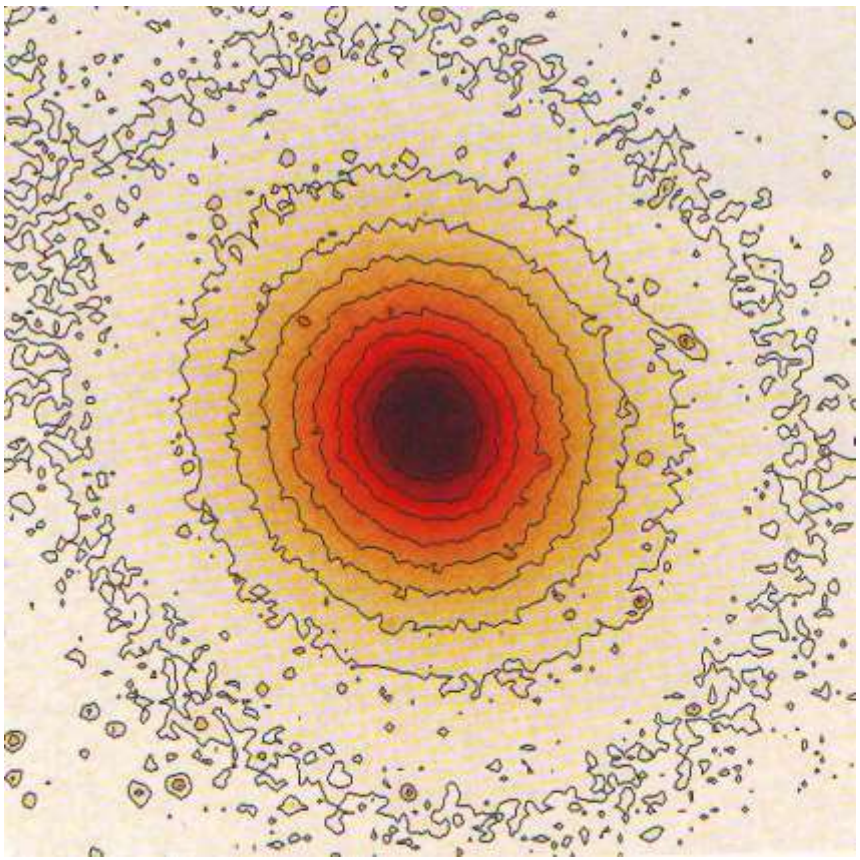
Lastnosti galaksij in merjenje oddaljenosti

eliptične



Sersic-ov zakon:

$$I(R) = I(0)e^{-kR^{1/n}}$$

n=4: de Vaucouleurs-ov zakon

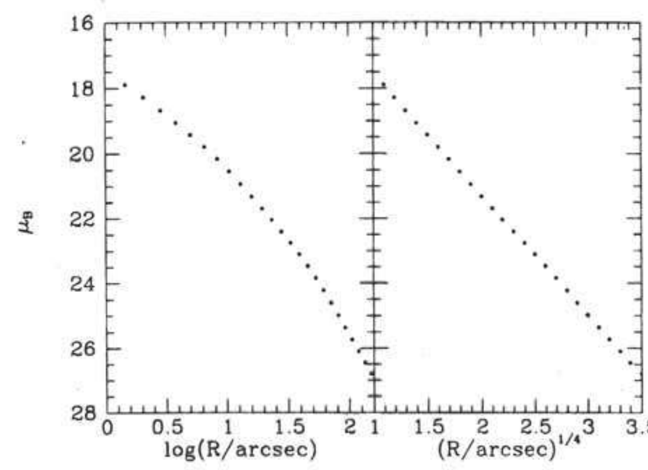
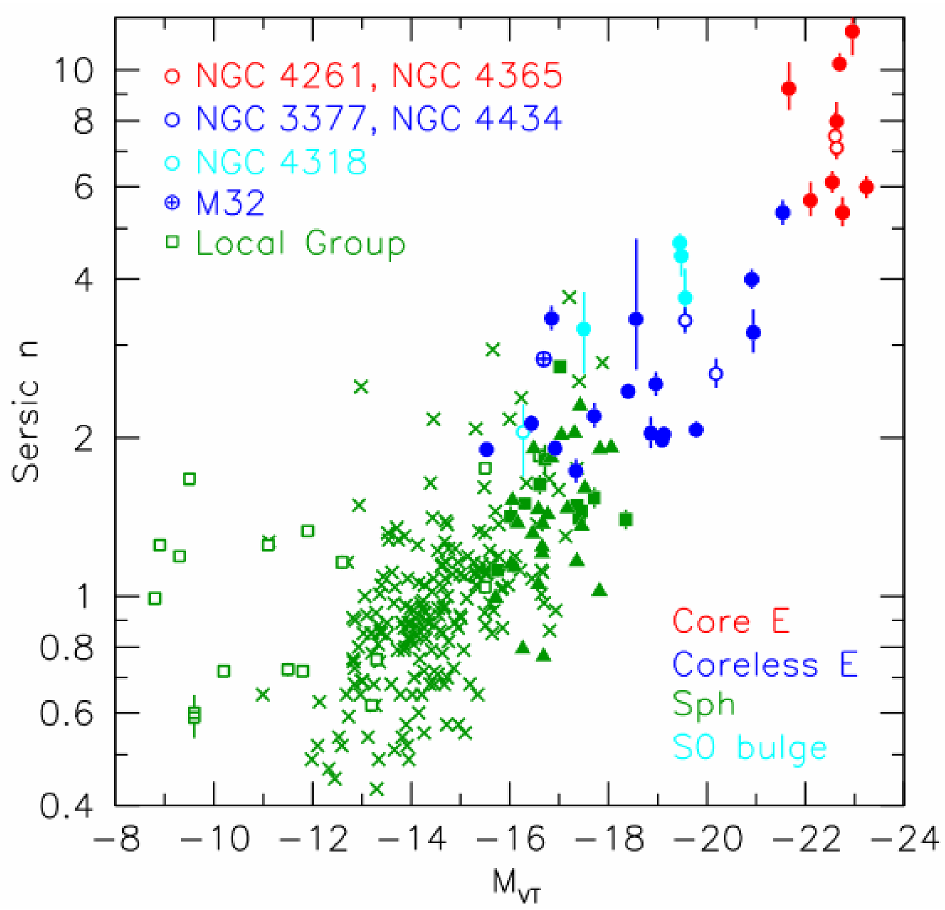
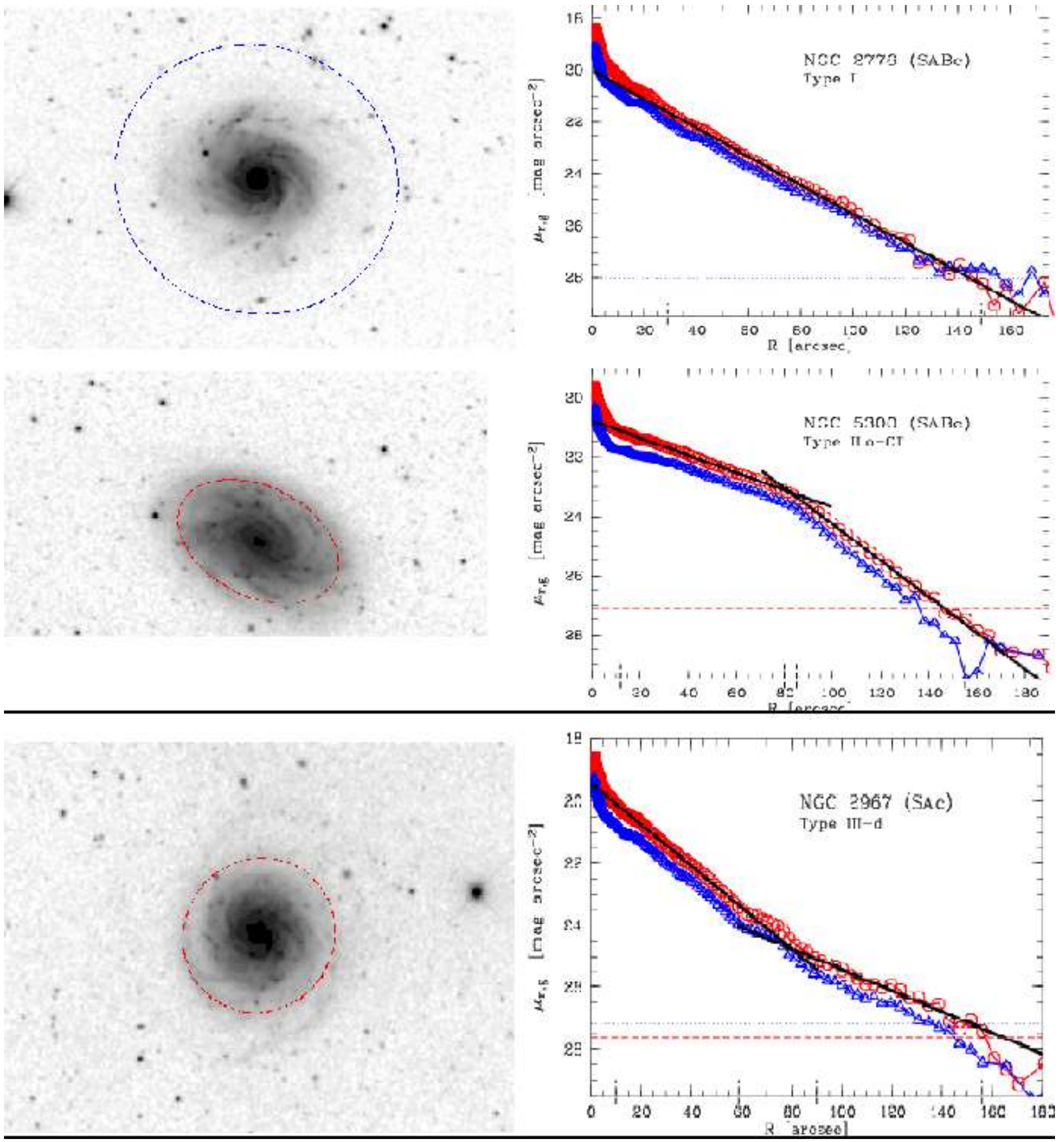


Figure 4.25 The major-axis brightness profile of NGC 1700 plotted against (a) $\log r$ and (b) $R^{1/4}$. [From data published in Capaccioli, Piotto & Rampazzo (1988)]



- bolj svetle eliptične galaksije – večji n

spiralne



eksponentna funkcija:

$$I(R) = I(0)e^{-R/R_d}$$

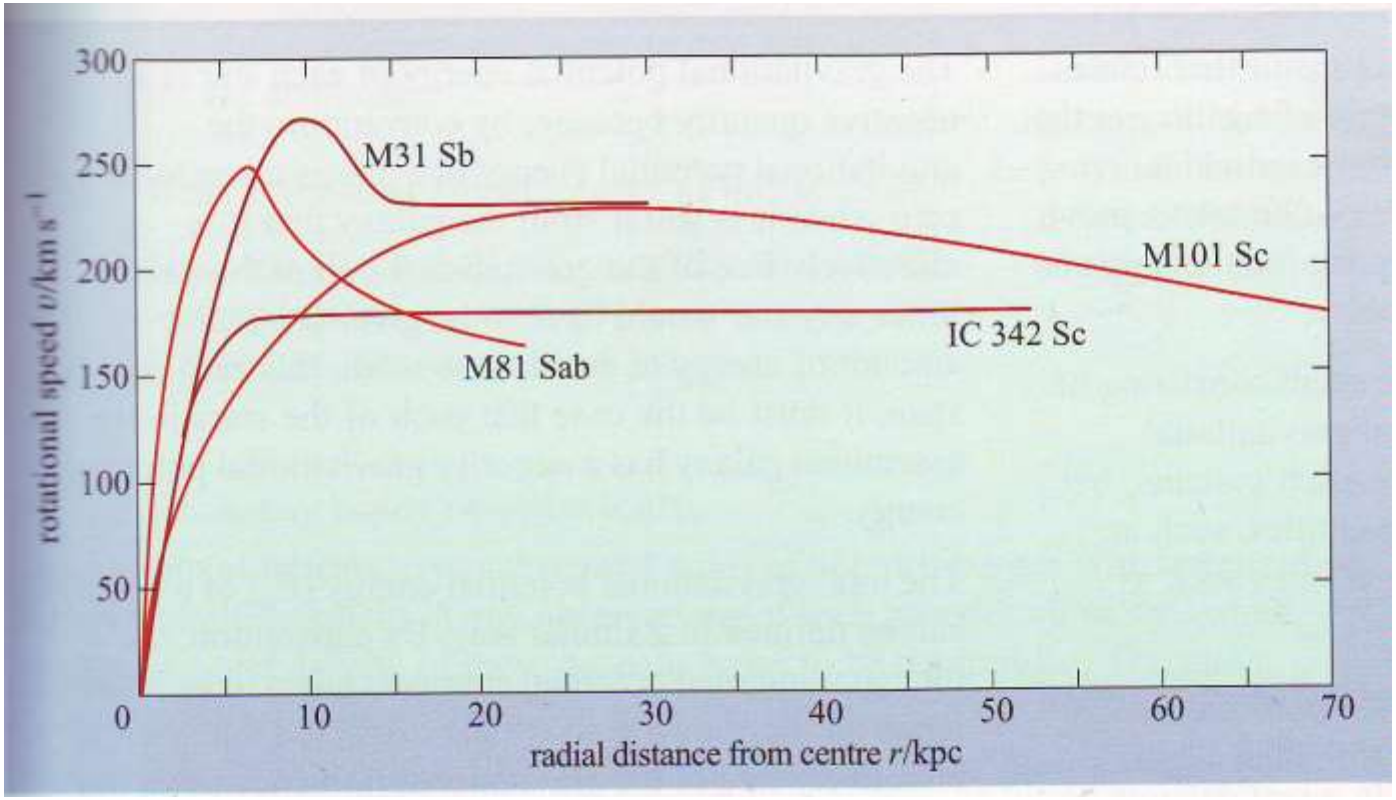
(tudi za lečaste)

vertikalni profil spiralnih:

