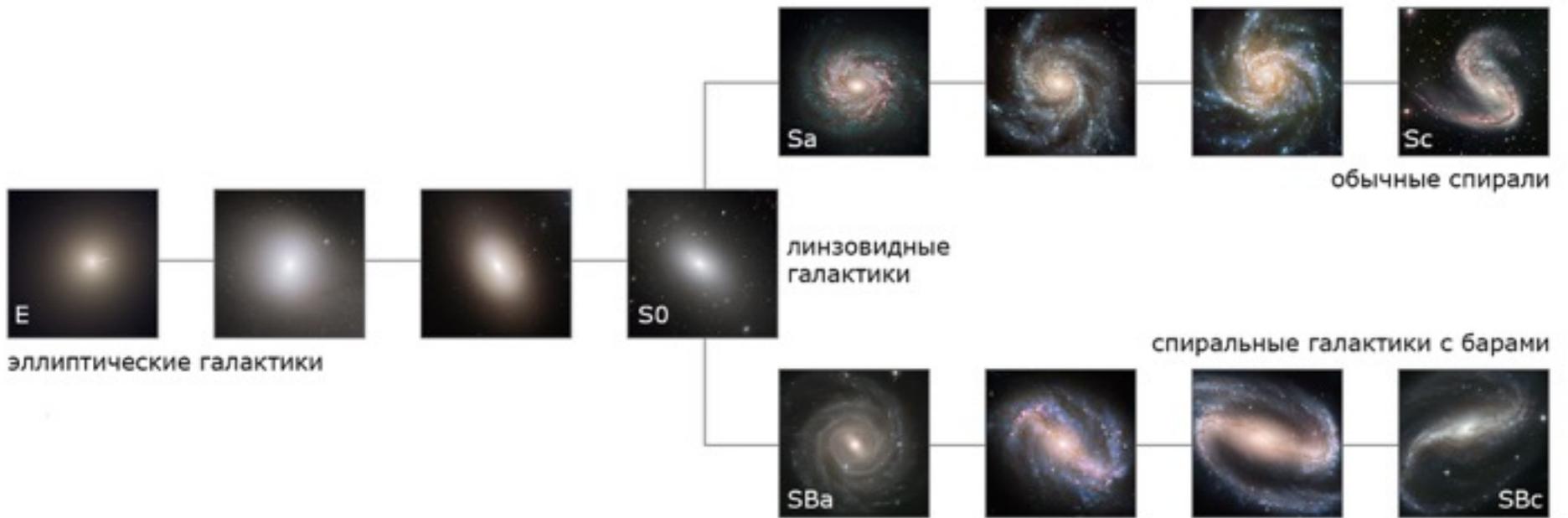


Загадки галактик

Сильченко Ольга Касьяновна
ГАИШ МГУ

Классификация галактик по Хаббл



Морфологический тип определяется соотношением диск:балдж



NGC 4565

