Parameters of Galactic Disks at Optical and NIR Wavelengths

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Disk's parameters

$I(r) = I_0 \exp(-r/h)$ or

$\mu(r) = \mu_0 + 1.086(r/h)$

μ_0 is a central surface brightness

h is a radial scale length

in *UBVRIJHK* passbands

+ integrated parameters of galaxies:

Type, M_B, D_{25}, V_{rot}, inclination, M_{dust}, etc.

Goals:

- Disk's parameters along the Hubble sequence (S0-S-Ir)
- *h*(blue)/*h*(red) *vs.* *e* → dust influence
- Color gradients → age and chemical gradients and dust distribution
- + rotation curve = mass distribution

Previous studies

μ, *h* (Type)

$\mu_0(K)$ = 15-16^m/arcsec^2 *h* = 1-2 kpc S0-Sa

$\mu_0(K)$ = 15-17^m/arcsec^2 *h* = 3-6 kpc Sc

$\mu_0(K)$ = 16-18^m/arcsec^2 *h* = 2-7 kpc Sd

Disks become thinner when going from S0 to Sc type

de Grijs (1998)

Previous studies

h(blue)/*h*(red) *vs.* Type

h(blue)/*h*(red) ≈ 1 S0-Sa

Barcells & Peletier (1994), de Grijs (1998)

spirals:

$\langle h(B)/h(K) \rangle$ =1.22 (de Jong, 1996)

=1.32 (Peletier et al., 1994)

=1.65 (de Grijs, 1998)

(1.0-2.0)

$\langle h(V)/h(I) \rangle$ =1.4 (Molenhoff, 2006)

Previous studies

Active galaxies:

h(blue)/h(red) ≈ 1

Cunow (2001)

But

$h(V)/h(I)$ = 1.25 for Seyferts

Xanthopoulos (1996)

Previous studies

***h*(blue)/*h*(red) *vs.* inclination**

<*h(V)/h(I)*> grows from 1 (e=0)
to 1.8 (e=0.8)

(Cunow, 2001)

Previous studies

Absorption

The centers of galactic disks are optically thick in the *B* band, but optically thin in the *K* band.

(van Driel et al., 1995; Cunow, 2001; Peletier et al., 1994)

The centers of galactic disks are optically thin in the both *B* and *K* bands.

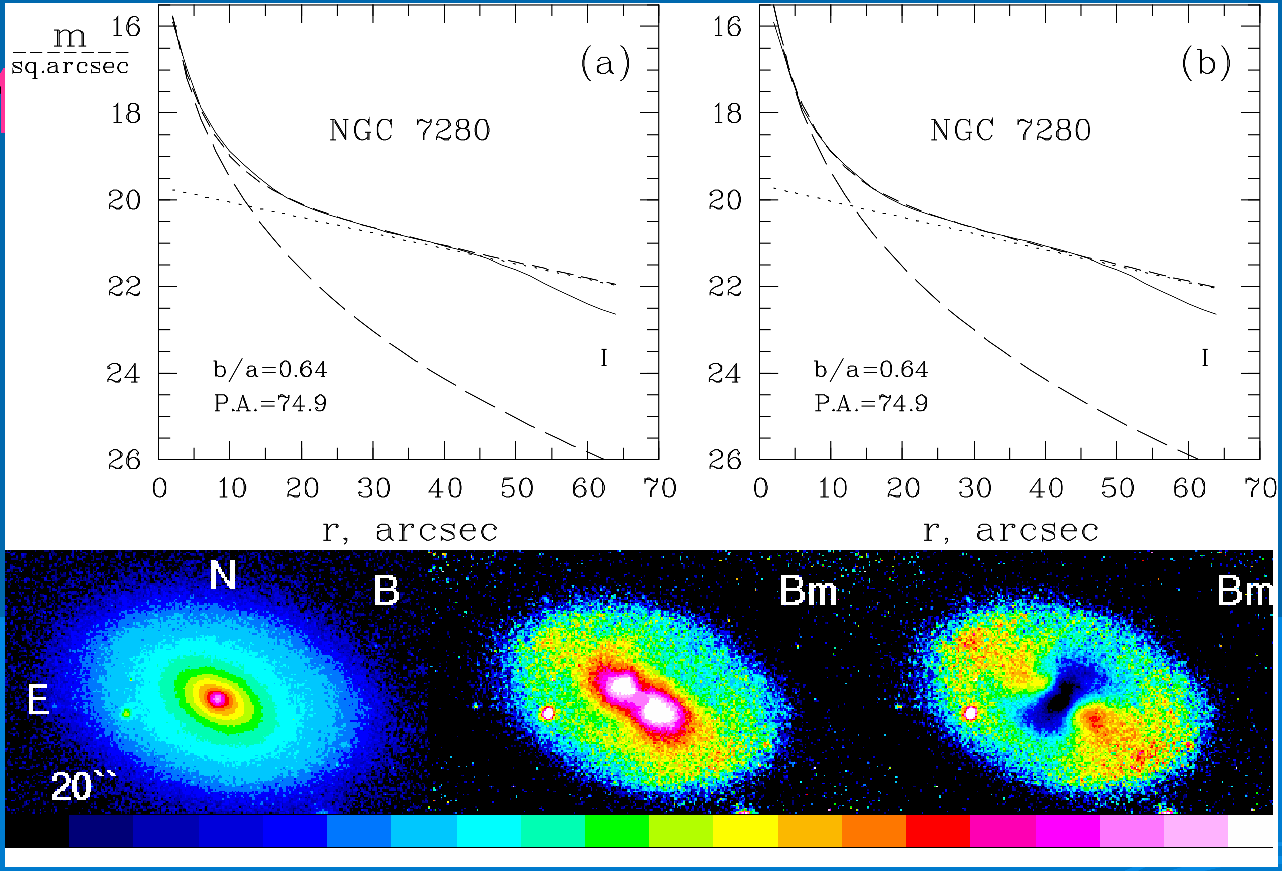
(Xilouris et al., 1999)

Defects of reviews

- Small number of photometric bands
- Galaxies with narrowly specified properties
- 1D decomposition

1D and 2D decompositions

2D 1



Samples of objects

From literature:

- 144 galaxies (2D decomposition)
- 248 galaxies (1D decomposition)

Our data:

- 12 galaxies (2D decomposition)