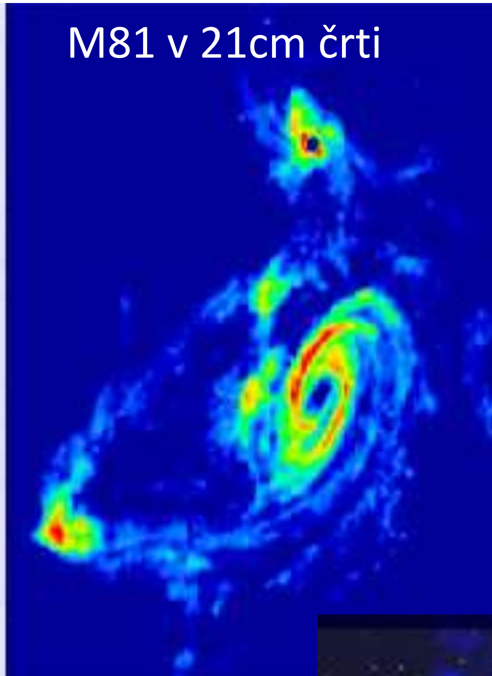
$$I(z) = \frac{I_0}{ch^2\left(\frac{z}{z_0}\right)}$$

masa

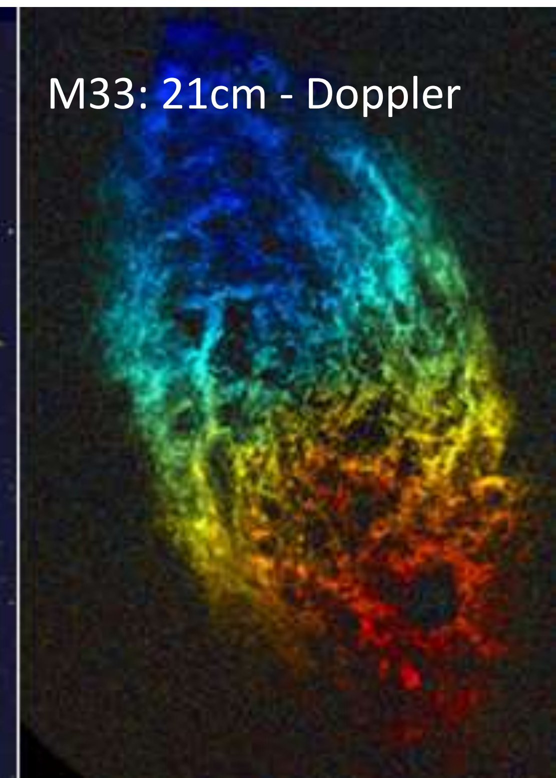
- rotacijska krivulja v(r):




M81 v vidni svetlobi


M81 v 21cm črti


M33: 21cm - vidna


M33: 21cm - Doppler

eliptične

- disperzija hitrosti: $\sigma \propto \sqrt{\frac{M}{R}}$

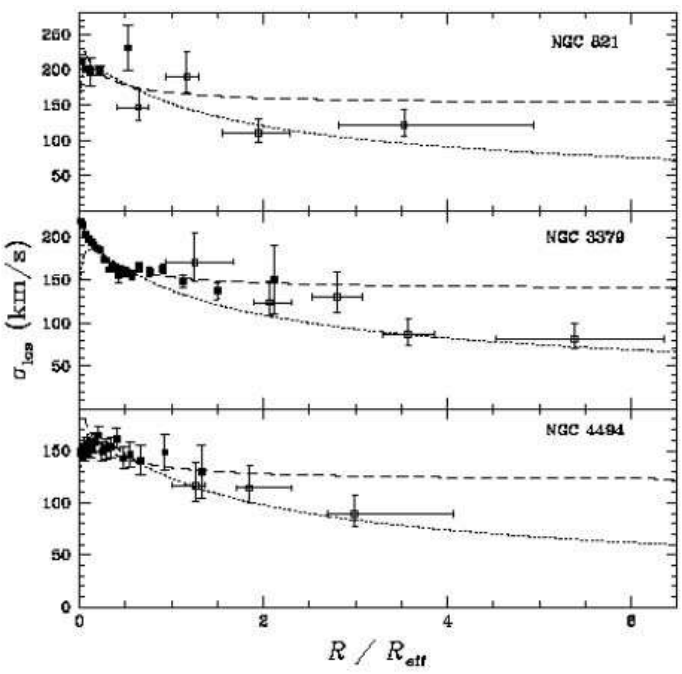
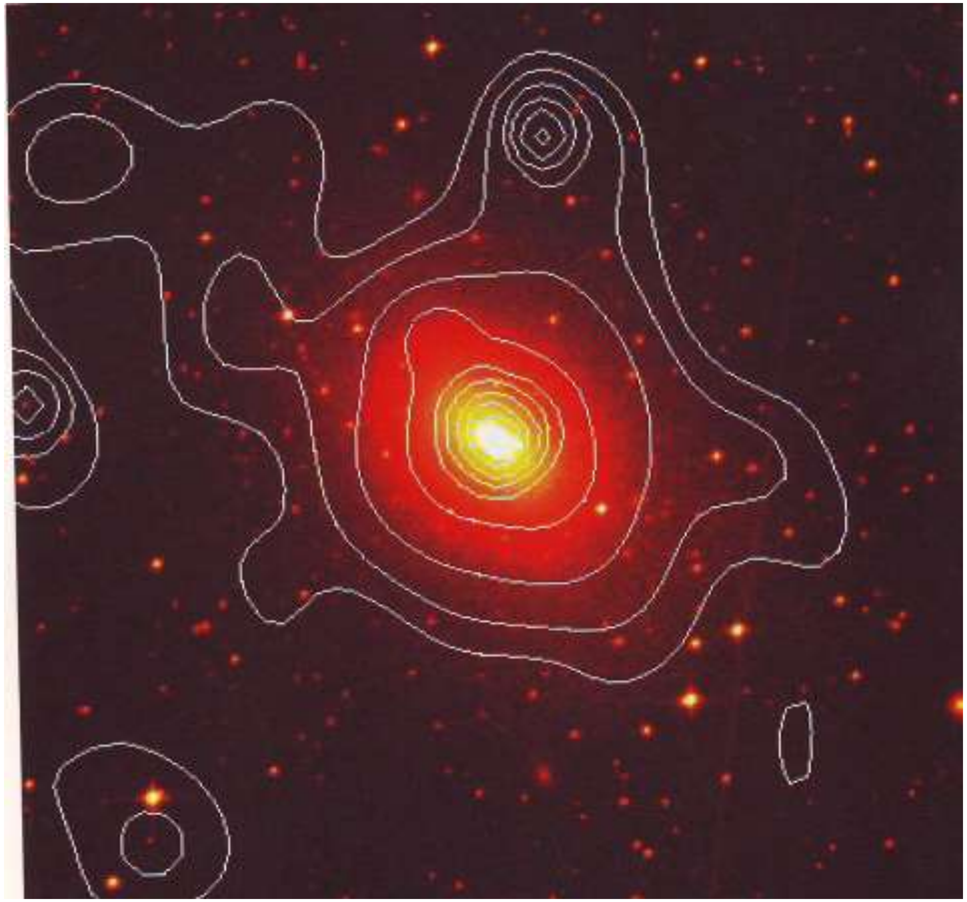


Fig. 39 - Line-of-sight velocity dispersion profiles for three elliptical galaxies, as function of projected radius in units of R_{eff}. Open points show PNe (from PN.S); solid points show diffuse stellar data. The vertical error bars show 1 σ uncertainties in the dispersion, and the horizontal error bars show the radial range covered by 68% of the points in each bin. Predictions of simple isotropic models are also shown for comparison: a singular isothermal halo (dashed line) and a constant mass-to-light-ratio galaxy (dotted lines).