Sombrero Galaxy • M104

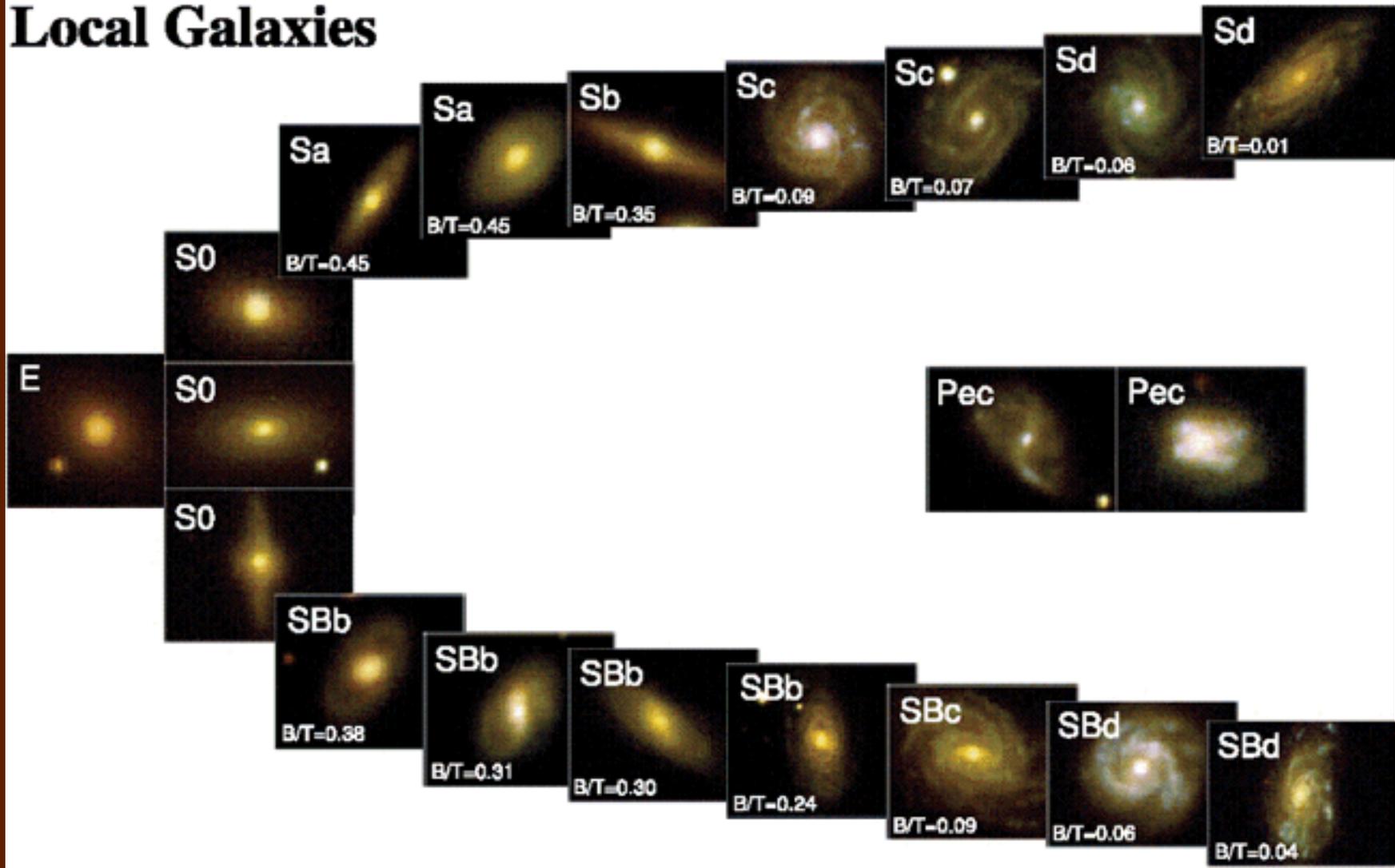


Hubble
Heritage

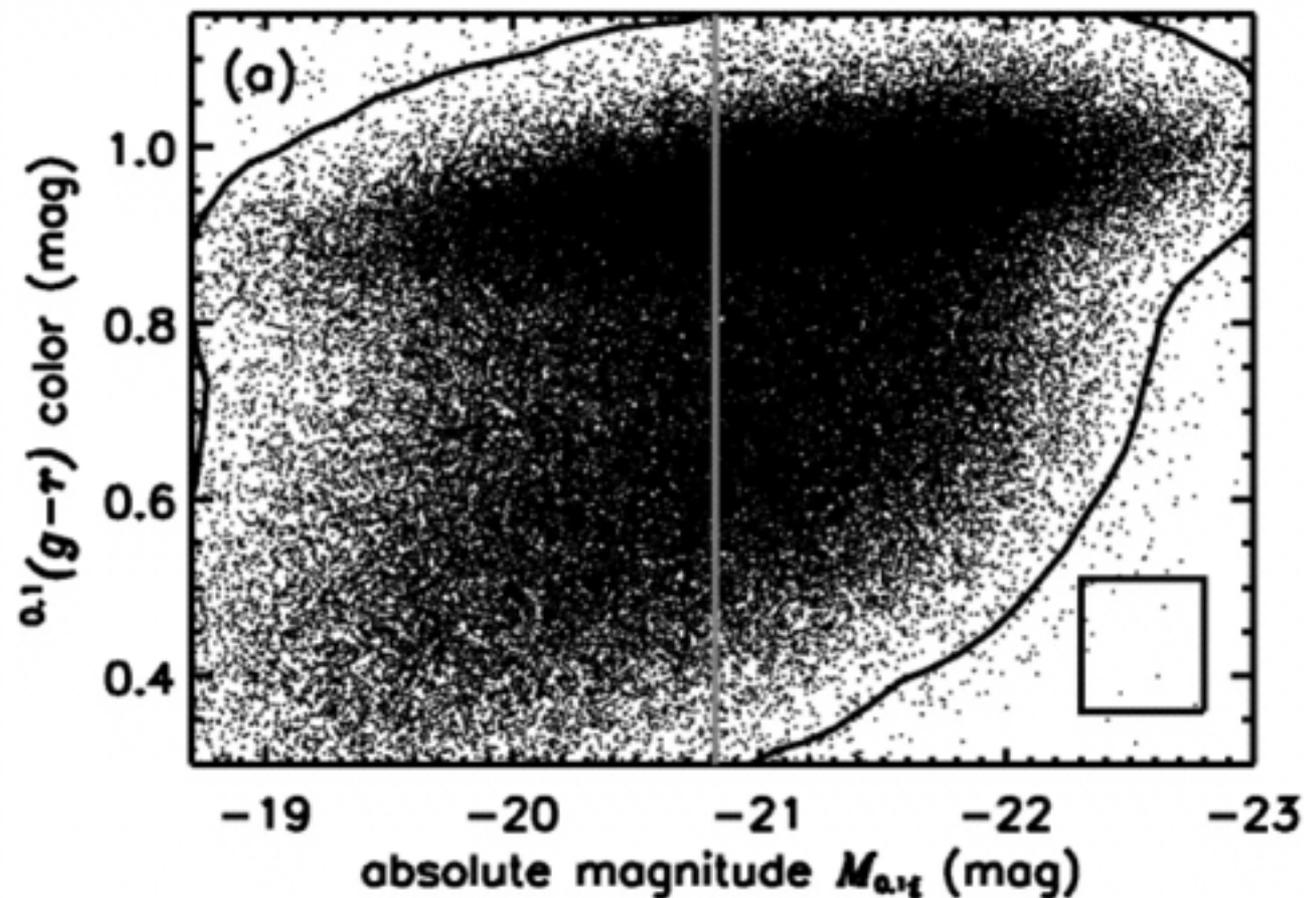
NASA and The Hubble Heritage Team (STScI/AURA) • Hubble Space Telescope ACS • STScI PR03-28