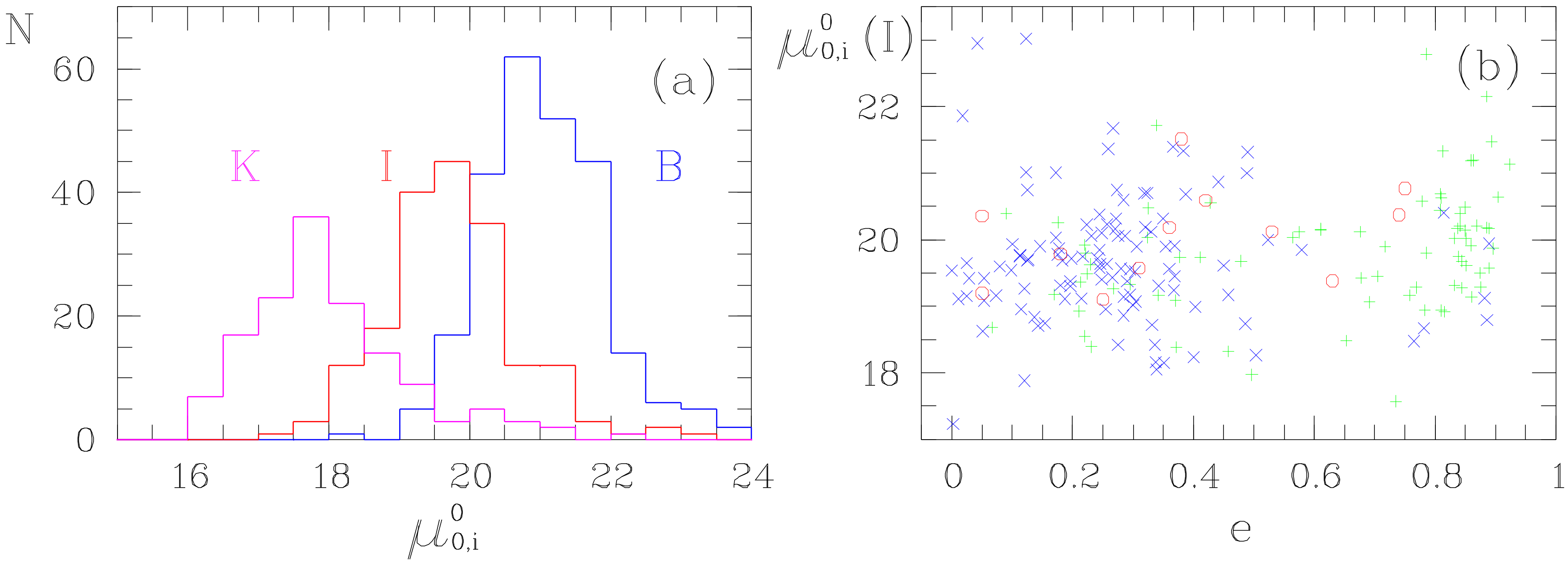
Thanks LEDA

Totally: 404 galaxies

Our data

NGC	Filters	Type	$M(B)_{0,i}$	D, Mpc	R_{25}, kpc	V_{rot}, km/s	e	M_{dust}, $10^6 M_{Sun}$
524	*UBVRIJHK*	-1.2	-21.63	32.4	17.0	300	0.05	0.35
532	*UBVRIJHK*	2.0	-19.48	31.5	16.0	191	0.74	3.3
783	*UBVRIJHK*	5.1	-21.14	70.5	16.8	46	0.25	26
1138	*UBVRIJHK*	-2.1	-19.57	32.9	8.7	25	0.05	-
1589	*UBVRIJHK*	1.8	-21.73	49.5	23.8	323	0.63	1.3
2336	*UBVRIJHK*	4.0	-22.32	32.2	30.0	256	0.42	9.7
4136	*BVRIJHK*	5.3	-18.41	7.6	4.1	93	0.18	0.17
5351	*BVRIJHK*	3.1	-21.19	48.9	19.6	202	0.53	1.3
5585	*UBVRI*	6.9	-18.48	5.7	3.5	79	0.38	0.12
7280	*UBVRIJHK*	-1.0	-19.41	25.9	8.1	131	0.36	0.056
7721	*UBVRI*	4.9	-21.14	26.3	11.6	142	0.75	-
I1525	*UBVRI*	3.1	-21.85	69.6	19.7	186	0.31	-

Central surface “face-on”