- rentgenski haloji



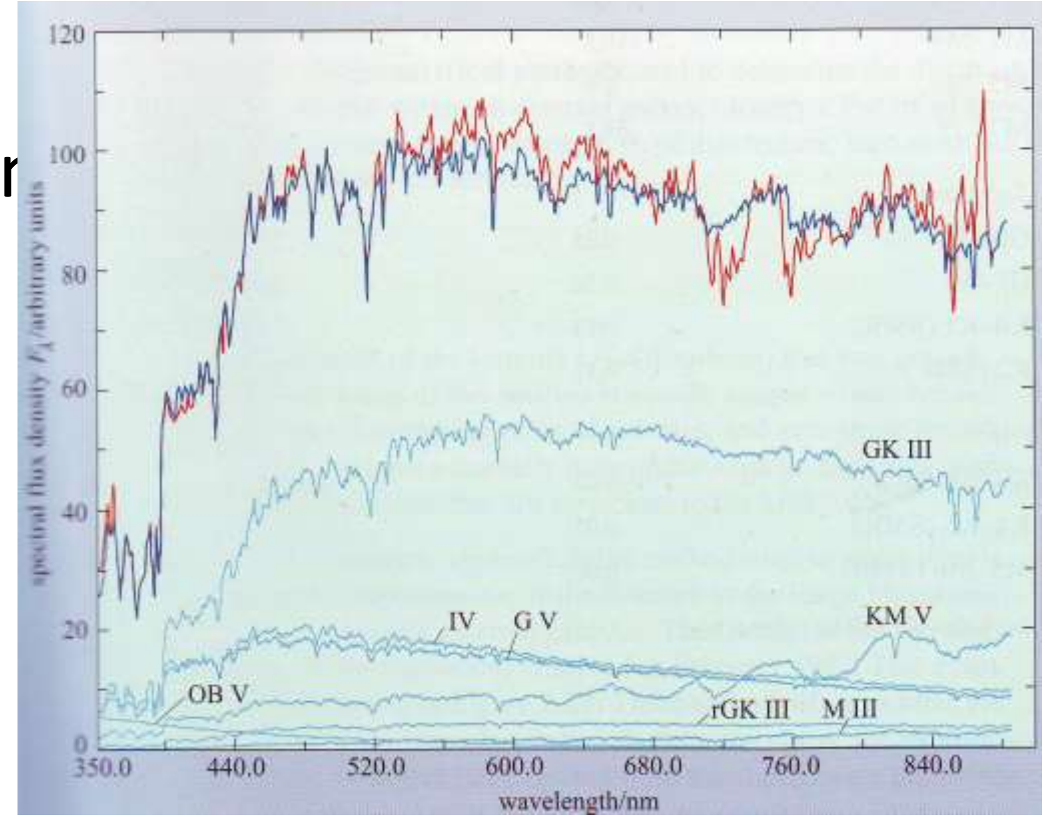
sestava

- temna snov, zvezde, plin, prah

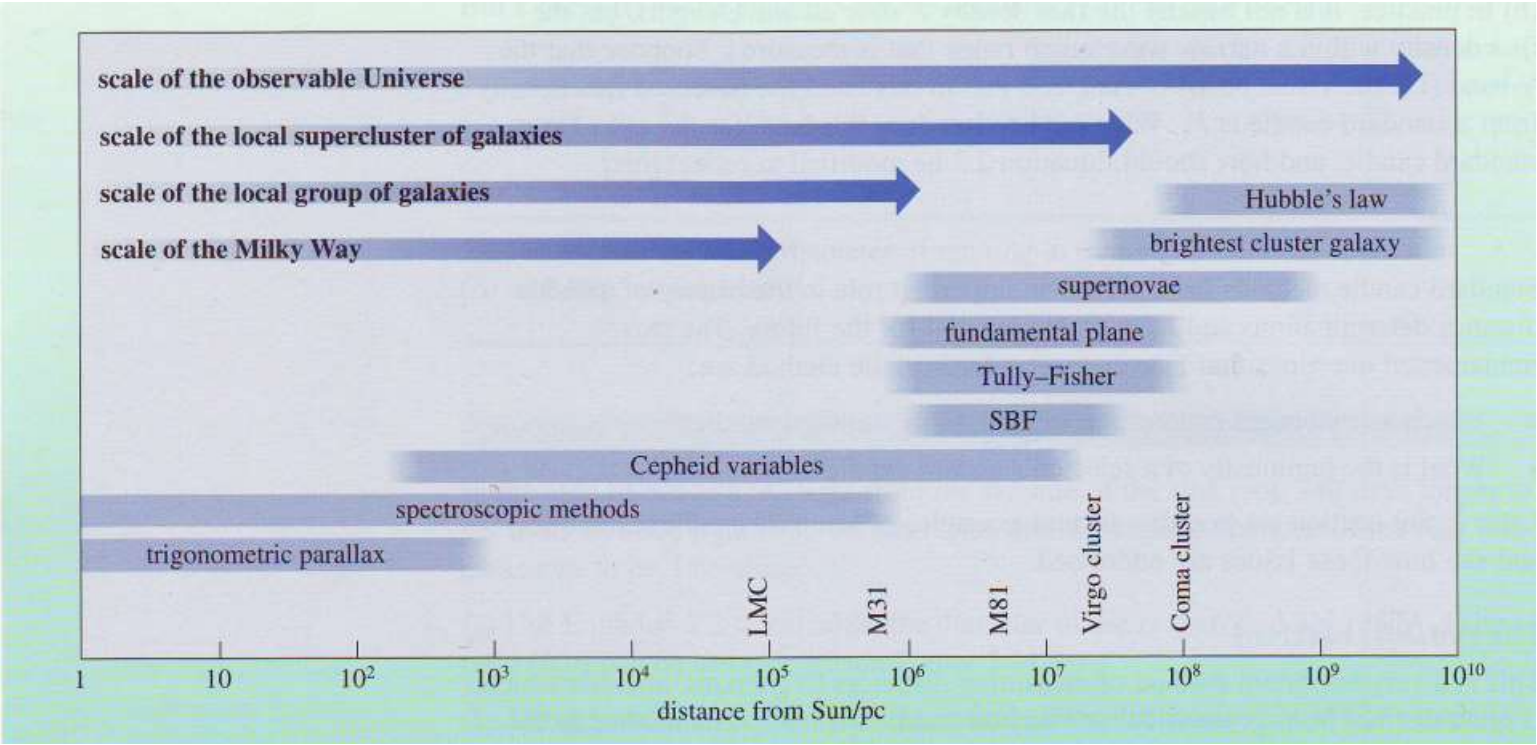
plin: iz 21cm, X-rays

zvezde: koliko in kakšn

populacijska sinteza



Razdalje do galaksij

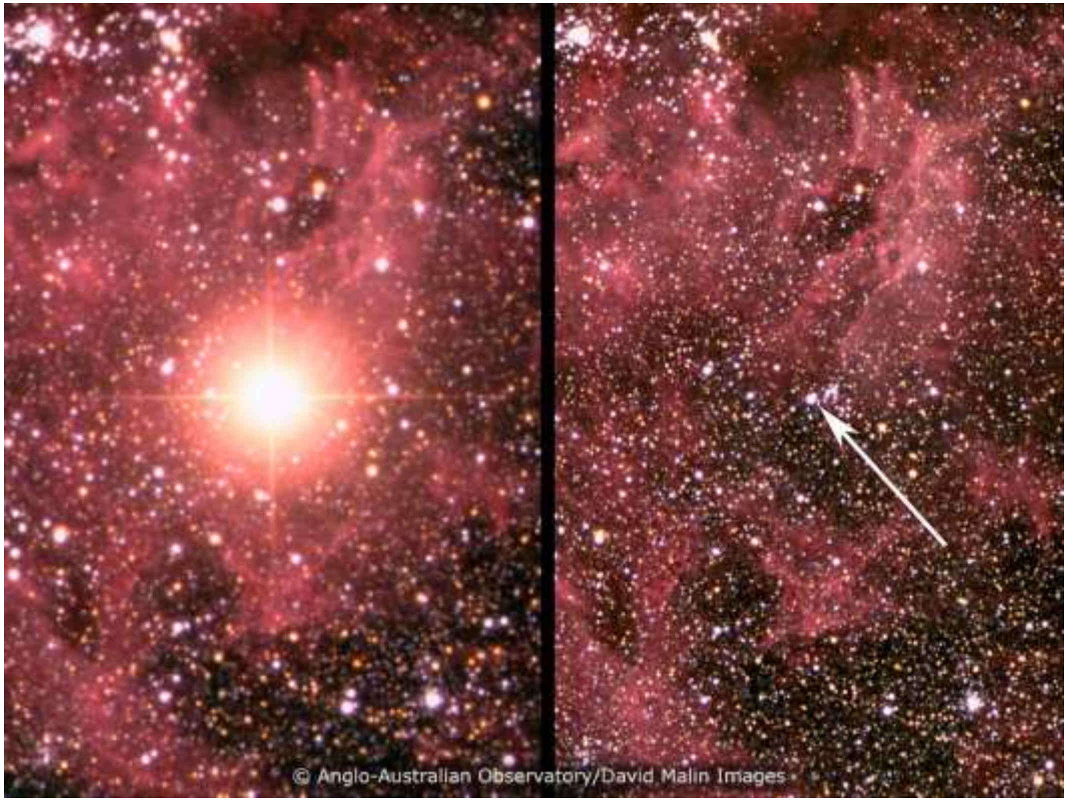


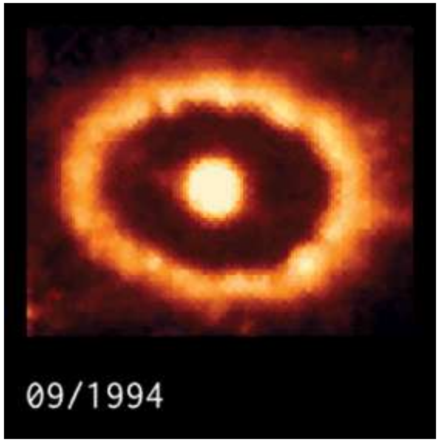
distance ladder: lestvica razdalj - kalibracija

geometrijske metode

$$d = \frac{l}{\vartheta}$$

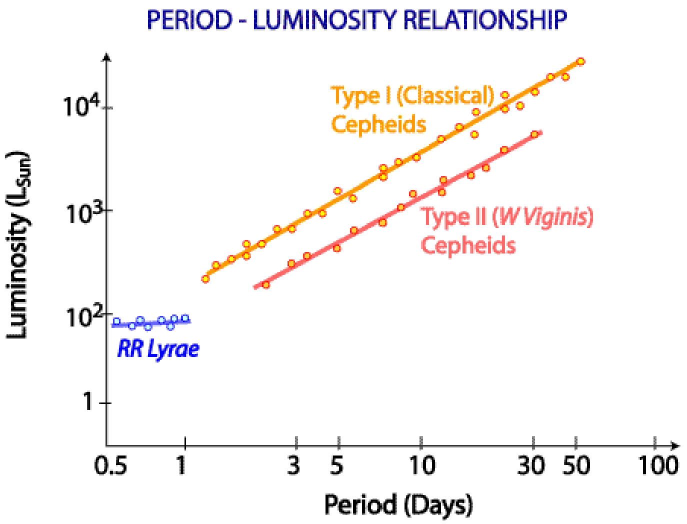
SN 1987A



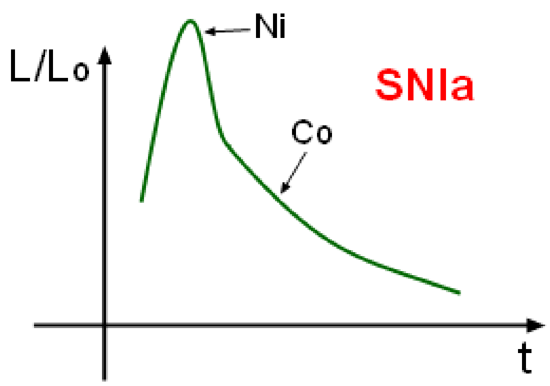


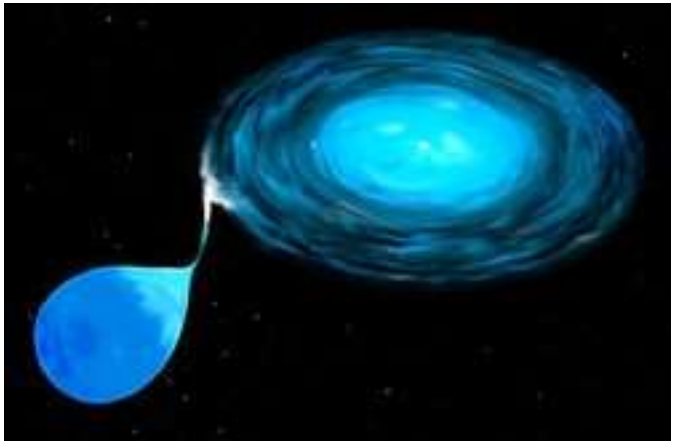
standardni svetilniki

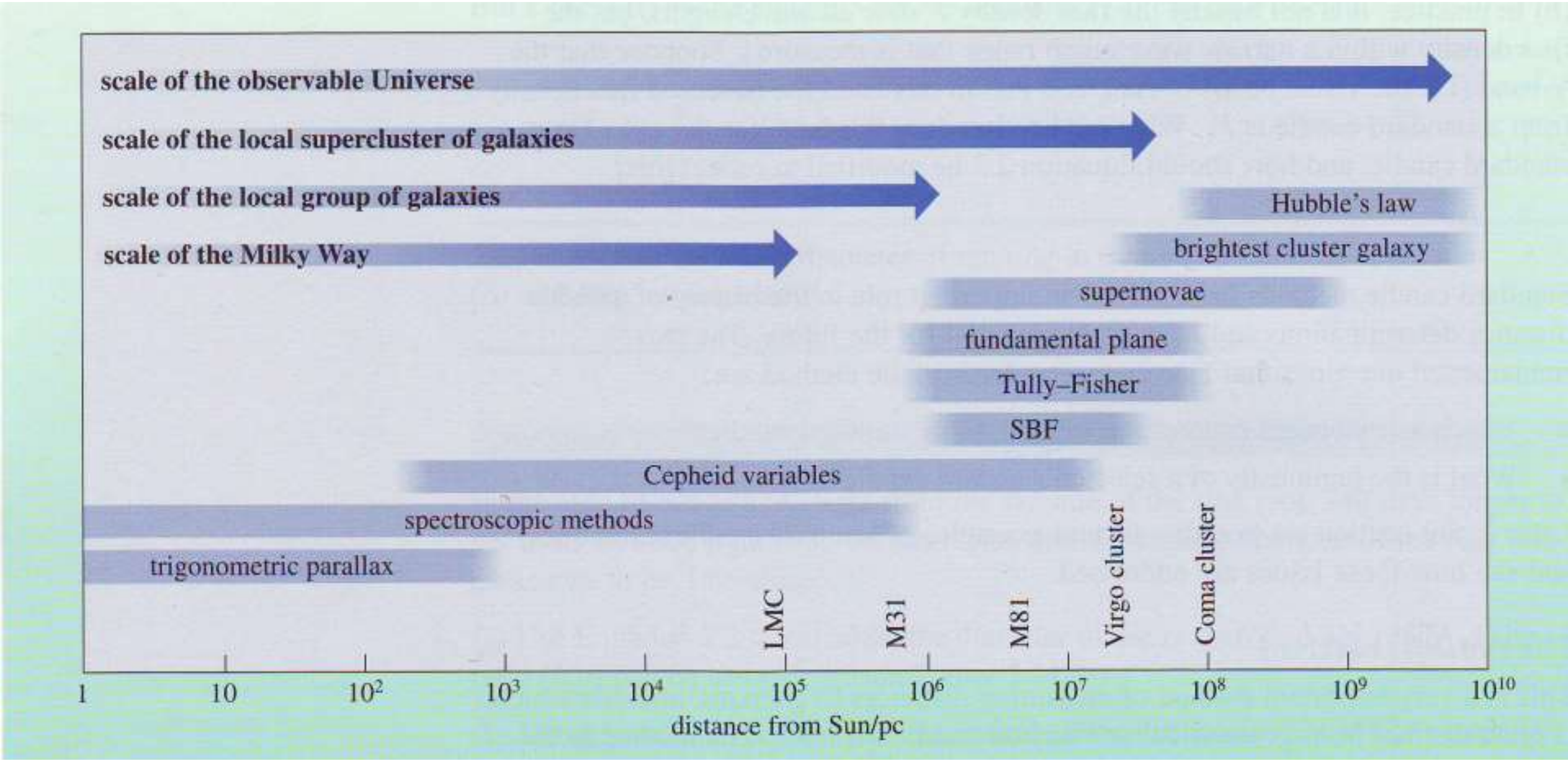
$$d = \sqrt{\frac{L}{4\pi j}}$$



RR Lire
kefeide
supernove Ia, II
galaksije kot standardni svetilniki



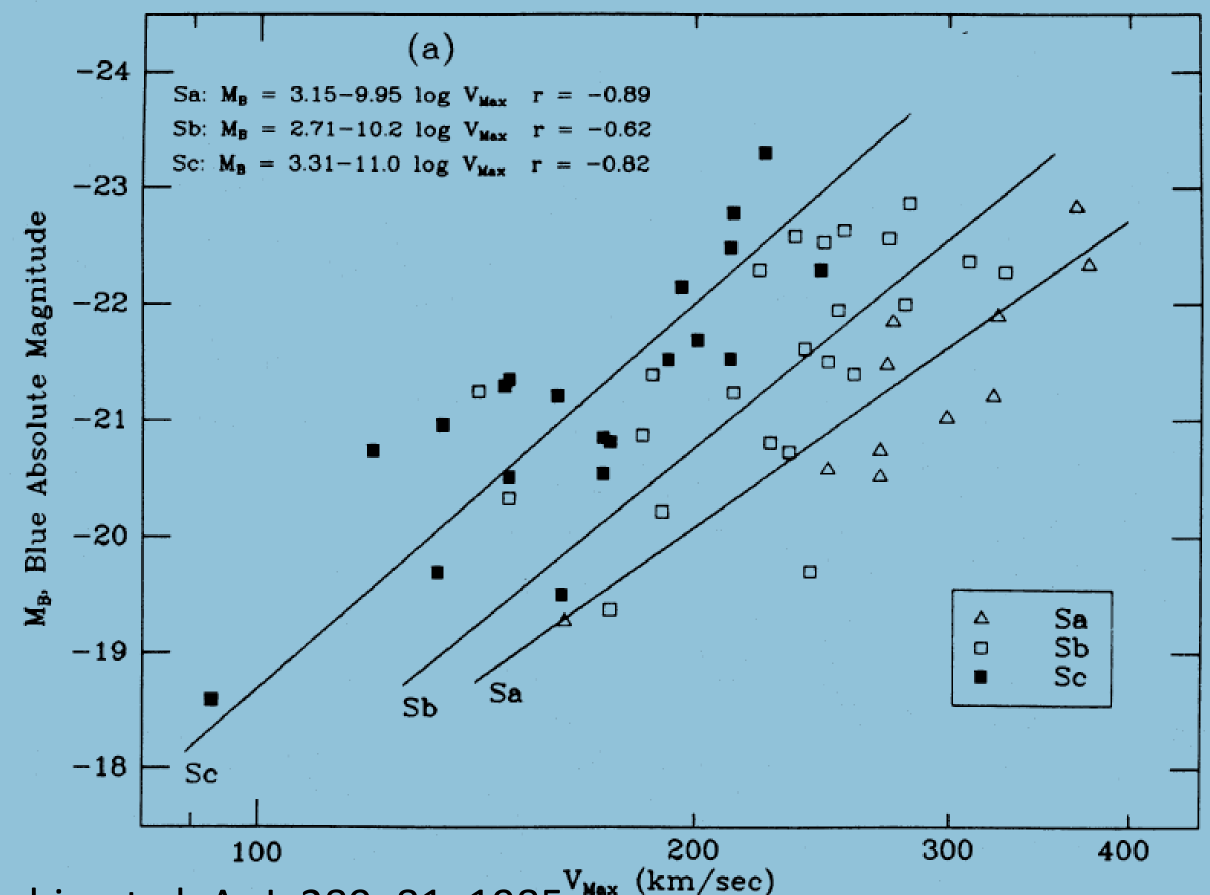



scale of the observable Universe
scale of the local supercluster of galaxies
scale of the local group of galaxies
scale of the Milky Way
Hubble's law
brightest cluster galaxy
supernovae
fundamental plane
Tully–Fisher
SBF
Cepheid variables
spectroscopic methods
trigonometric parallax
LMC
M31
M81
Virgo cluster
Coma cluster
1
10
10^2
10^3
10^4
10^5
10^6
10^7
10^8
10^9
10^{10}
distance from Sun/pc