NGC 4594

Local Galaxies



Галактики распадаются на два населения по цвету – красные и голубые

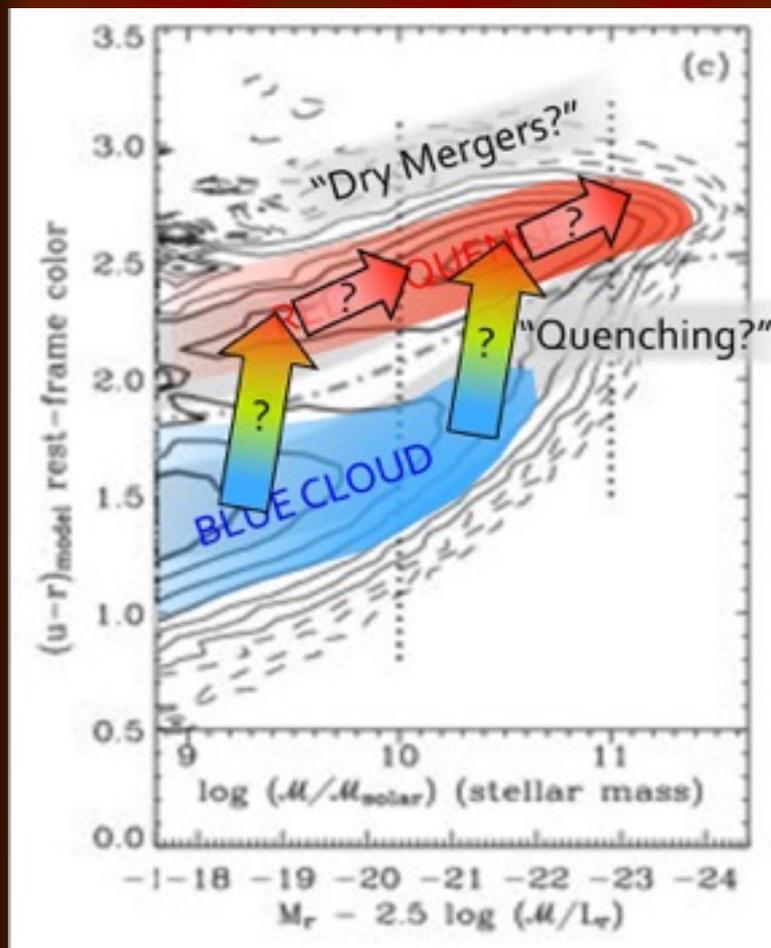


E and S0s

Hogg et al. 2003

Spirals

Можем ли мы нарисовать направление эволюции галактик?



- Это если убрать газ из спиральной галактики, она пойдет в красные.
- А если наоборот, «уронить» газ на красный звездный диск S0-галактики?

Без аккреции внешнего газа на спиральные галактики не обойтись: парадокс G-карликов в Млечном Пути