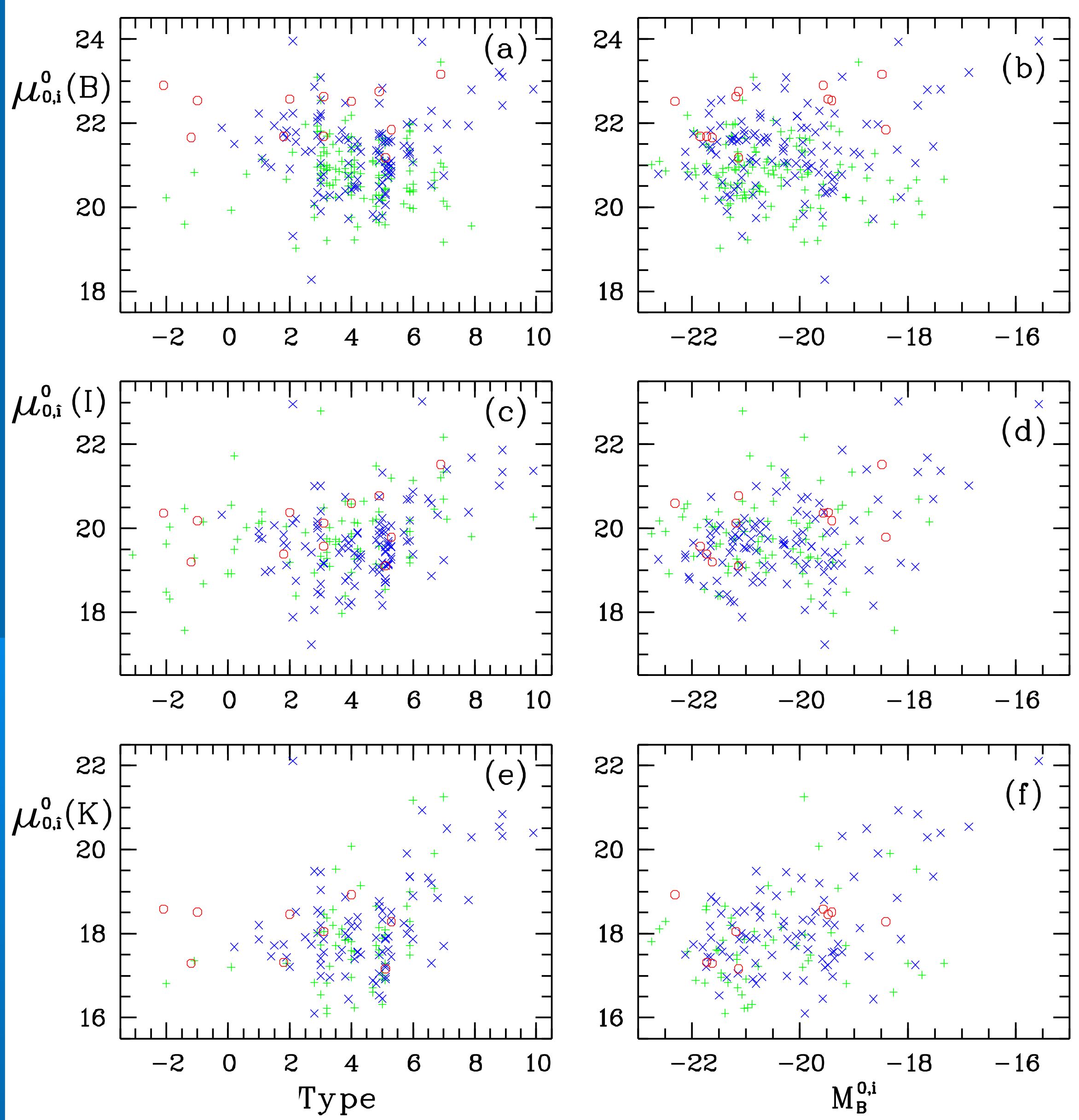
our samples

2D samples

1D samples

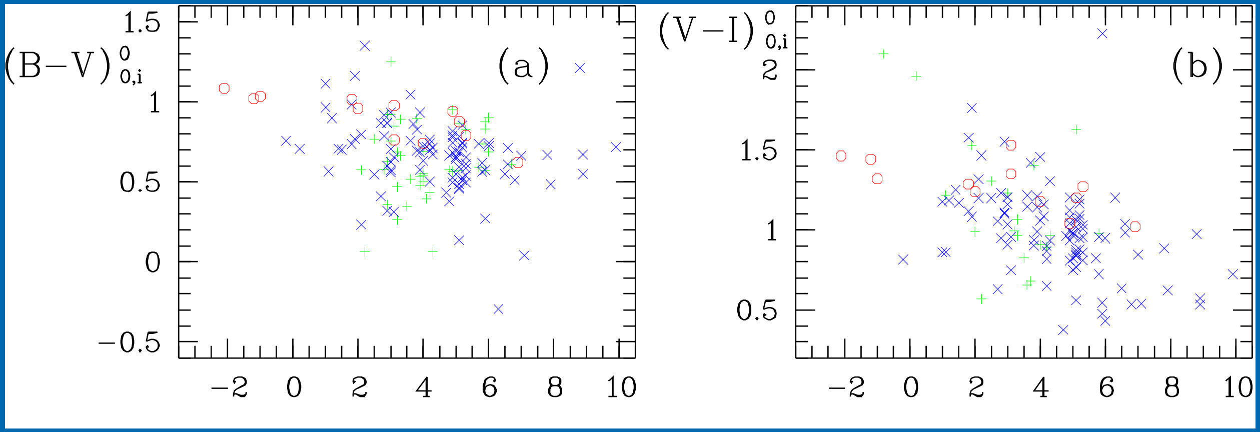
μ vs. Type, luminosity

No correlation for the any types

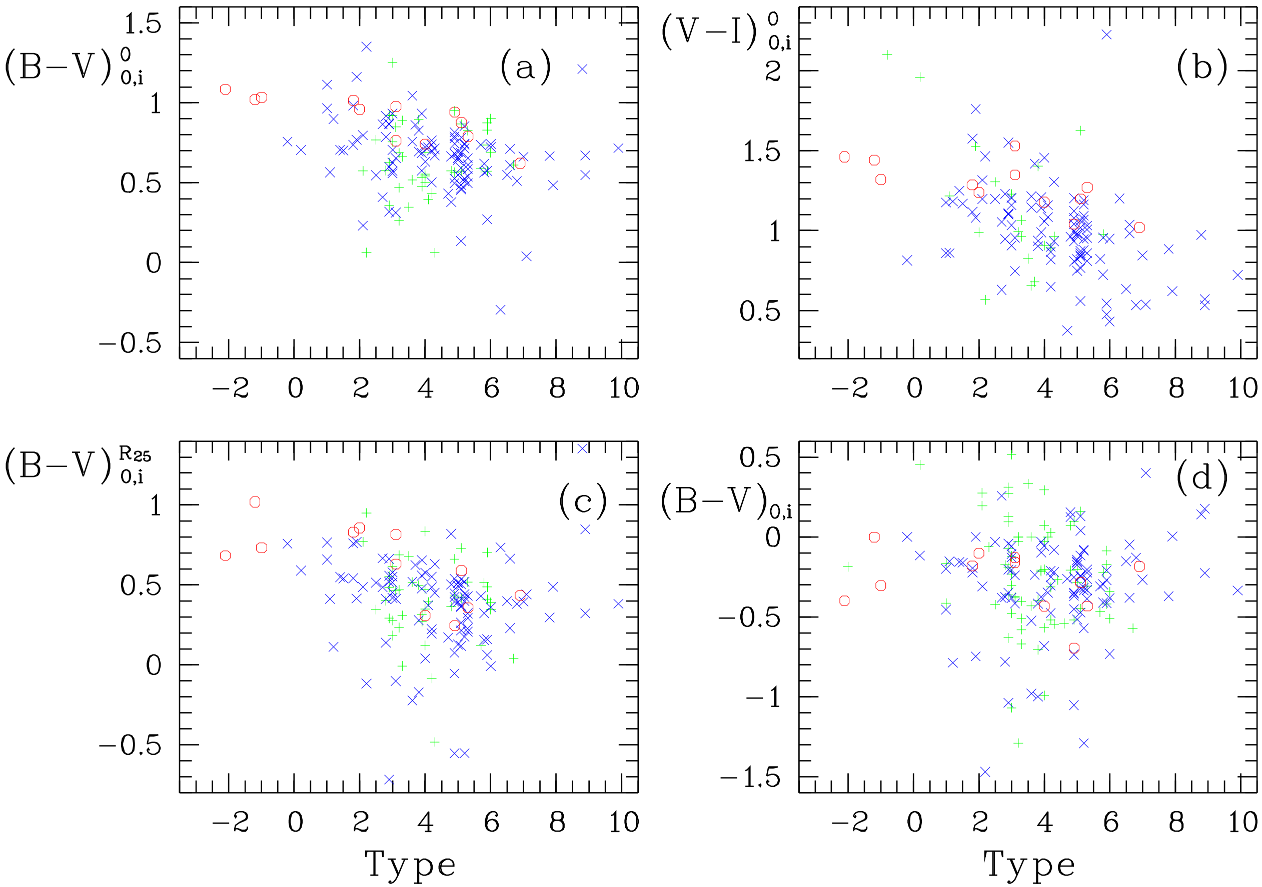


Scd and later galaxies are systematically dimmer