galaksije kot standardni svetilniki

- spiralne: Tully - Fisher relacija (1977)

$$L \propto v_{\max}^4$$



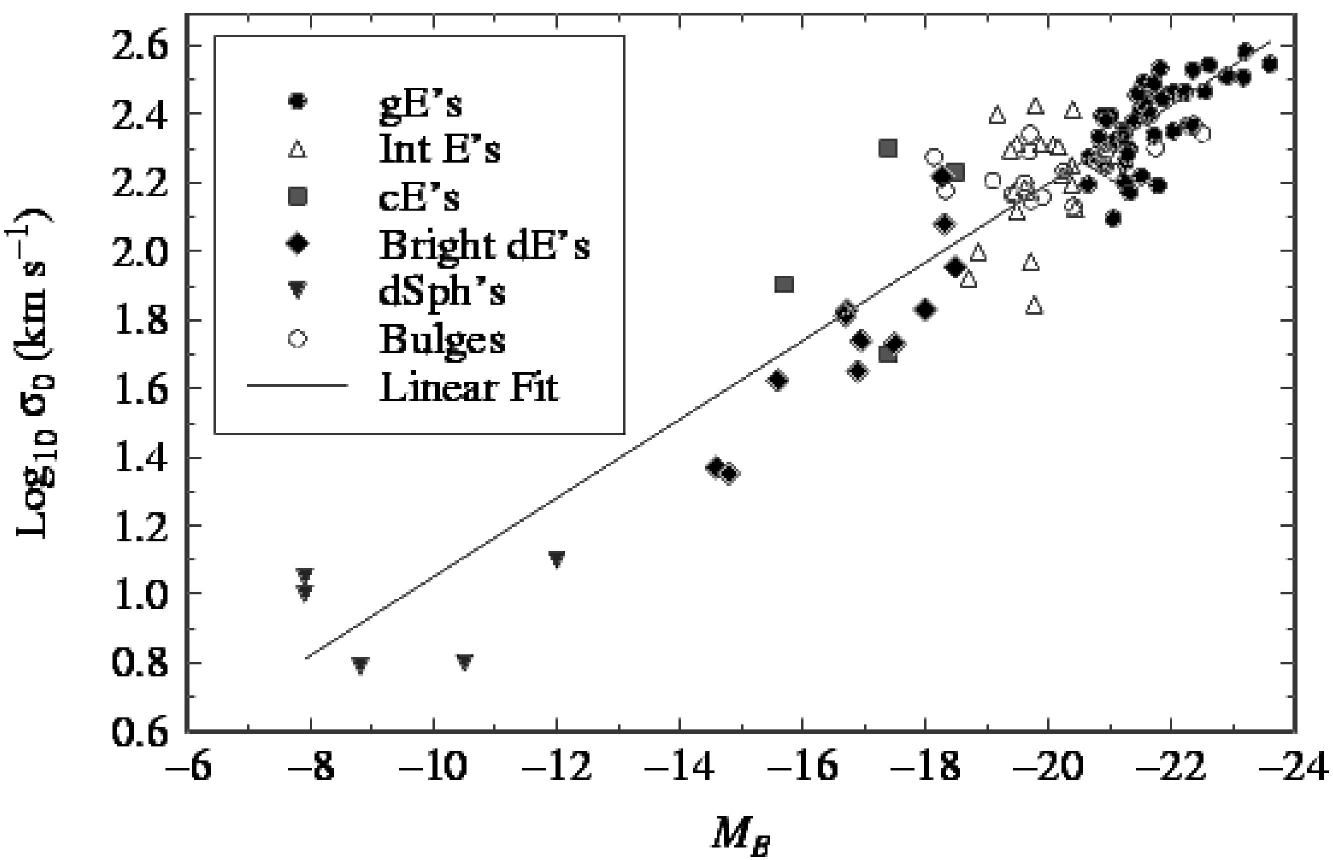
Rubin et al, ApJ, 289, 81, 1985

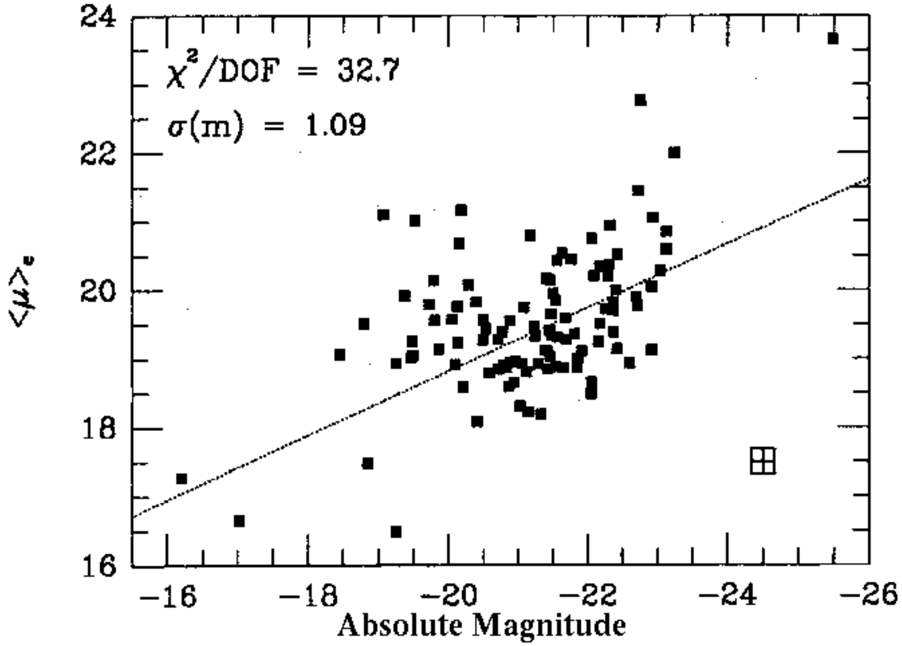
- eliptične: Faber – Jackson relacija (1976)

$$L \propto \sigma^4$$

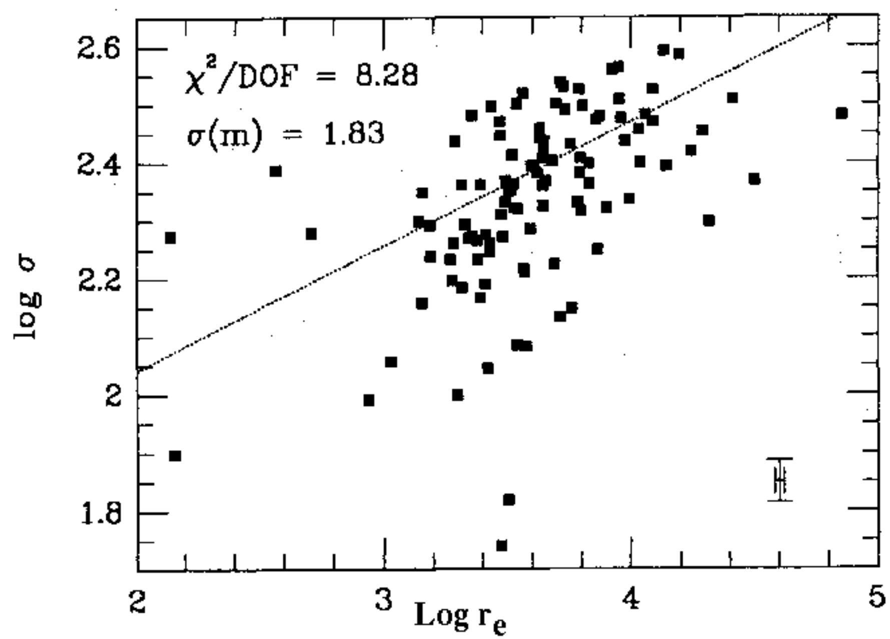
$$L \propto \sigma^x,$$

$$x = 3 \ldots 5$$





χ^2/DOF = 32.7
σ(m) = 1.09
$<\mu>_e$
24
22
20
18
16
−16
−18
−20
−22
−24
−26
Absolute Magnitude



χ^2/DOF = 8.28
σ(m) = 1.83
log σ
2.6
2.4
2.2
2
1.8
2
3
4
5
Log r_e

fundamentalna ravnina

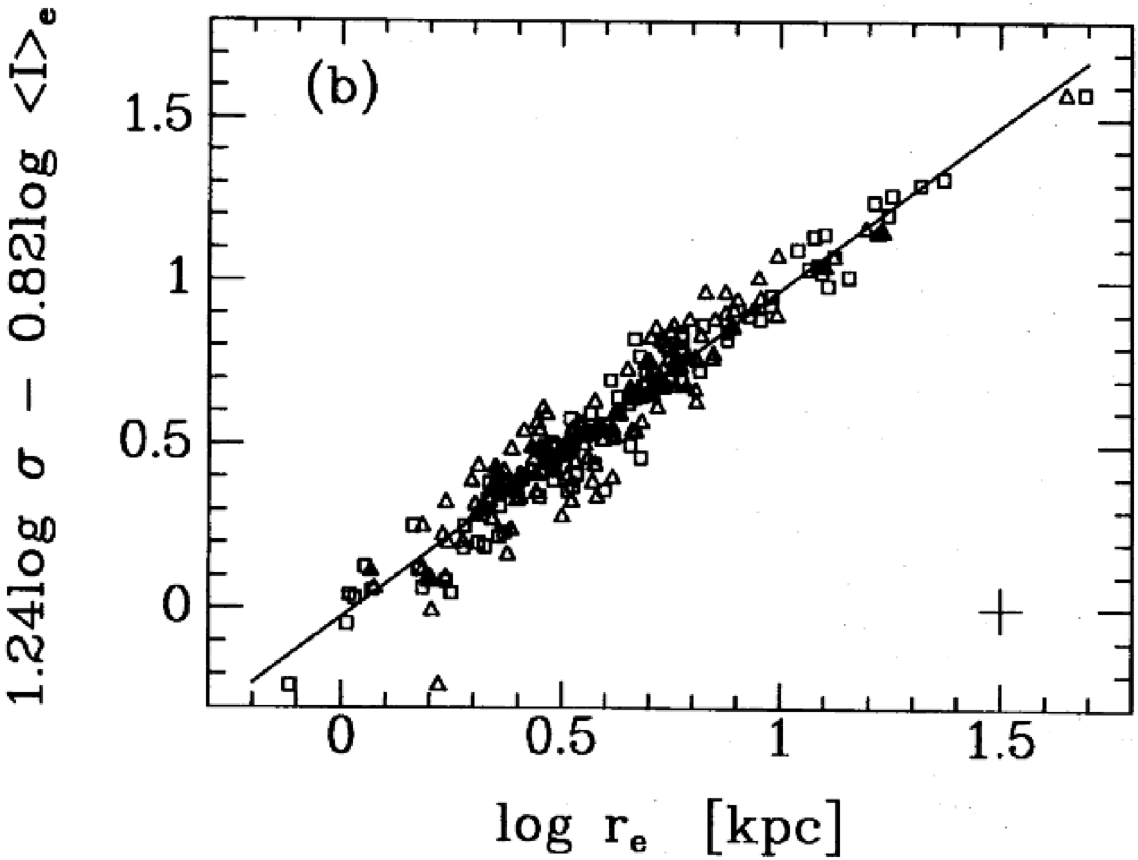
- graf linearne kombinacije dveh parametrov proti tretjemu

$$r_e \sim \sigma^{1.24} \langle I \rangle^{-0.82}$$

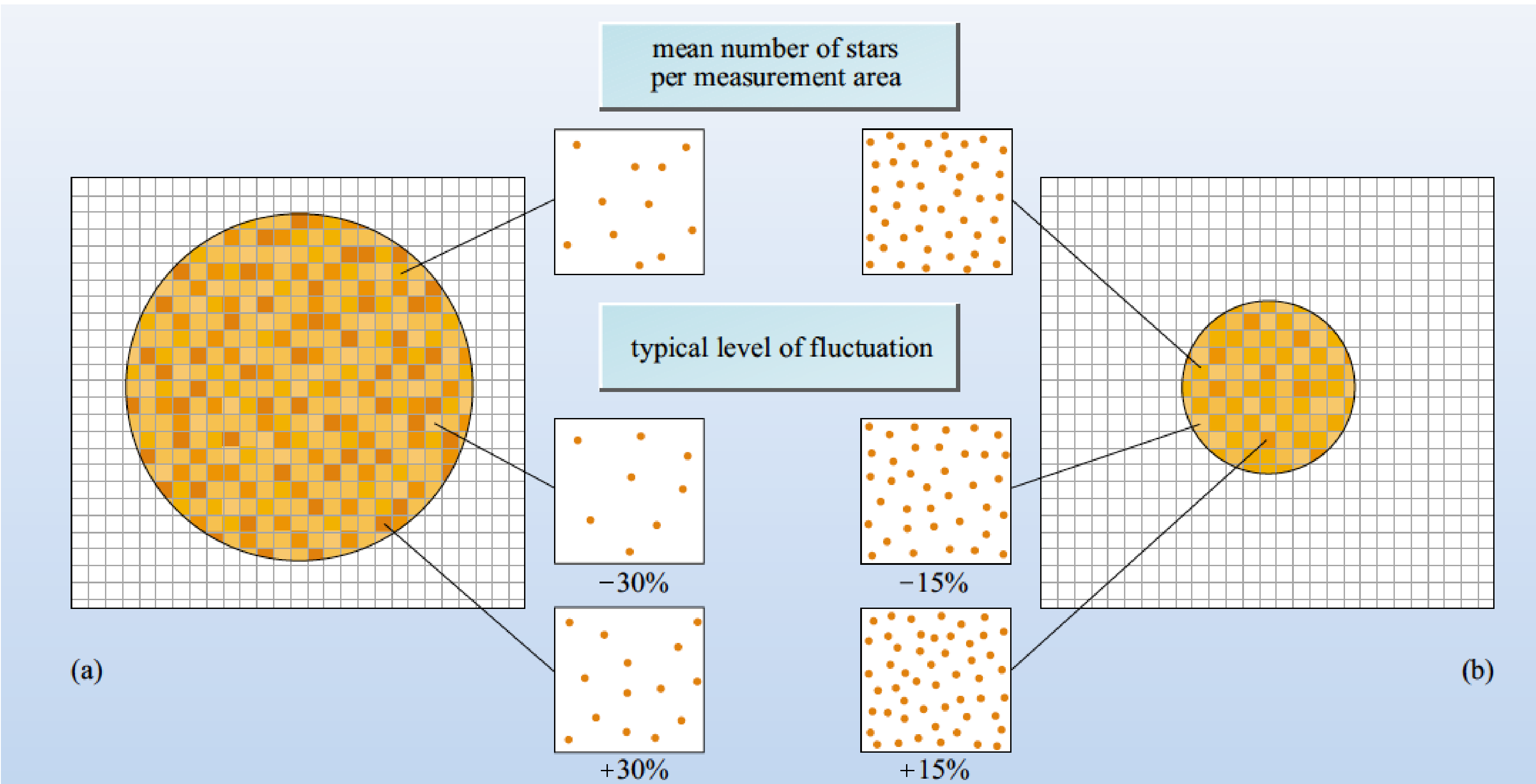
$$L \propto \sigma^{8/3} < I_e >^{-3/5}$$