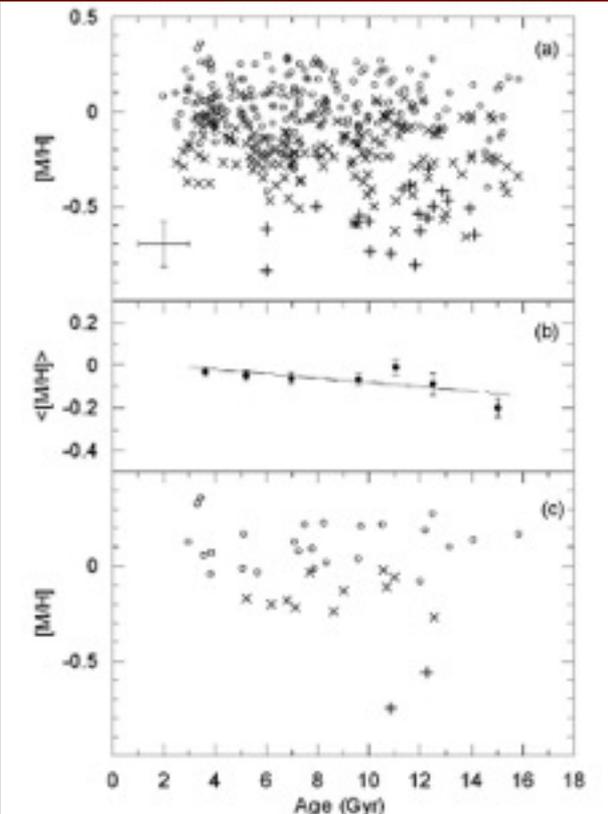


Figure 9. (a) Age-metallicity relation for our stellar sample. The circles show the stars with $X < -33$, which are the definite thin-disc stars. Cross signs indicate stars with $-33 < X < -21$, which are probable thin-disc stars but with some small probability of being thick disc, and the plus signs show the probable thick-disc stars, respectively. A typical average error bar, referring to the uncertainties of 1 Gyr in age and 0.12-0.14 dex in Schuster & Nissen's (1989) metallicity calibration, is indicated