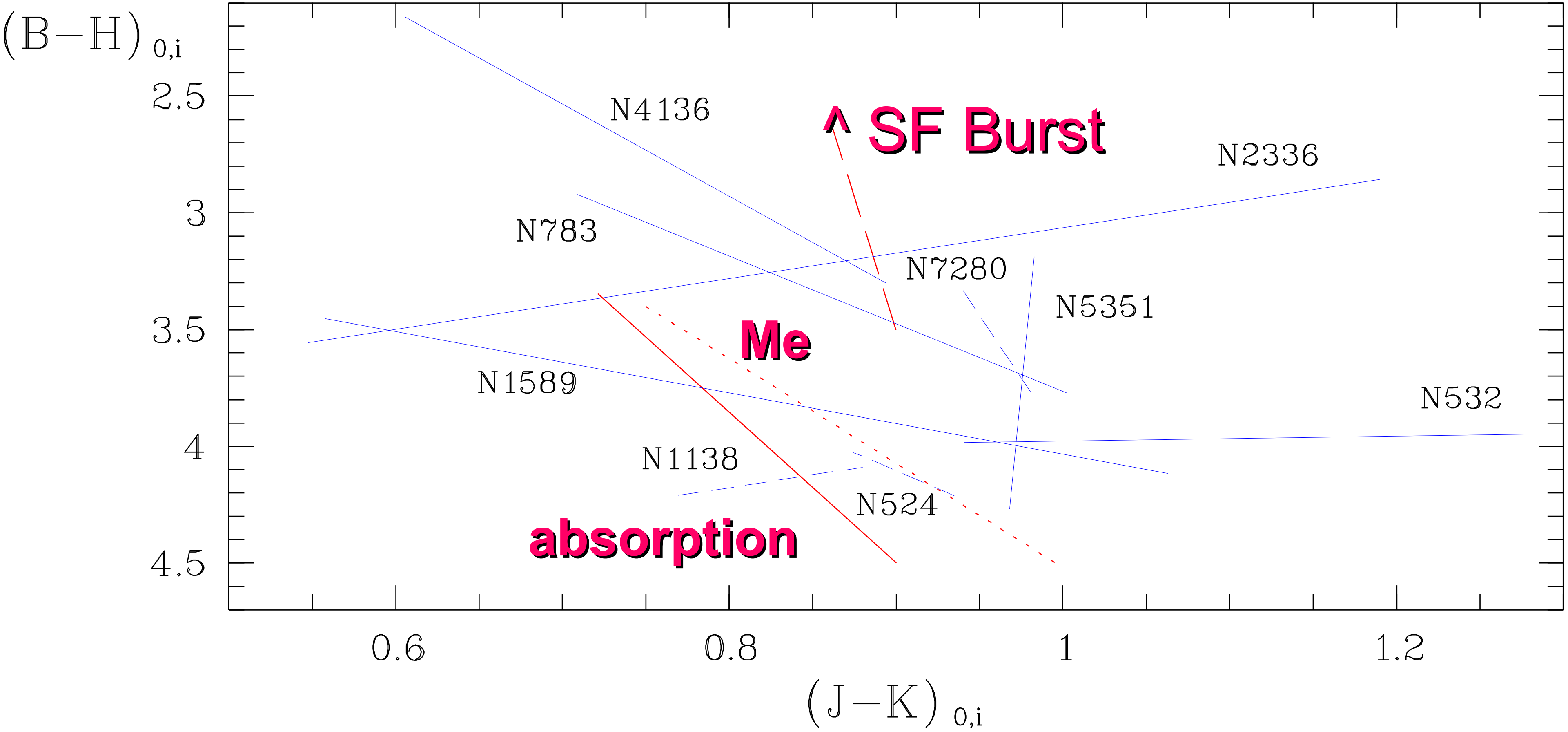
CIs *vs.* Type

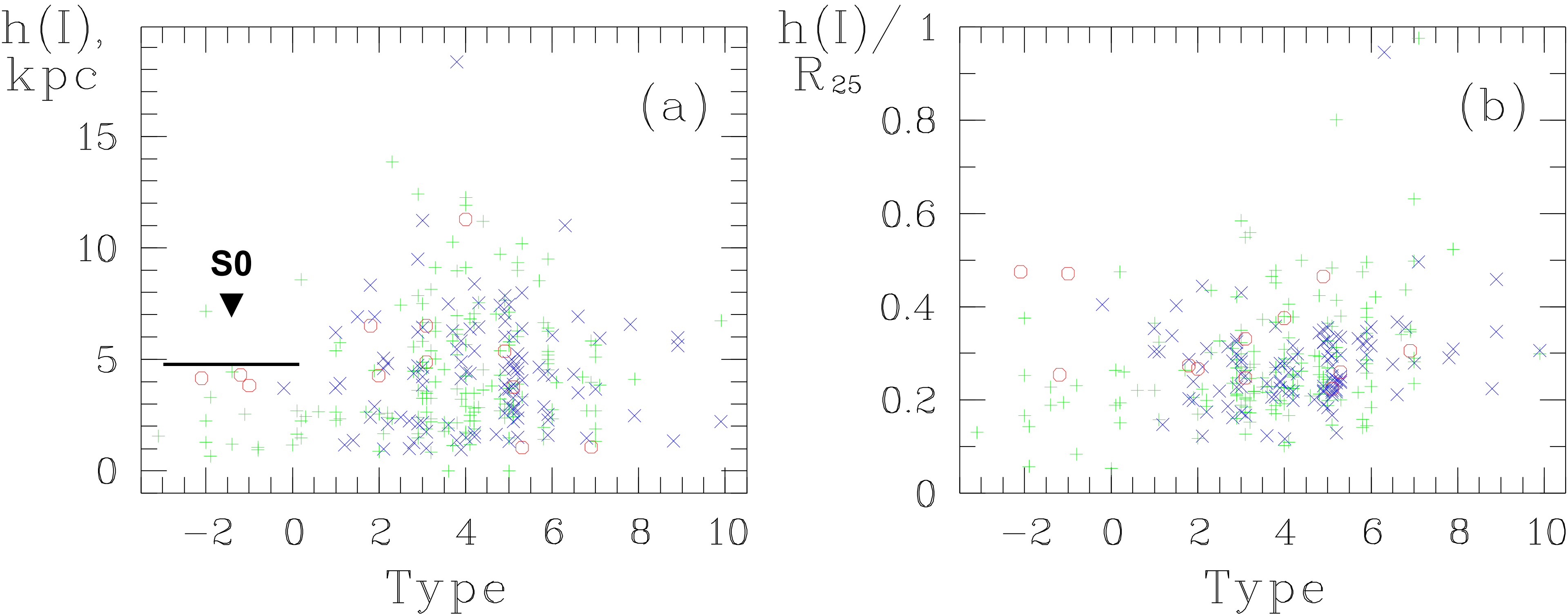


CIs vs. Type



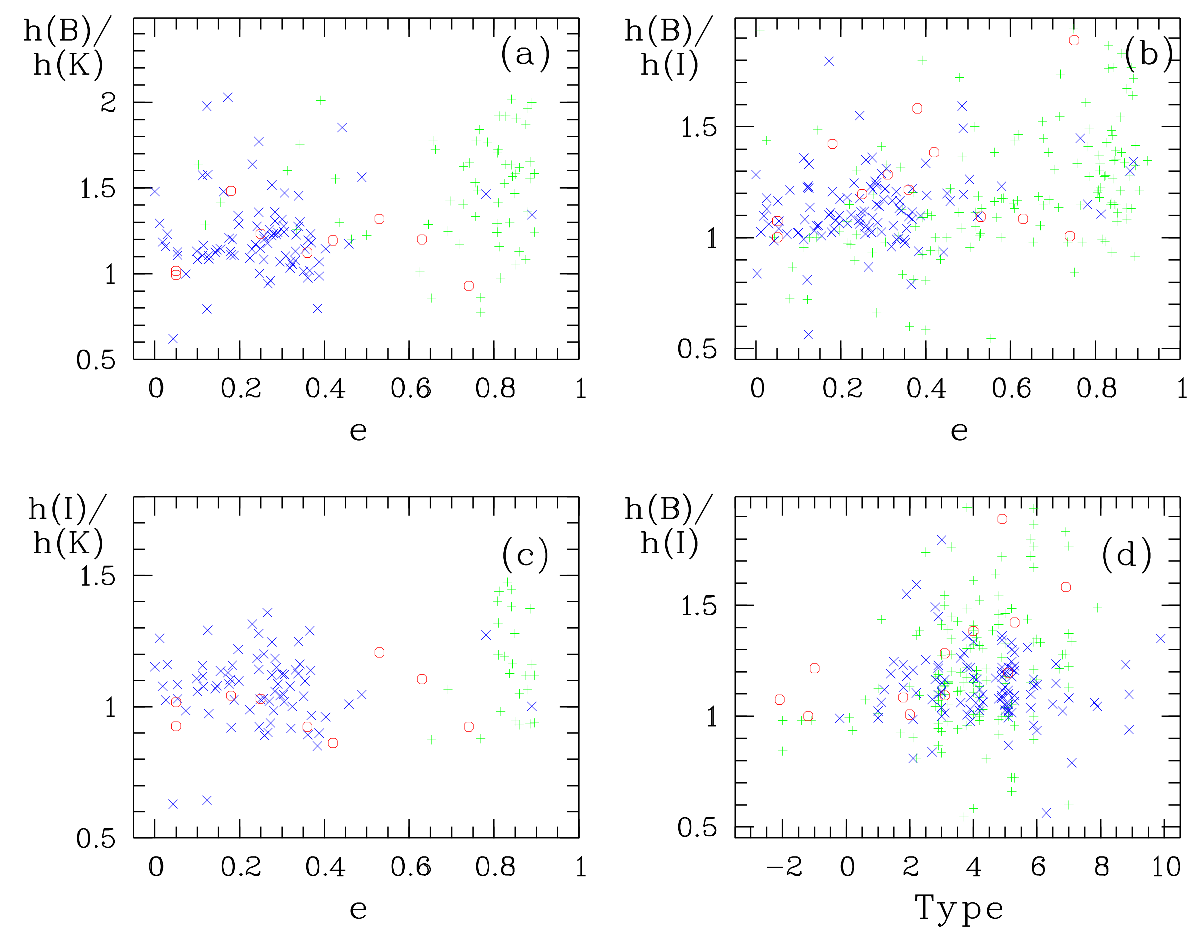
Two-color diagram





h(I), kpc
(a)
S0
0
5
10
15
−2
0
2
4
6
8
10
Type
h(I)/ R25
(b)
0
0.2
0.4
0.6
0.8
1
−2
0
2
4
6
8
10
Type