$$r_e \propto \sigma^{1.4} I_e^{-0.9}$$

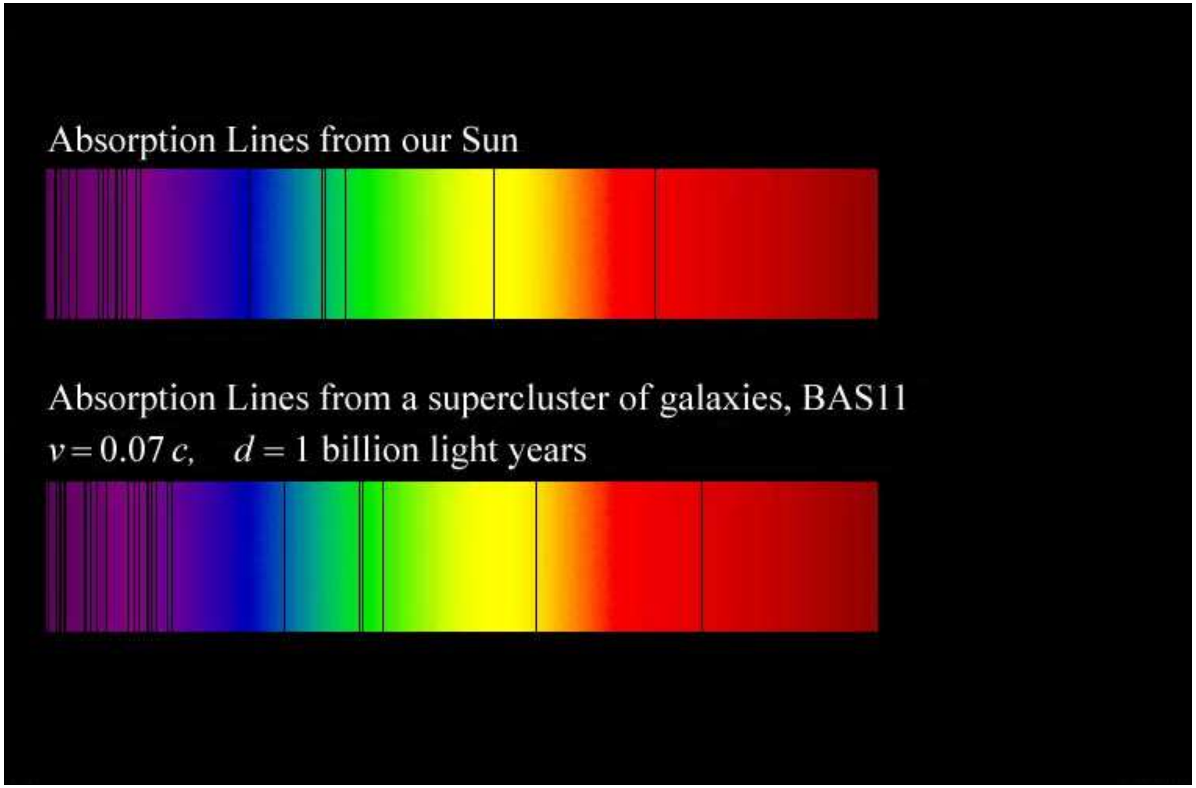
$$L \propto \sigma^{1.55} r_e^{0.9}$$



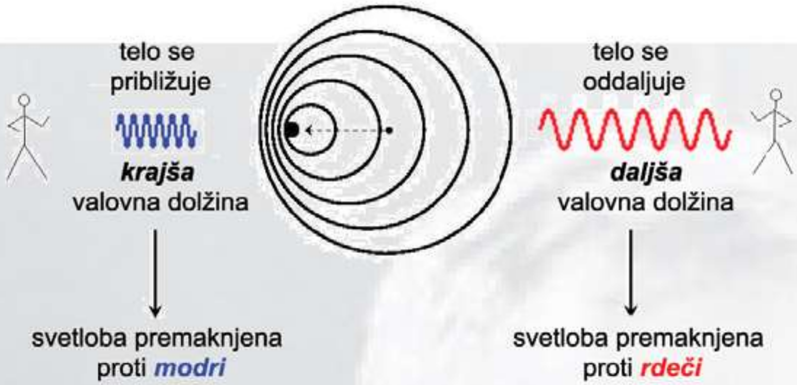
fluktuacije površinske svetlosti



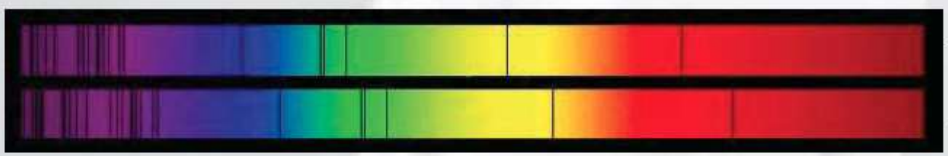
kozmološki rdeči premik



Dve razlagi rdečega premika:



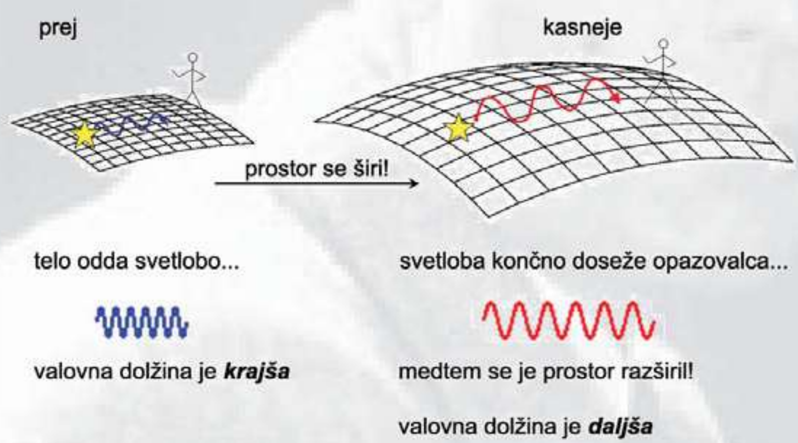
(i) ***Dopplerjev pojav.*** *Zaradi gibanja izvora svetlobe vstran od opazovalca so vrhovi valov videti raztegnjeni – valovna dolžina je daljša, premaknjena k rdečemu delu spektra.*



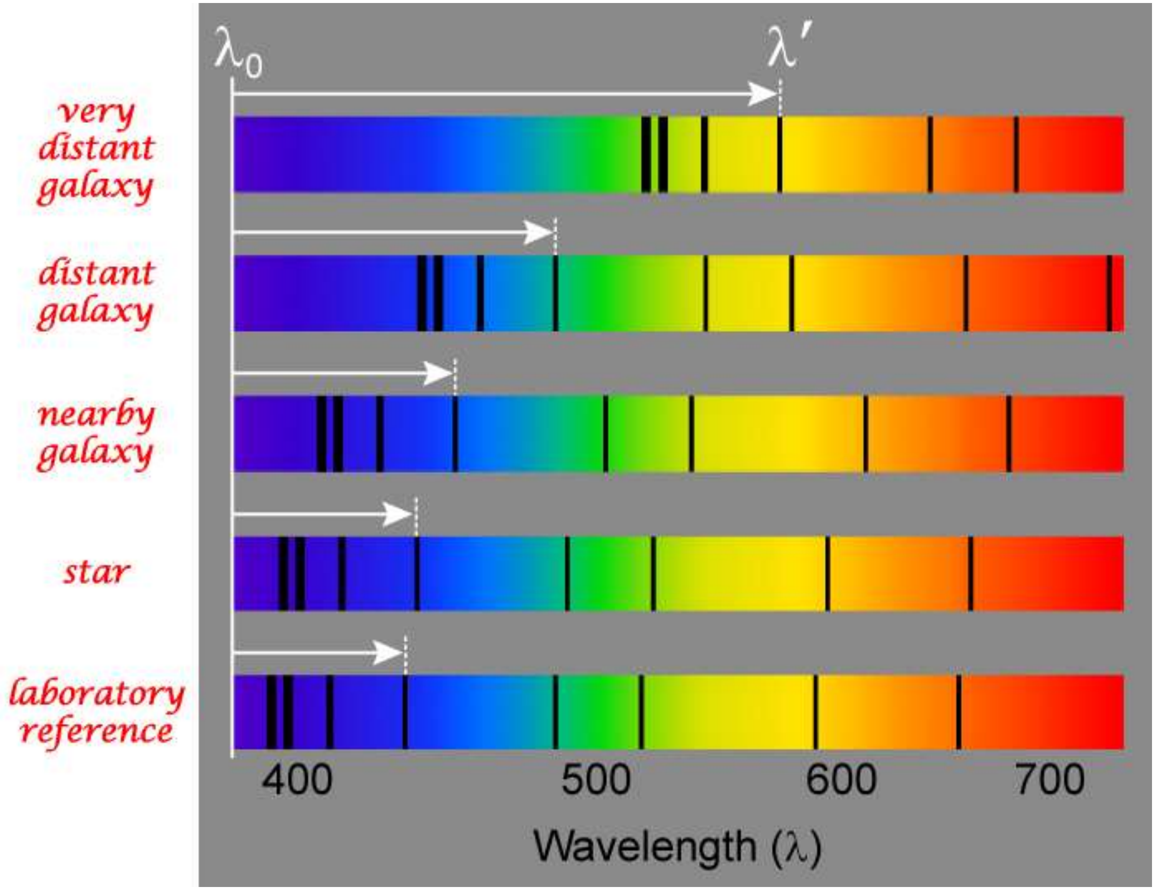
Absorpcijske črte:

v Sončevem spektru

v oddaljeni galaksiji ***(premaknjene zaradi rdečega premika)***



(ii) ***Širjenje prostora.*** *Svetloba z oddaljene galaksije potrebuje dolgo časa, da doseže opazovalca. Med tem potovanjem se je vesolje širilo – in skupaj z njim se je valovna dolžina raztegnila – premaknila proti rdeči.*

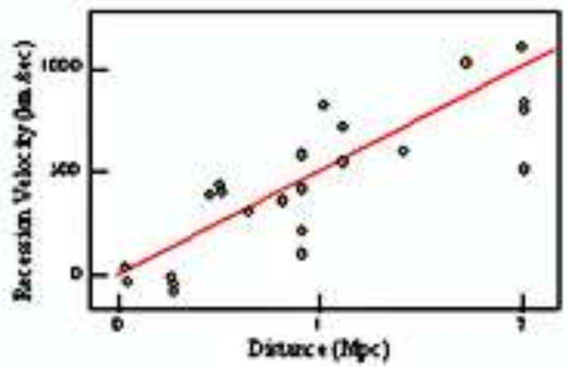


$$\frac{\lambda_{obs}}{\lambda_{em}} = \frac{\lambda_{em} + \Delta\lambda}{\lambda_{em}} = 1 + \frac{\Delta\lambda}{\lambda_{em}} = 1 + z$$

$$z = \frac{\Delta\lambda}{\lambda_{em}}$$

Hubblov zakon

Hubble's Data (1929)