in the lower left-hand corner of panel (a). (b) Average metallicity $\langle [M/H] \rangle$ in age bins. The straight line is a least-squares fit having a slope of -0.01 ± 0.005 dex Gyr^{-1} . Error bars are the standard deviation of the mean of the values in each bin. (c) Age-metallicity relation for 38 main-sequence stars which have extra-solar planets according to the catalogues of Schneider (2005) and Mayor et al. (2005).

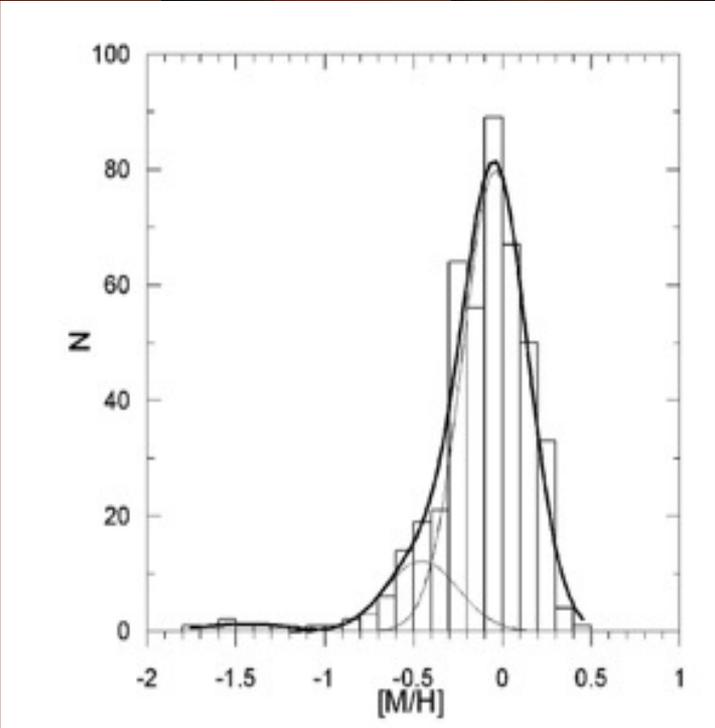
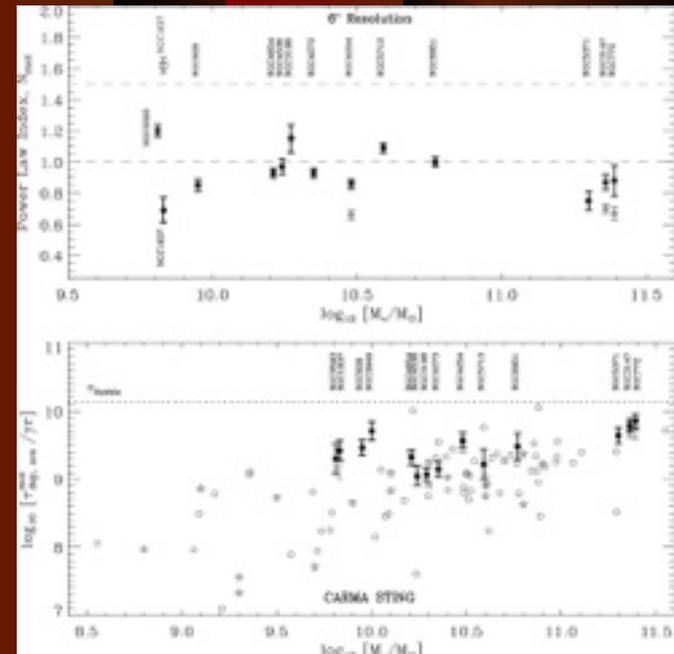
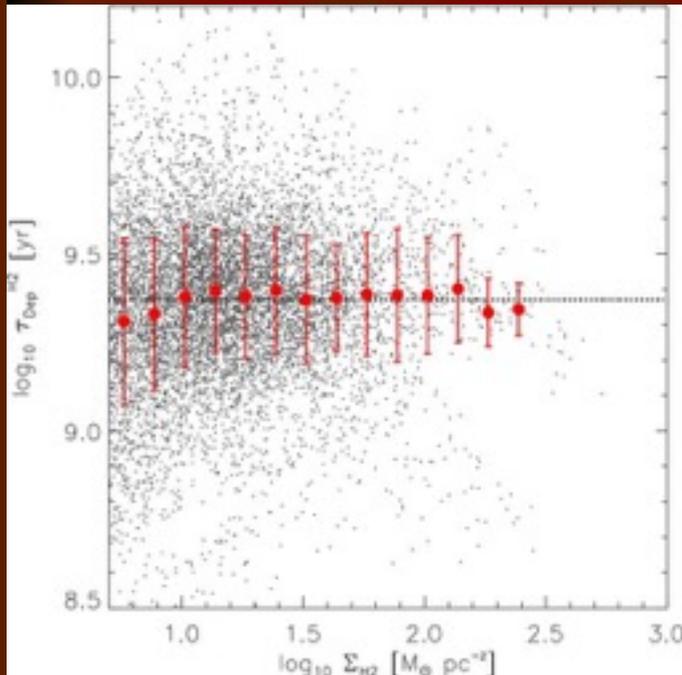


