves resemble those of dwarf and irregular galaxies (Karachentsev & Xu 1991). These simple disk systems offer the unique opportunity to constrain galaxy disk evolution in under-evolved galaxies in the nearby Universe.



This  $m_{\text{petro}}(g)$  vs.  $u_{\text{petro}} - r_{\text{petro}}$  color-magnitude diagram (CMD) can be used as a color separator between morphological types (see text below for more details)

## RESULTS

After removing contaminants from the collected systems we found 3306 edge-on galaxies. Using visual inspection, we found that nearly half of the objects show pure disks and the other half exhibits small bulges and/or nuclei. Therefore we divided our sample into pure disk (flat) galaxies (blue) and the other edge-on systems (red). It is known (Strateva *et al.* 2001) that the  $m_{\text{petro}}(g)$  vs.  $u_{\text{petro}} - r_{\text{petro}}$  diagram allows one to distinguish early morphological types from late-type galaxies at a color of  $u-r = 2.22$ . The CMD shows that most of the flat galaxies are of later type than the other edge-on systems. This means that early-type galaxies can dilute our sample because it is known that a few elliptical and lenticular galaxies have axial ratios  $> 3$  (Bernardi *et al.* 2003). The reference objects in the CMD are the recovered Revised Flat Galaxy Catalogue (RFGC) objects (Karachentsev *et al.* 1999). It is assumed that the RFGC galaxies resemble only pure disk galaxies but in the CMD we see that these objects also have colors of early types.

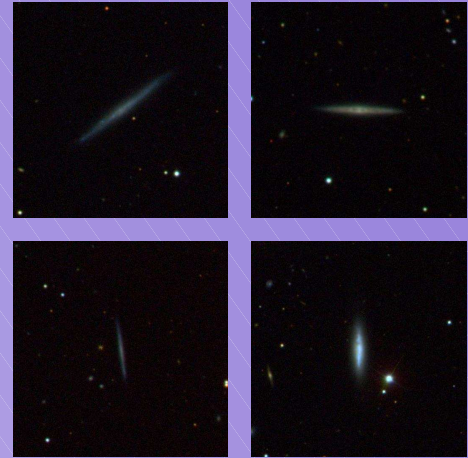
## DETECTION PROBABILITY

The sample is divided with the aid of eye inspection into a subsample of disk dominated flat galaxies and other edge-on galaxies with small bulges and/or nuclei. Here we present the detection quantities for our two subsamples. The used values are the apparent extinction-corrected petrosian magnitudes and the observed isophotal major and minor axis. All these quantities are downloaded from the SDSS database and are given in the g filter. The results are presented in the histograms (Fig. 1 – Fig. 4).

## DISCUSSION AND PREVIEW

We gathered a big sample of edge-on galaxies from the DR1. This collection is limited by the given selection criteria and the SDSS photometry itself. Some of the edge-ons are normal spirals such as Andromeda or ellipticals and lenticulars but it seems that a large amount (~2000) are real pure disk or disk-dominated galaxies although they have signatures of early-type systems. This work will be continued by searching for real flat and superthin galaxies and separating them from objects with bulges and bars. Subsequently we will study the group and individual properties of the flat galaxies in more detail.

Because of the high detection rate of flat galaxies there must be a mechanism that facilitates the frequent formation of large disk-dominated systems. We will investigate the implications of flat galaxies on galaxy evolution because these objects may be one of the most common products of galactic disk formation (Matthews *et al.* 1999b). Since flat galaxies are often found to be more or less isolated systems and merger scenarios do not explain the origin of pure disks it seems that these quiescent evolving objects are of great interest on the disk-forming stages of galaxy evolution.



Four examples of flat galaxies which we found in the DR1 (scale = 204.8 arcsec x 204.8 arcsec)

## THE SEARCH

### Selection Criteria:

In order to detect edge-on galaxies in the DR1 we defined following conditions:

- Axial ratio in the g filter  $a/b > 3$
- Angular diameter (major axis of galaxy in g filter)  $a > 15$  arcsec
- Colors in the range of  $-0.5 < g-r < 2$  mag and  $-0.5 < r-i < 2$  mag
- Magnitude limit in g filter  $< 20$  mag

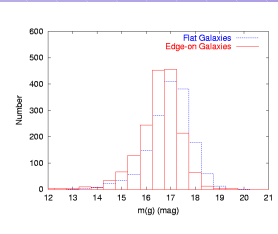


FIG. 1

This histogram presents how many galaxies can be detected in different magnitude intervals. The magnitude distribution of flat galaxies is similar to that of the other edge-on galaxies but about a half magnitude fainter. All galaxies fainter than 20 mag in g are excluded by the selection criteria. Based on this histogram, we estimate that incompleteness becomes significant at  $g > 17$  mag.

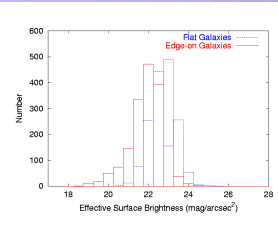


FIG. 2

The number distribution of the effective surface brightness shows that flat galaxies have fainter disks than objects with bulges and/or nuclei. This means that flat galaxies are mainly low surface brightness galaxies. The maximum effective surface brightness of flats is one mag/arcsec<sup>2</sup> fainter than those of the other edge-on galaxies.

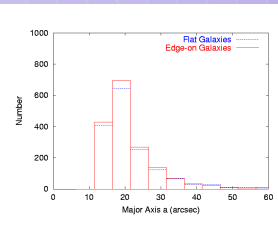


FIG. 3

The apparent angular extent along the major axis is similar for all collected galaxies. Owing to the minimum length of  $a = 15$  arcsec chosen in our selection criteria there is a detection bias against flat and other edge-on systems at large distances whose apparent major axis diameter falls below this threshold. On the other hand nearby objects with compact disks ( $a < 15$  arcsec) are excluded from our sample.

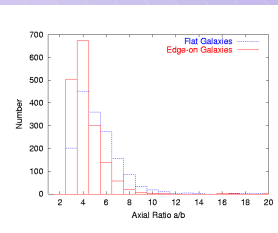


FIG. 4

Here it is shown that flat galaxies exhibit larger axial ratios than other edge-on objects. We can assume that our edge-on subsample is actually more bulge dominated and probably embedded in a thicker disk.

## RESOURCES:

+ SDSS DR1: <http://www.sdss.org/dr1/>

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