$$z \propto d$$

$$z = \frac{H_0}{c} d$$

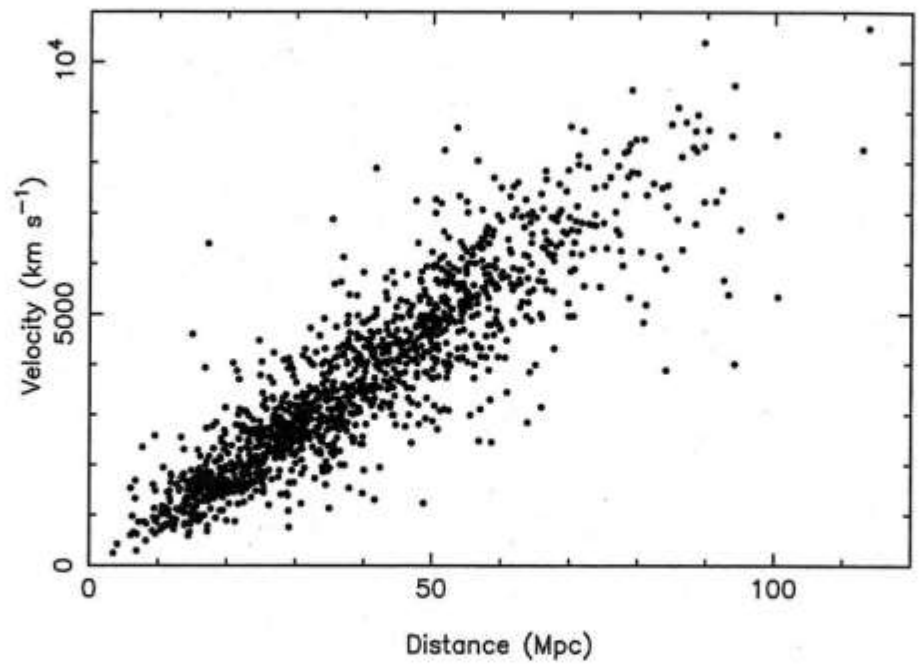
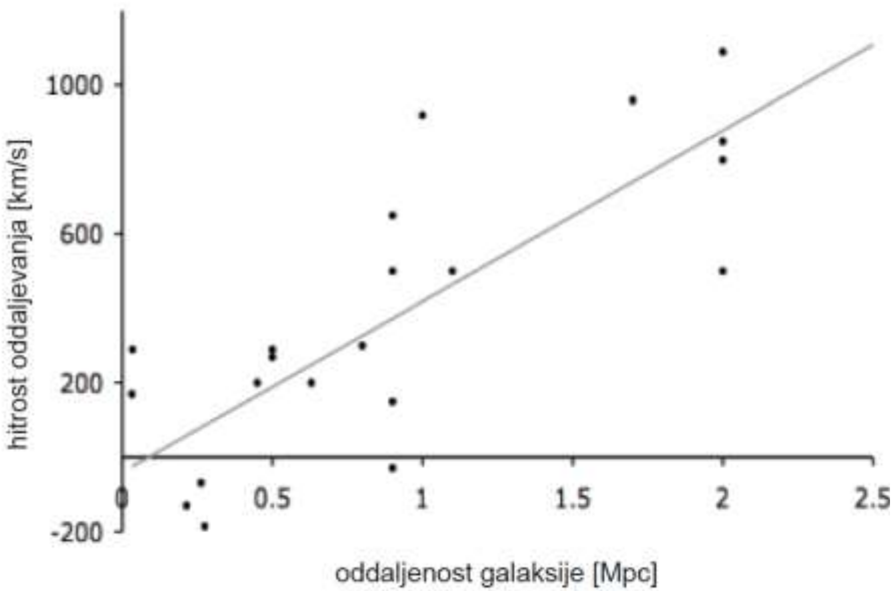


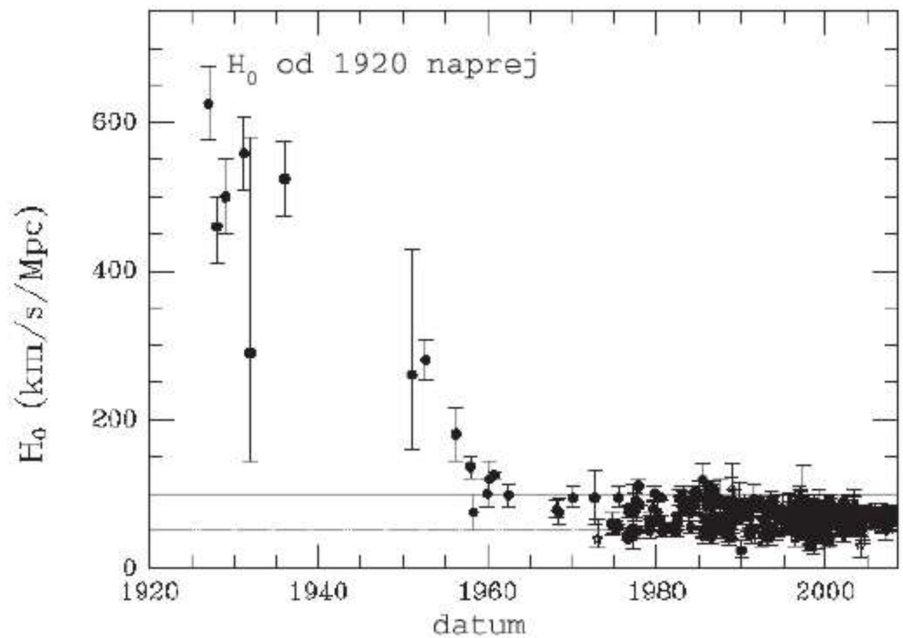
Figure 2.5 A plot of velocity versus estimated distance for a set of 1355 galaxies. A straight-line relation implies Hubble's law. The considerable scatter is due to observational uncertainties and random galaxy motions, but the best-fit line accurately gives Hubble's law. [The x-axis scale assumes a particular value of H_0.]

vrednost H_0 ?



$1/H_0$ = starost vesolja

$H_0 = 71\ km\ s^{-1}/\ Mpc\ \ [1/s]$



- Hubblov tok
- peculiar motion – lastno gibanje:
- z≈0.001
- na d > ≈ 40 Mpc ≈ 130 Mlyr dominira širjenje vesolja

interpretacija z in H. zakona

$$z \propto d$$

$$z = \frac{H_0}{c} d$$

$$1 + z = \frac{\lambda_{obs}}{\lambda_{em}} = \frac{R_{obs}}{R_{em}}$$

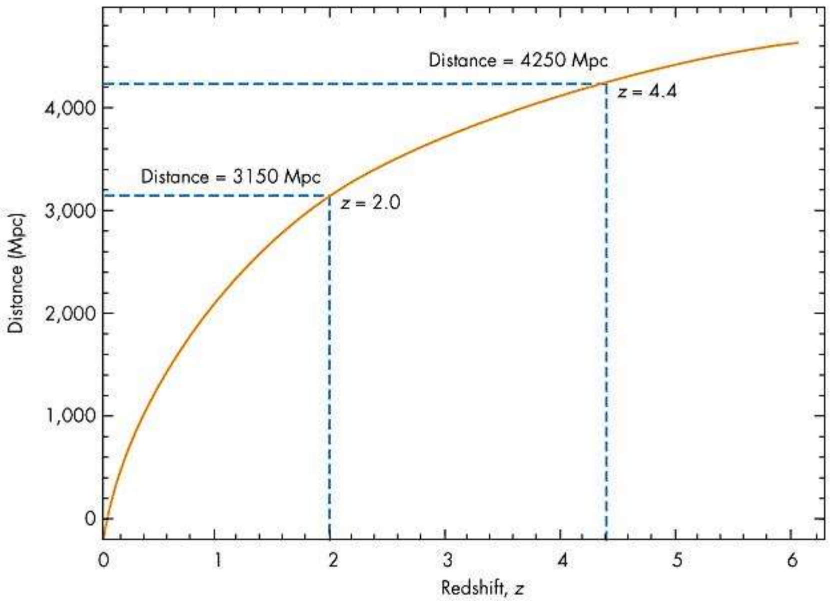
linearna zveza velja le do z≈0.2!

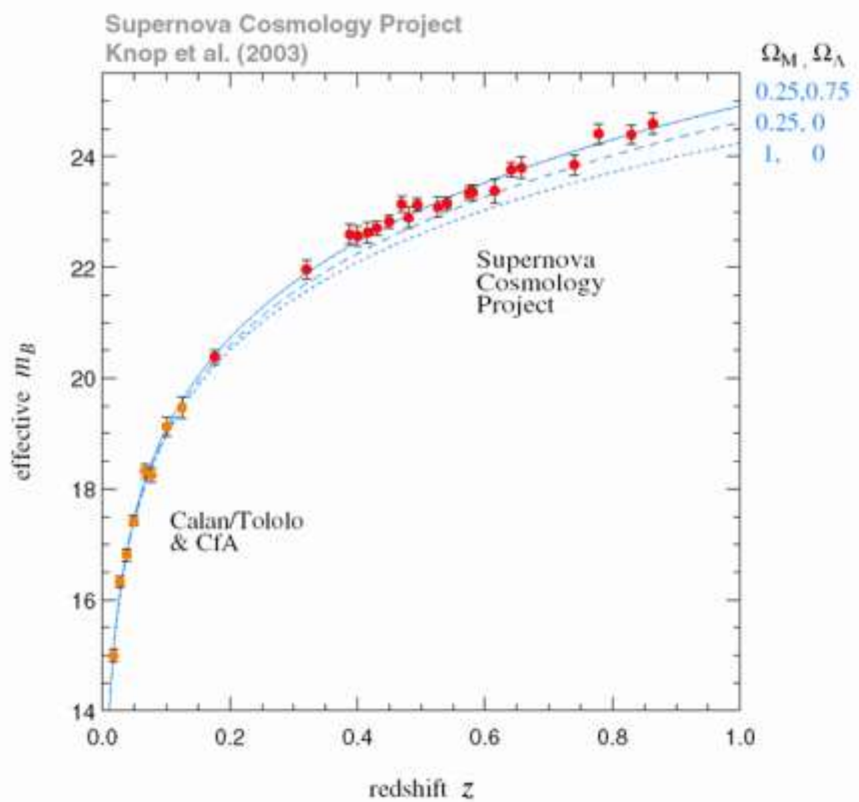
širjenje vesolja (ne Doppler)!

R... velikost vesolja

za z>0.2 moramo poznati kozmološki model, če želimo iz z določiti oddaljenost
http://www.astro.ucla.edu/~wright/CosmoCalc.html

$$m = M_{abs} + 5\log\left(\frac{d}{10pc}\right) \propto 5\log z$$





novejša odkritja

- Sloan Digital Sky Survey: http://www.sdss.org/
- 2dF Galaxy Redshift Survey: http://www2.aao.gov.au/2dFGRS/

velika vzorca,

računalniška analiza slik in spektrov

porazdelitev svetlosti

Sersic-ov zakon:

$$I(R) = $$

n=4: de Vauco

n=1: eksponer

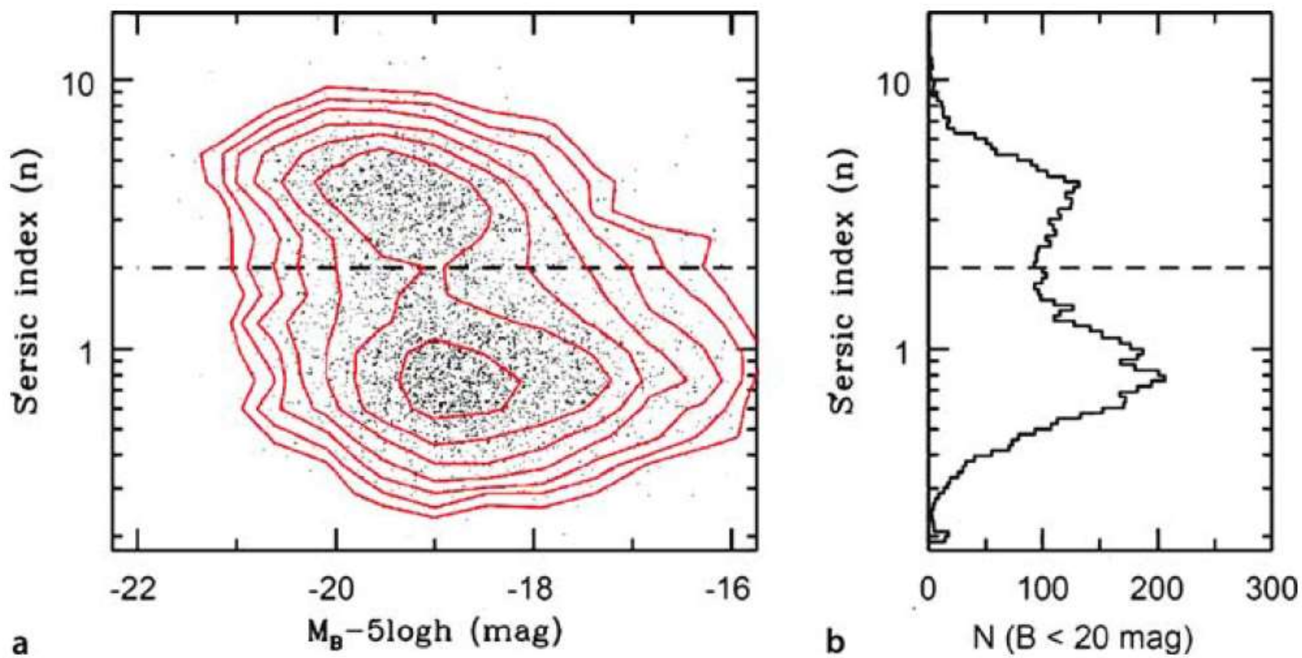


Fig. 3.8. a A plot of the observed value of the Sérsic index n as a function of the absolute blue magnitude in a sample of 10,095 galaxies from the Millennium Galaxy Catalogue. **b** The histogram showing the number of galaxies in equal logarithmic bins of Sérsic index n (Driver et al., 2006)