Figure 5. Distribution of the metallicities of our stars. Curves are the fitted Gaussian distributions, which give the mean metal abundances of $\langle [M/H] \rangle = -0.04$, -0.45 , and -1.30 dex for the thin and thick discs, and halo (thin curves), respectively, and their sum (heavy curve). For the halo component (centred at -1.30 dex), the thin and heavy curves merge, as does the thin-disc curve for $[M/H] > 0.0$; the thick-disc curve is that centred at -0.45 dex.

Современные запасы газа в спиральных галактиках рассчитаны на 2-3 млрд лет



Нужна постоянная аккреция!

Откуда берется газ для образования звезд?

Или падение спутников?

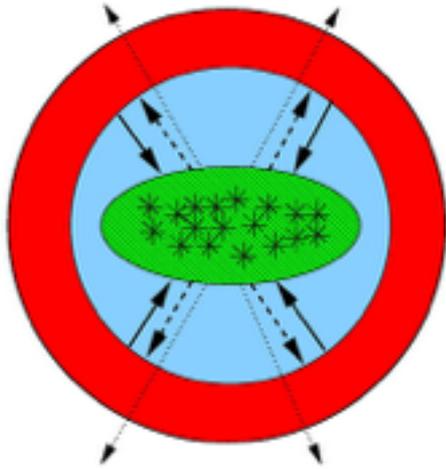
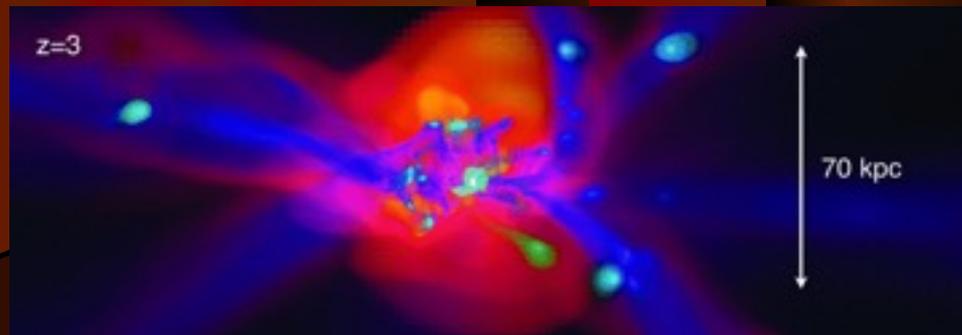


Figure 10. A schematic figure showing gas cooling from the hot halo (solid lines) and building up the reservoir of cold gas in the galactic disc. The cooled gas is turned into stars on a timescale set by the parameters of the model. Supernova explosions can reheat a fraction of the cooled gas and return it to the hot phase (dashed lines) or eject material from the halo altogether (dotted lines).