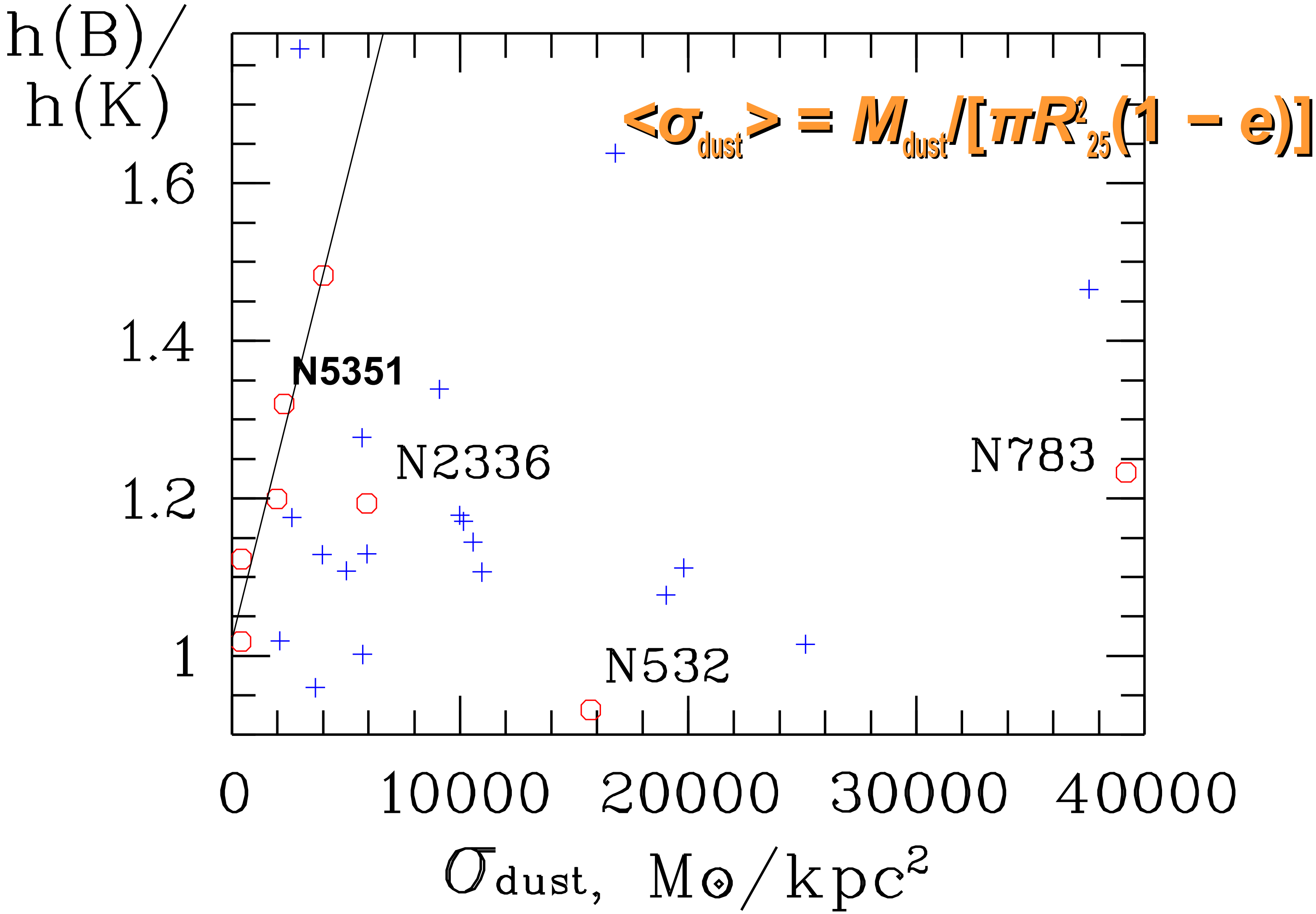
h(blue)/*h*(red) *vs.* e, Type



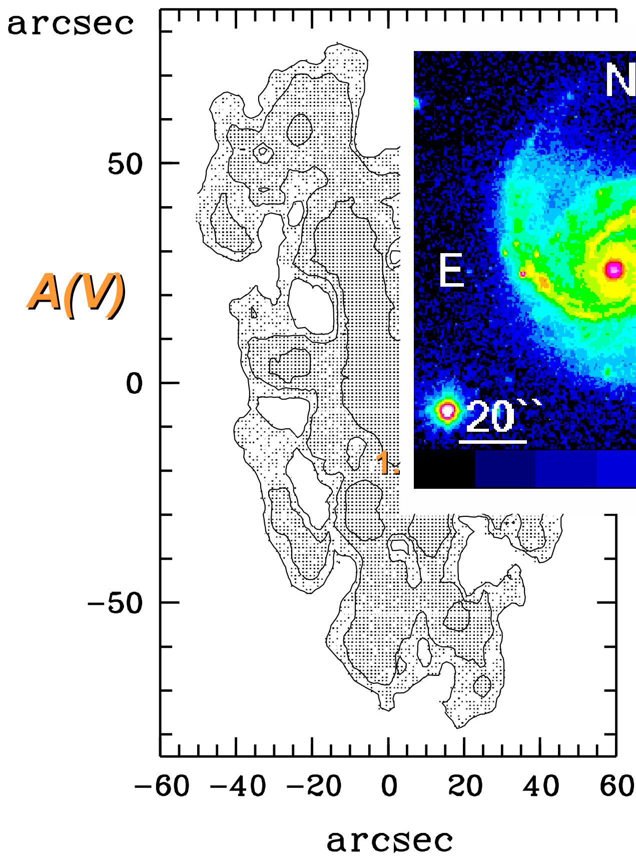
No visi

Increase toward late types

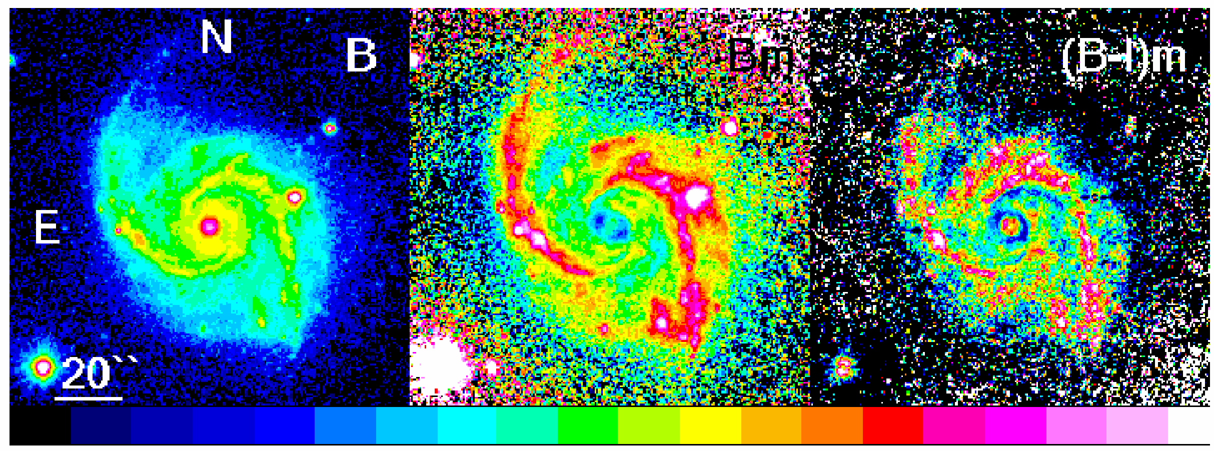