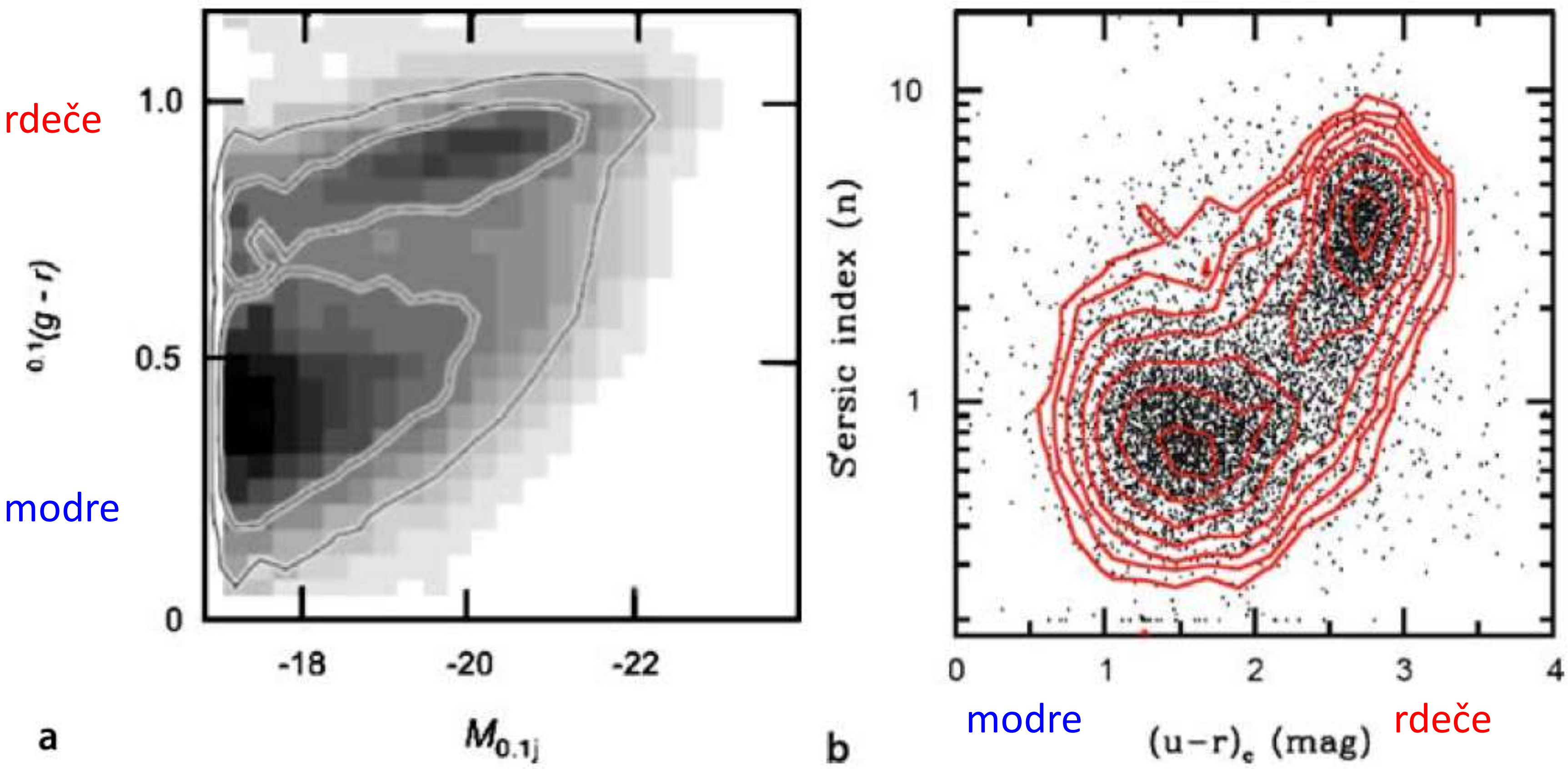


Fig. 3.20. **a** Illustrating the bimodality in the distribution of colour ${}^{0.1}(g - r)$ of galaxies as a function of optical absolute magnitude (Blanton et al., 2003). **b** A plot of Sérsic index against colour for 10,095 galaxies selected from the Millennium Galaxy Catalogue (Driver et al., 2006)

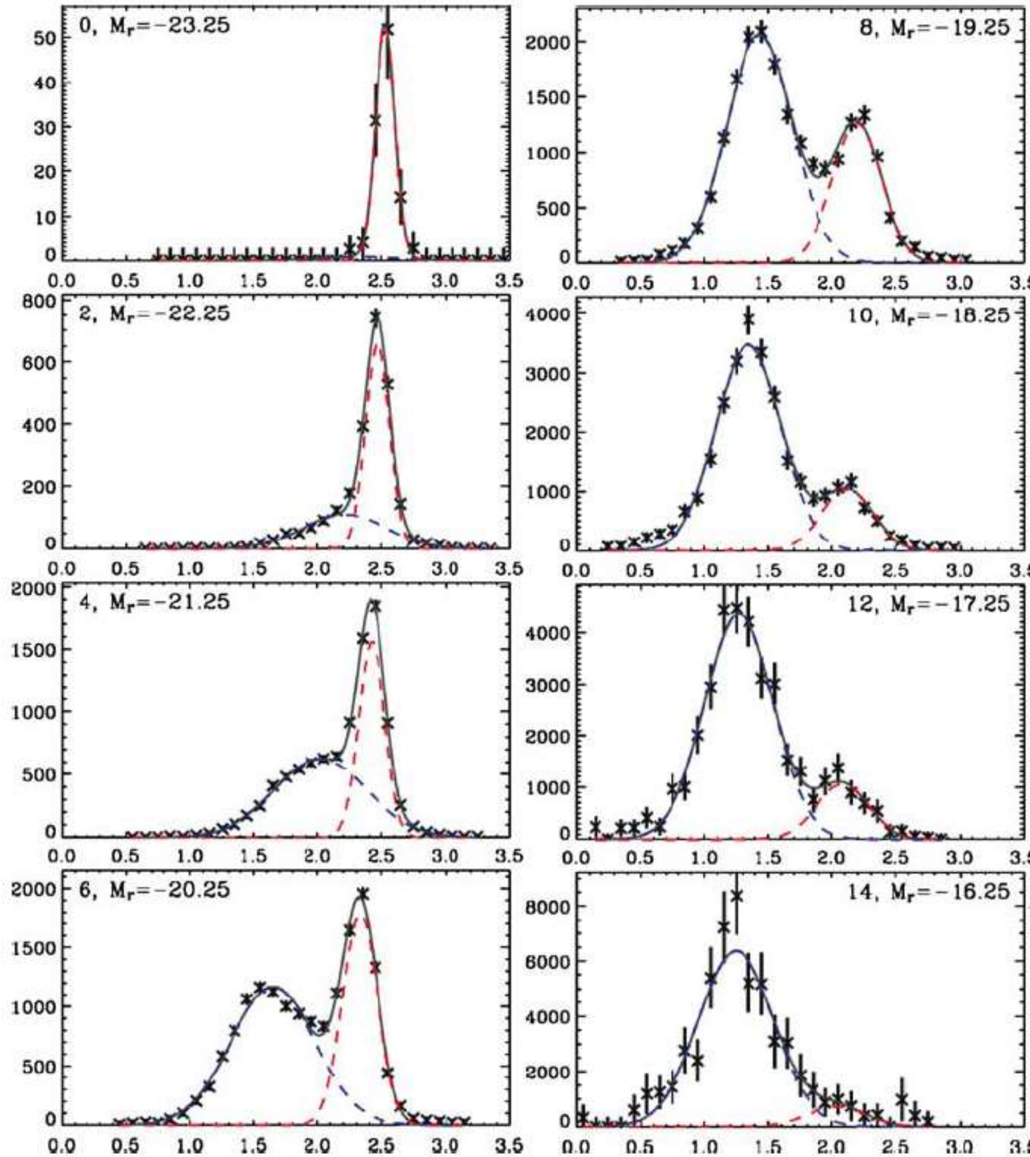


Fig. 3.21. Illustrating the bimodality in the distribution of the colours of galaxies as a function of optical absolute magnitude for a sample of 66,848 galaxies selected from the Sloan Digital Sky Survey (SDSS). The distributions of colours have been fitted by pairs of Gaussians. The data have been binned in intervals of 0.1 in the rest frame $(u - r)$ colour. The galaxy distributions are binned in 0.5 magnitude intervals. Only half of the histograms presented by the authors are shown (Baldry et al., 2004)

vpliv okolja

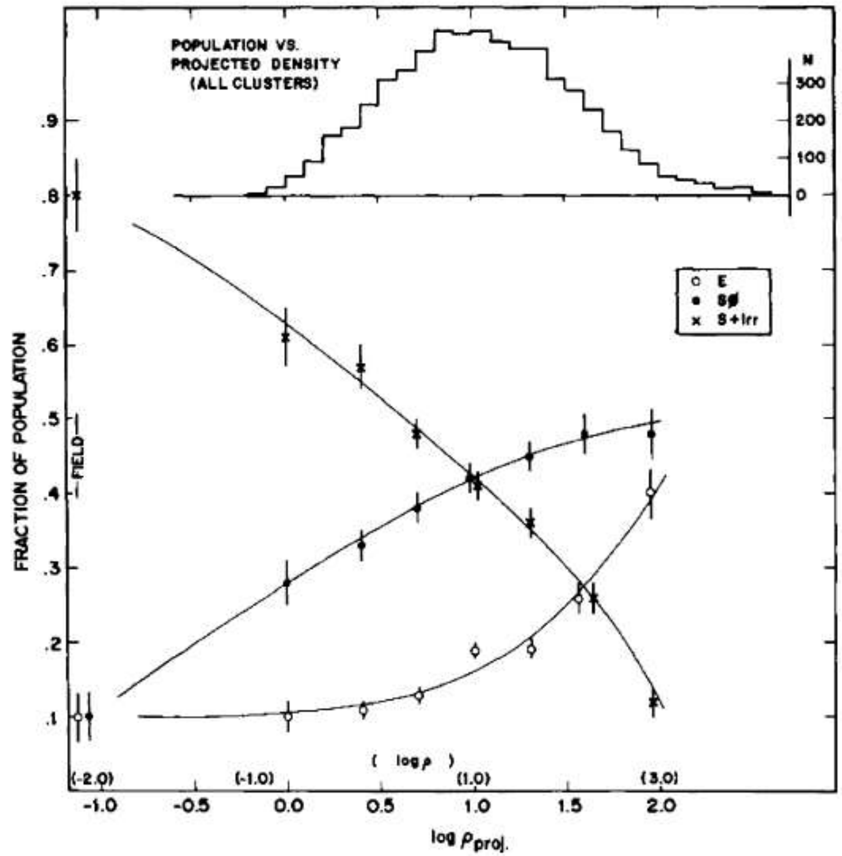


Fig. 3.4. The fractions of different morphological types of galaxy found in different galaxy environments. The local number density of galaxies is given as a projected surface density, $\varrho_{\rm proj}$ of galaxies, that is, numbers $\rm Mpc^{-2}$ (Dressler, 1980)

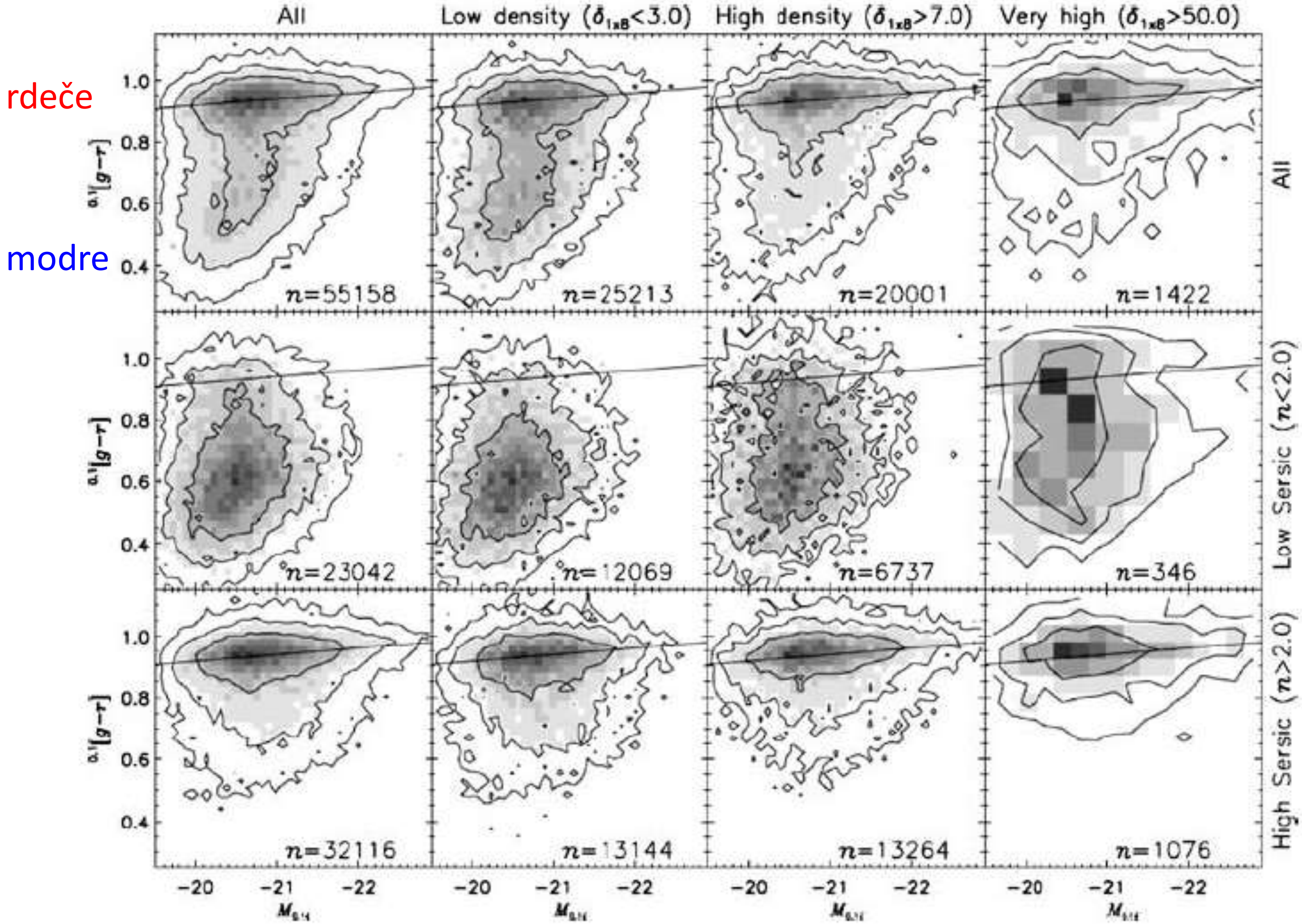


Fig. 3.23. Illustrating the bimodality in the distribution of the colours of galaxies as a function of the density of galaxies in which the galaxy is observed and as a function of their structures as parameterised by the Sérsic index n (Hogg et al., 2004)