?



?

Наша Галактика состоит из...

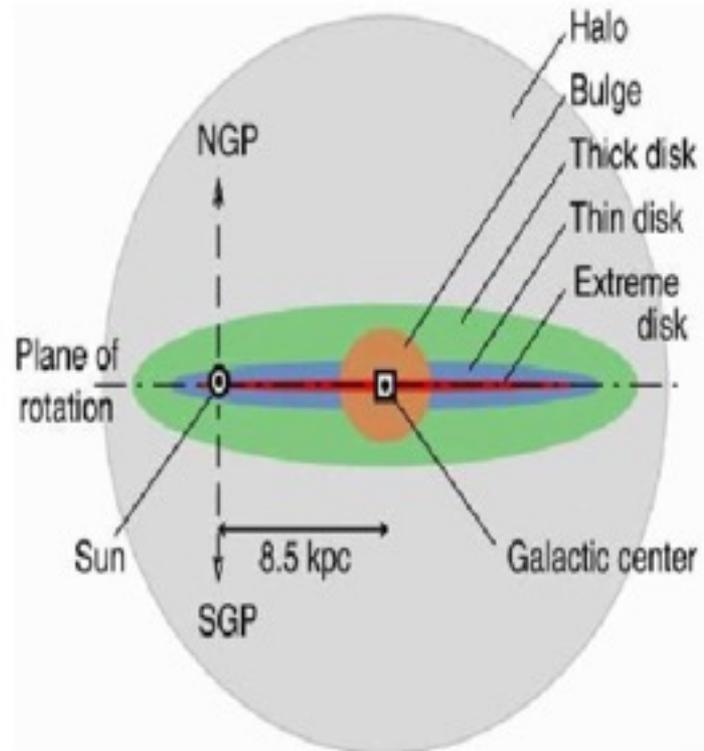
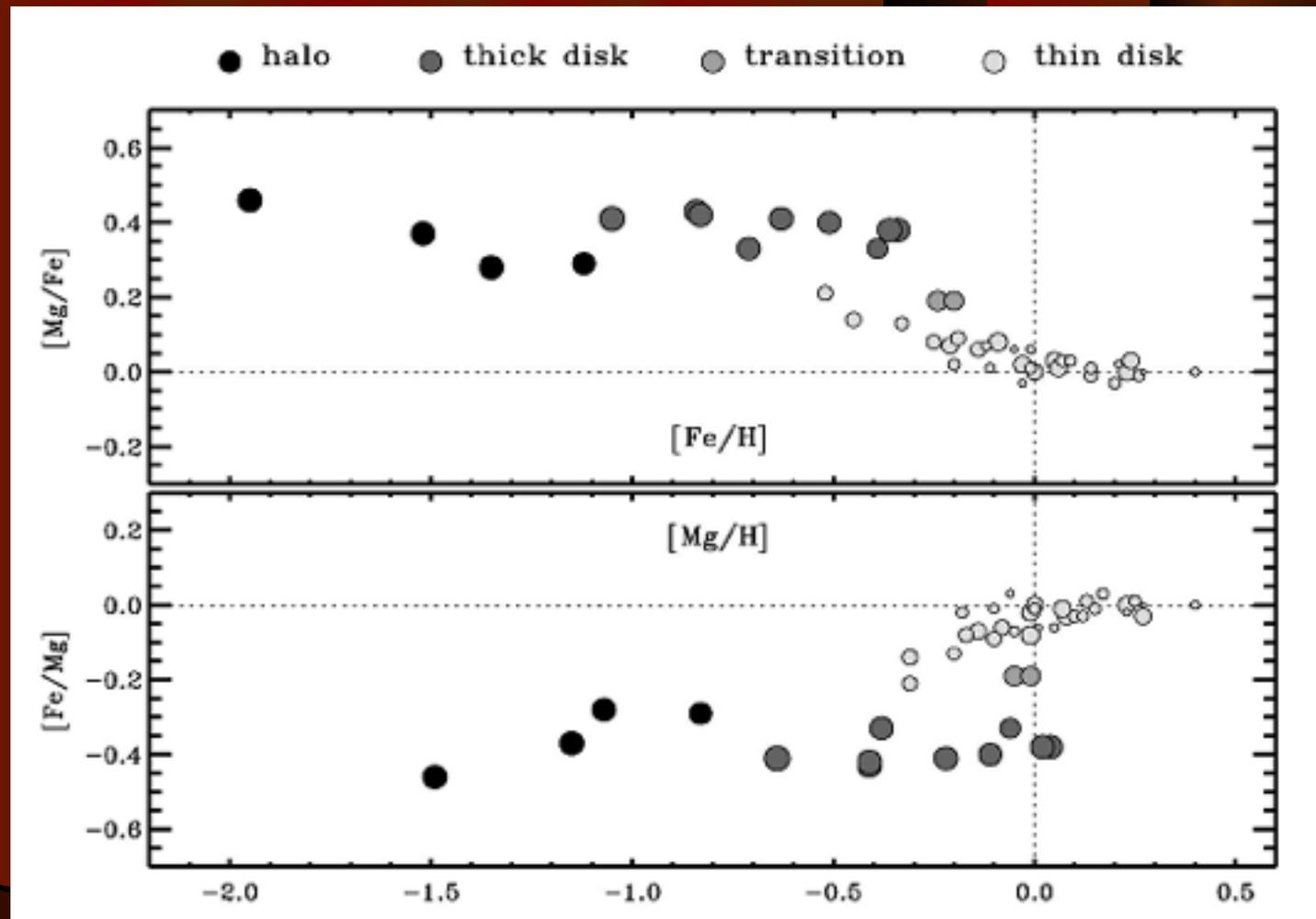