Dust and *h*(blue)/*h*(red) ratio



NGC 5351 and NGC 783

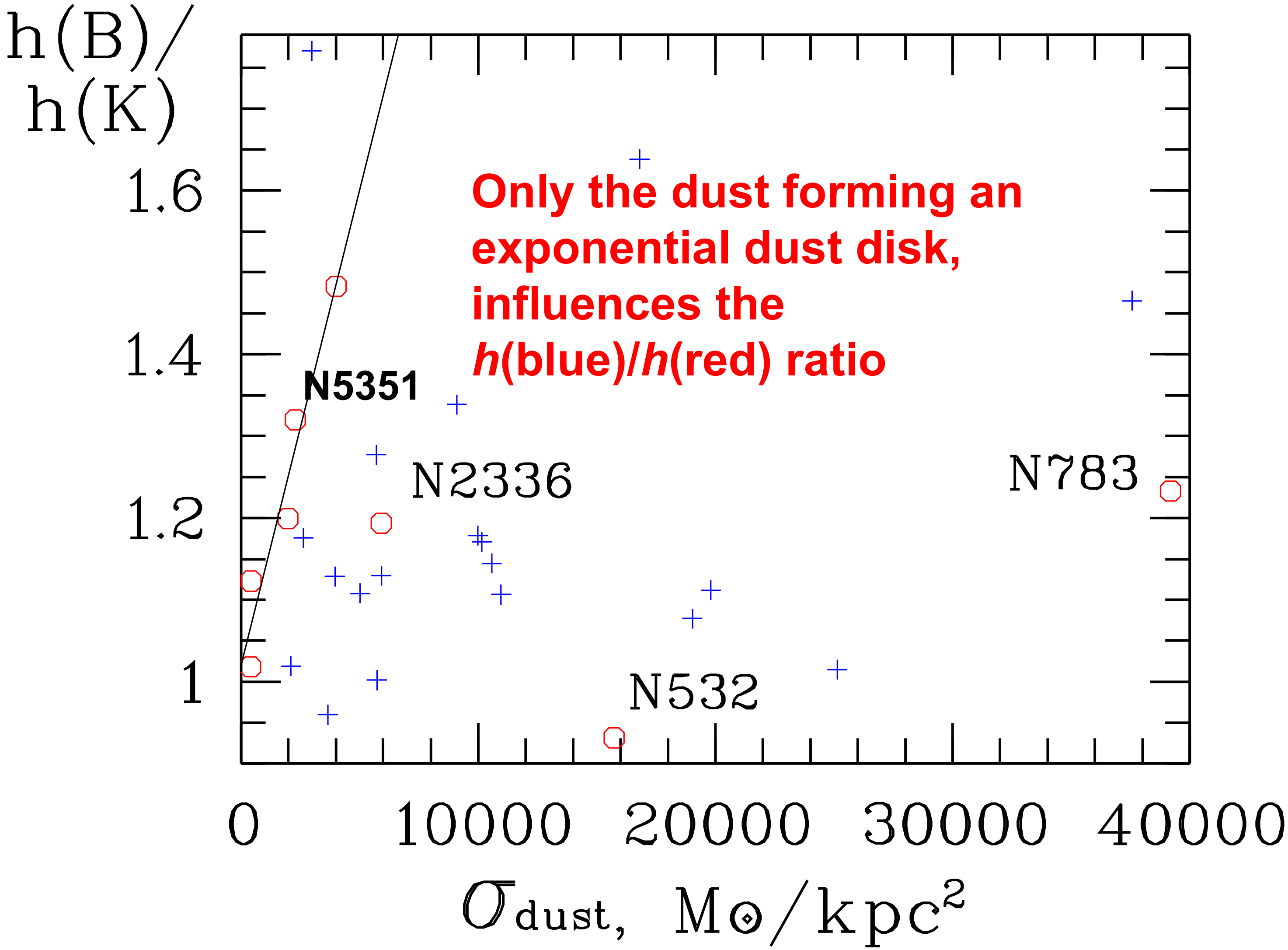


Gusev & Kajsin (2004)

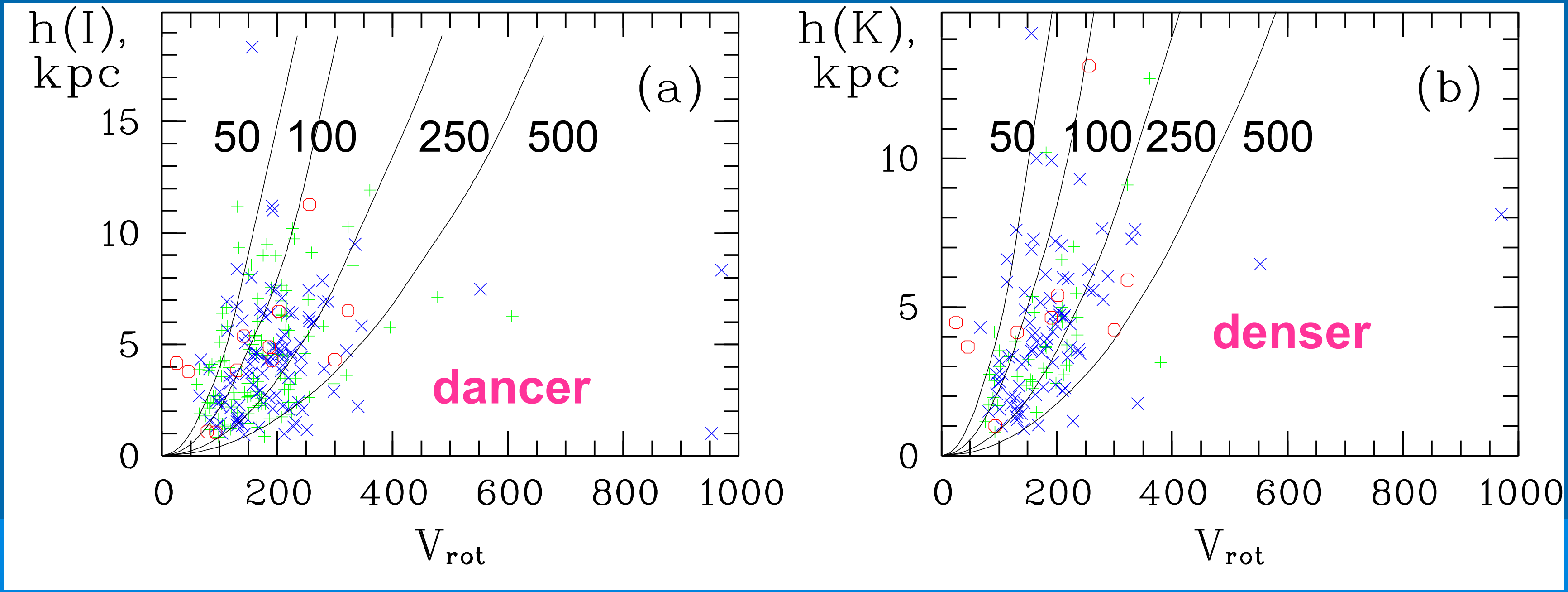


Gusev (2006)