kovinskost

metallicity

relation

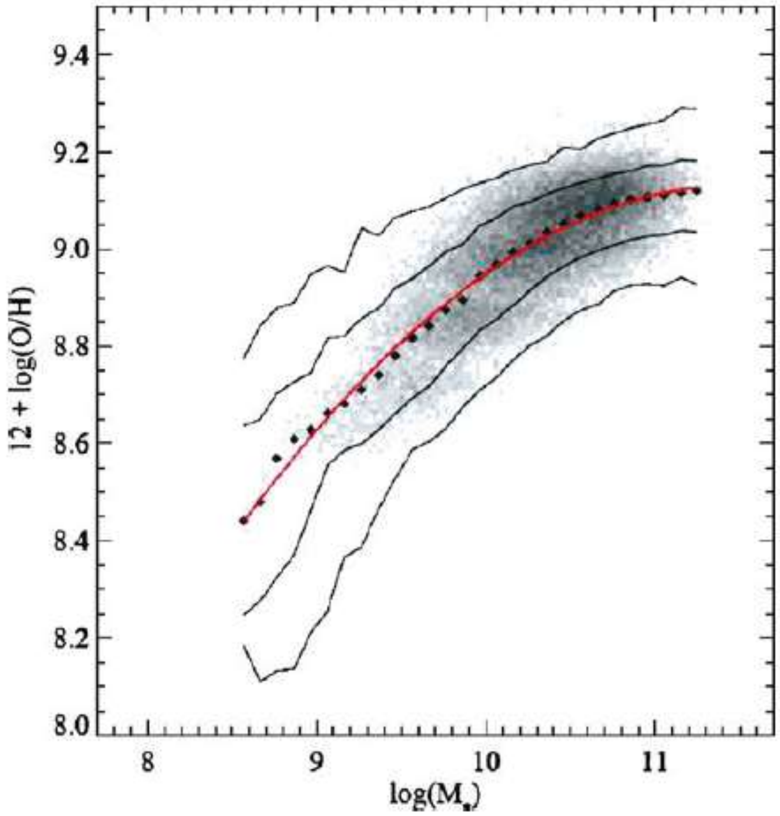
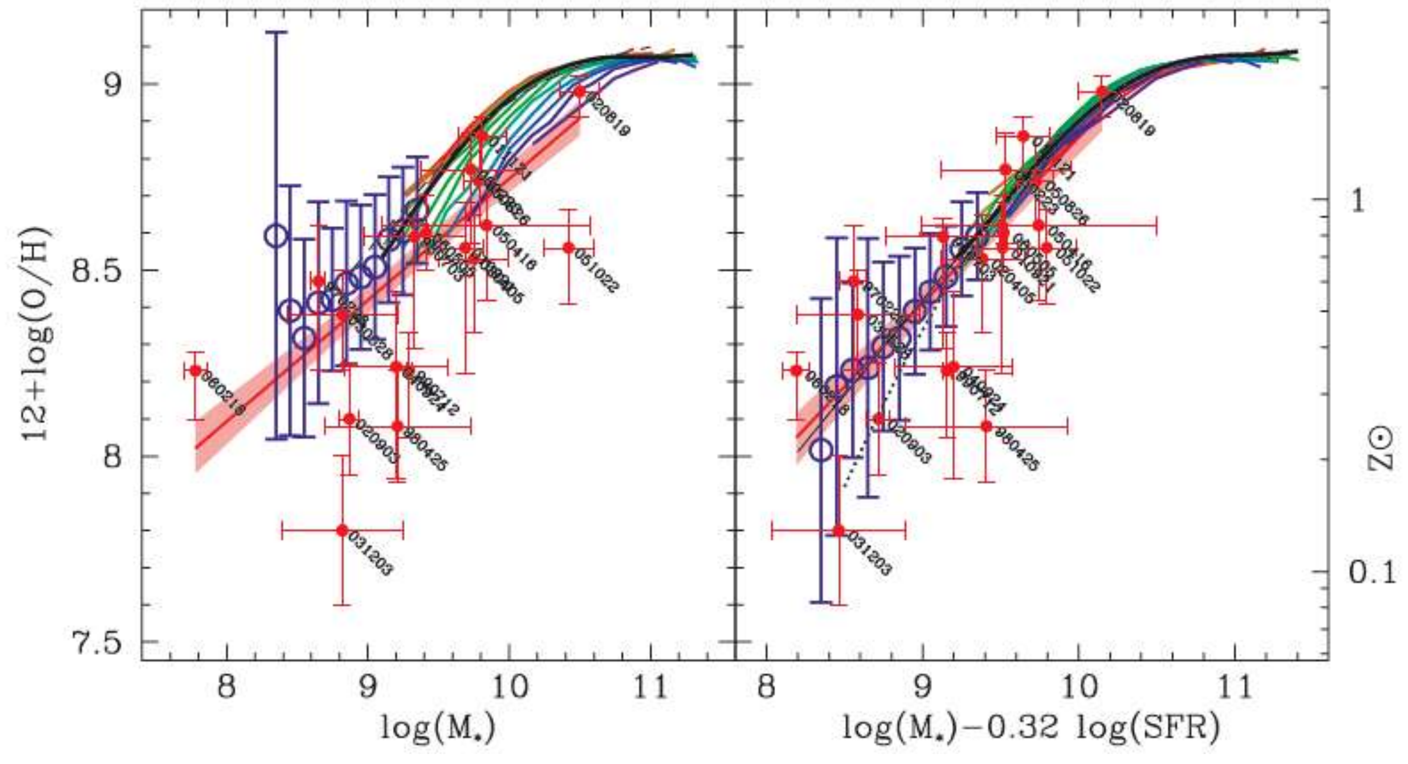


Fig. 3.13. The stellar mass–gas phase metallicity relation for 53,400 star-forming galaxies from the SDSS. The large *black points* represent the median in bins of 0.1 dex in mass which include at least 100 data points. The *thin line* through the data is a best-fitting smooth curve and the *solid lines* are the contours which enclose 68% and 95% of the data (Tremonti et al., 2004)

- fundamental metallicity relation



Mannucci et al. 2011

Luminosity function

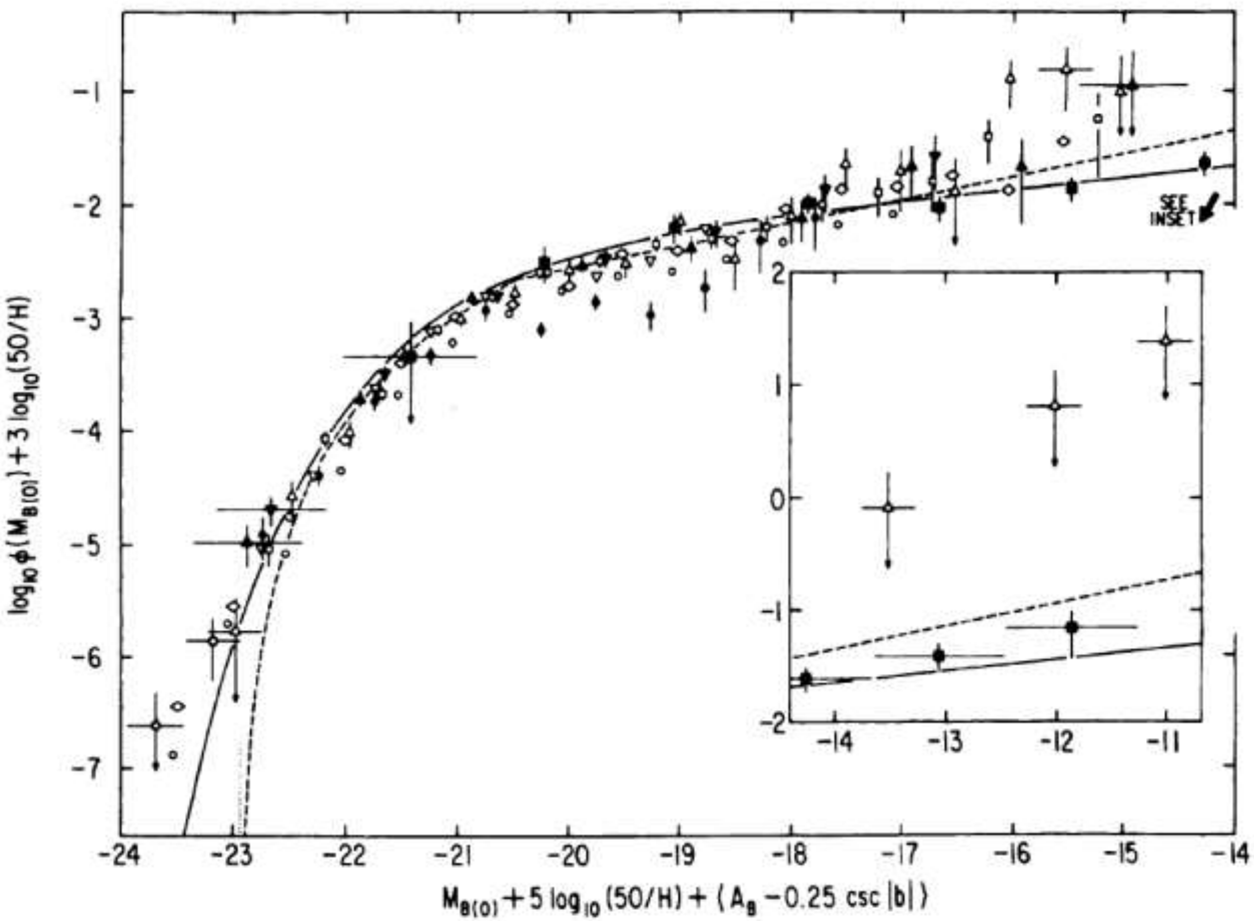
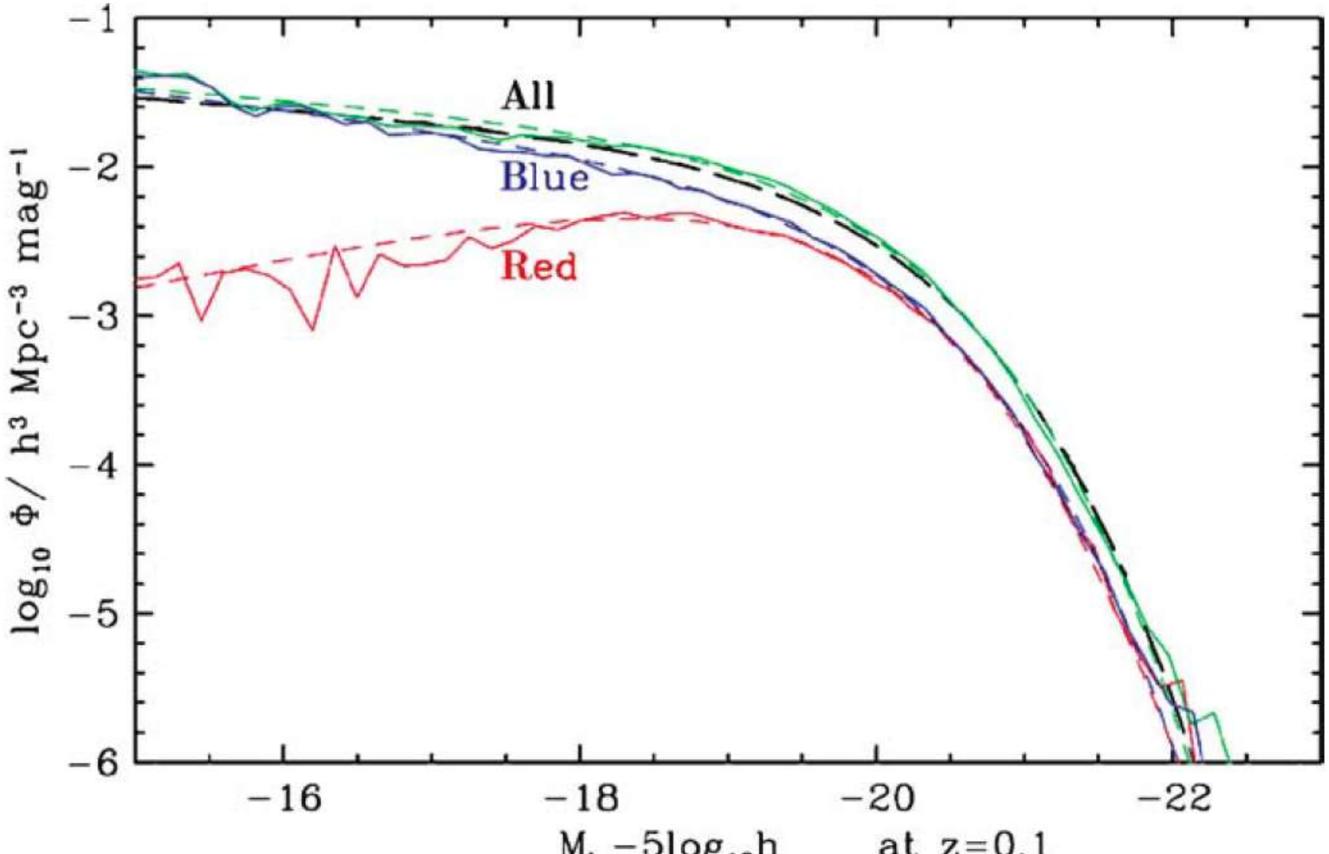


Fig. 3.14. The local luminosity function of galaxies from nine independent estimates considered by Felten fitted by a Schechter luminosity function of the form $n(x)\,\mathrm{d}x \propto x^{\alpha} \mathrm{e}^{-x}\,\mathrm{d}x$, where $x = L/L^*$ (Felten, 1977)



a

Fig. 3.15. a The luminosity function of galaxies derived from a sample of 221,414 galaxies observed in the 2dF galaxy survey. The overall luminosity function and those of the red and blue galaxies in the sample have been fitted by Schechter luminosity functions (Cole et al., 2005)

Table 3.4. Parameters describing the overall luminosity function of galaxies from the 2dF and SDSS surveys. The functions are determined at a redshift of 0.1 and include K-corrections and evolutionary corrections for the observed change in form of the luminosity functions over the redshift interval $0 < z < 0.3$

Galaxy survey	Waveband	$\phi^*/h^3\,\mathrm{Mpc}^{-3}$	$M^* - 5\log_{10} h$	α
2dF galaxy survey	b_J	0.0156	−19.52	−1.18
SDSS galaxy survey	r	0.0149 ± 0.0004	-20.44 ± 0.01	-1.05 ± 0.01

- Viri:
- Jones & Lambourne: An Introduction to Galaxies and Cosmology
- Longair: Galaxy Formation