Dust and *h*(blue)/*h*(red) ratio



Disk scale length and the max rotational velocity

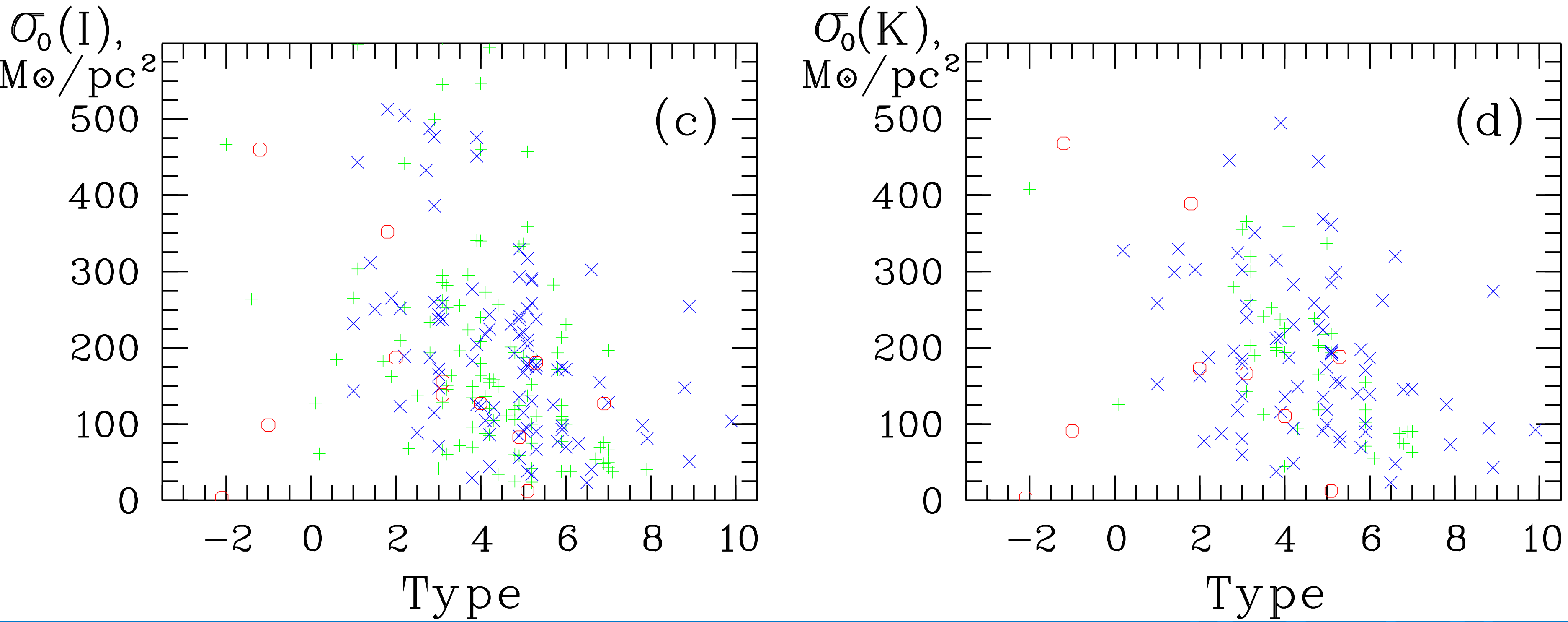


σ_0 [M_{Sun}/pc^2] ≈ 0.044 V^2_{disk} [km/s]/h [kpc]

V_{disk} = (0.6–0.8) V_{rot} ⟶ **if $h(I, K) \approx h(\sigma)$**

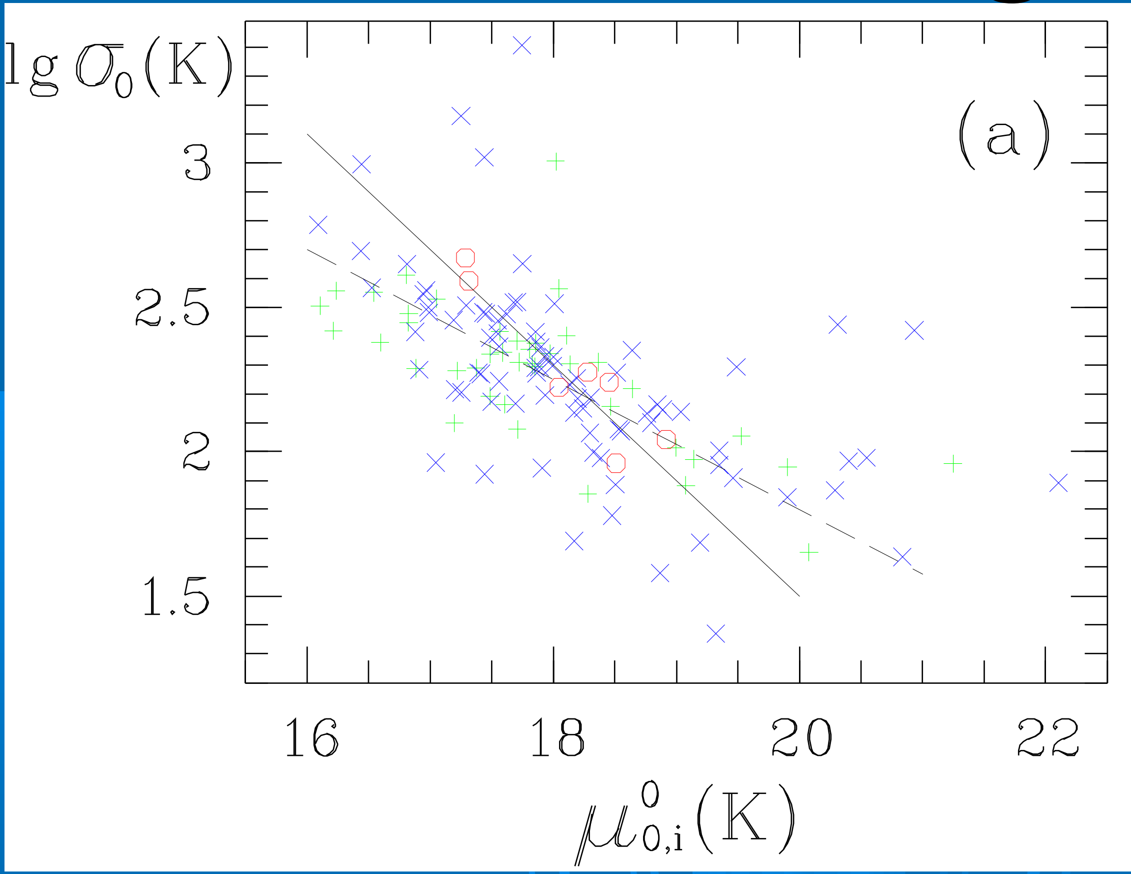
σ_0 [M_{Sun}/pc^2] ≈ 0.022 V^2_{rot} [km/s]/h [kpc]

Central surface density of the disk *vs.* Type



The central surface density decreases along the Hubble sequence

Estimated central surface density and the central surface brightness

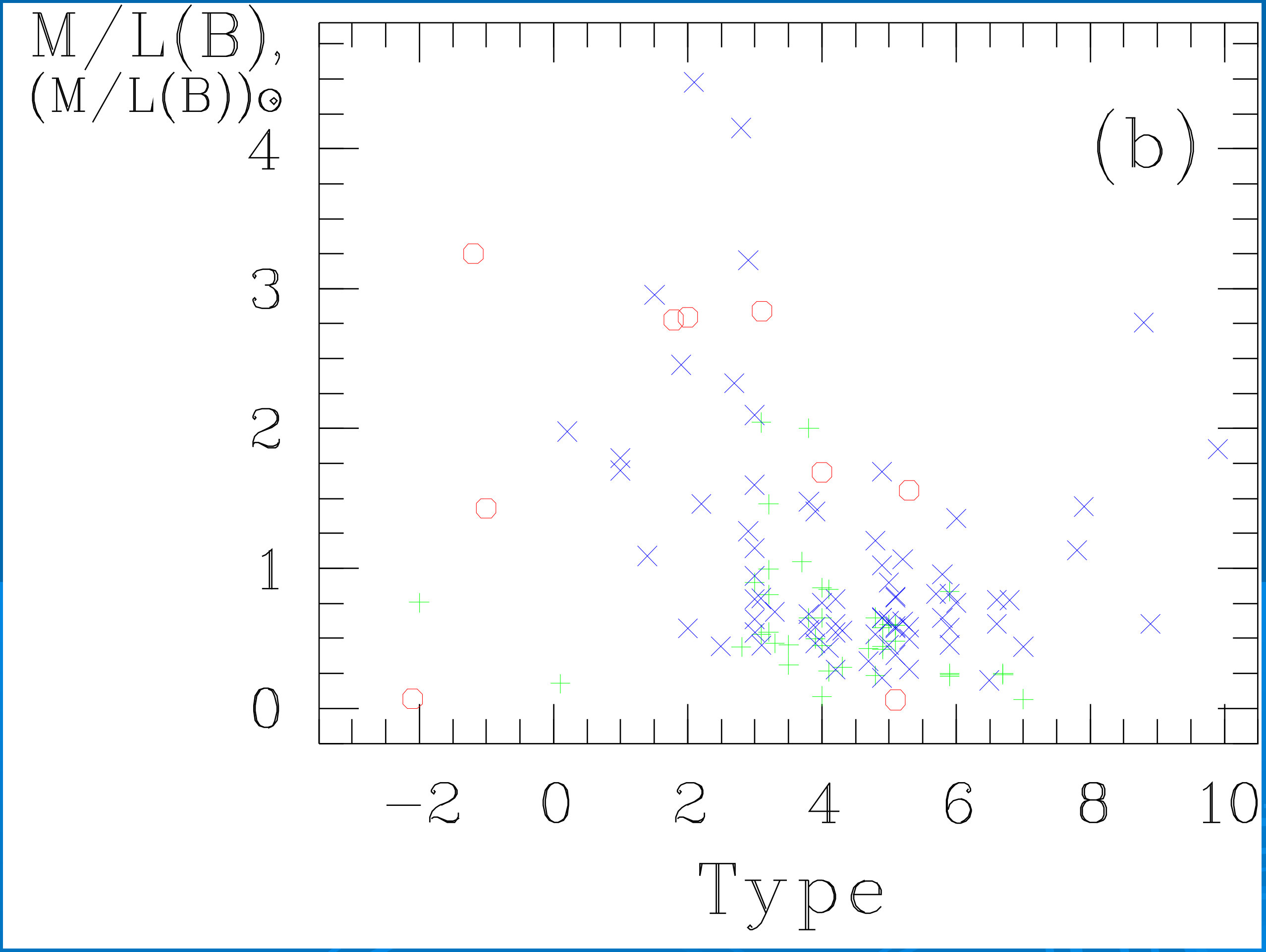


$\log \sigma_0(K) = -0.4\ \mu_0^{0,i}(K) + 9.5$
(|r| = 0.30)
or $\sigma_0(K) \approx 0.36\ (M/L(K))$

<$M/L(K)$> = 0.5 ± 0.2
(Bell & de Jong, 2001)

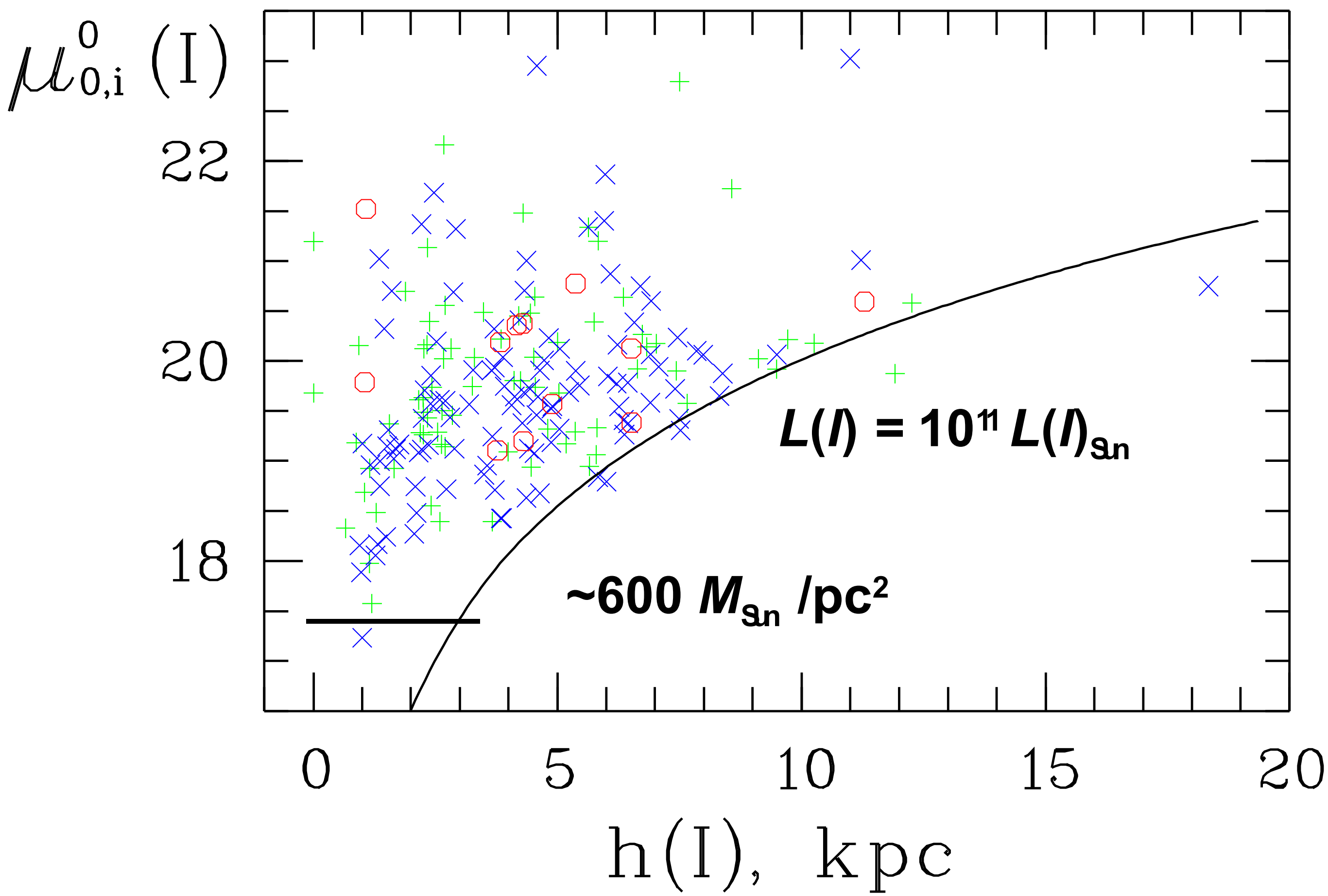
$\log \sigma_0(K) \approx -0.225\ \mu_0^{0,i}(K)$

M/L ratio *vs.* Type



***M/L*(*B*) ratio decreases along the Hubble sequence**

Central surface brightness *vs.*



Conclusions

Along the Hubble sequence:

- **The value of disk central *K* surface brightness,**
- **The central surface density,**
- **Central mass-to-luminosity ratio *M/L*(*B*),**
- **Integrated and the central color indices values**

are decrease.

- **The color gradient normalized to the radius of the galaxy,**
- **The "blue" central surface brightness of the disk**

independent of the galaxy type.

- **The radial disk scales ratios (blue/red),**
- **The relative sizes (h/R_{25})**
- **The impact of dust**

are increase.

Conclusions

- The disks in S0 galaxies have more homogeneous parameters than those in spiral galaxies. This may be due to the lower linear age and metallicity gradients of their stellar populations, as well as the lower amounts of dust in the disks of S0 galaxies.

- The linear sizes (*h*) of disks in S0 galaxies less than 5 kpc, disks in lenticulars are shorter than in spirals.

- In all photometric bands, the central surface brightnesses of the disks increase with the total luminosity of the parent galaxy.

- The ratio of linear disk scales measured in different photometric bands *h*(blue)/*h*(red) increases with the isophote ellipticity *e* of the disk (the inclination of the galaxy); however, the range of *h*(blue)/*h*(red) values for each e value exceeds the range of variations of *h*(blue)/*h*(red) over e. This is due to the fact that very broad intervals are observed for the radial variations of the composition of the stellar population in the disk and the parameters of the dust disks in the galaxies.

Conclusions

By photometric parameters,
disks are closer,
than its parental galaxies.

Disks are islands of stability
in our unstable world

Thanks