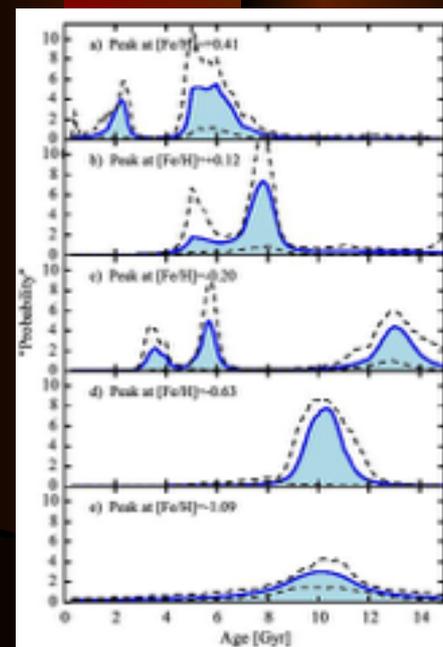
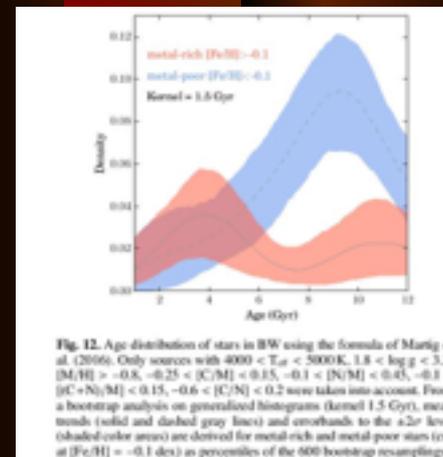
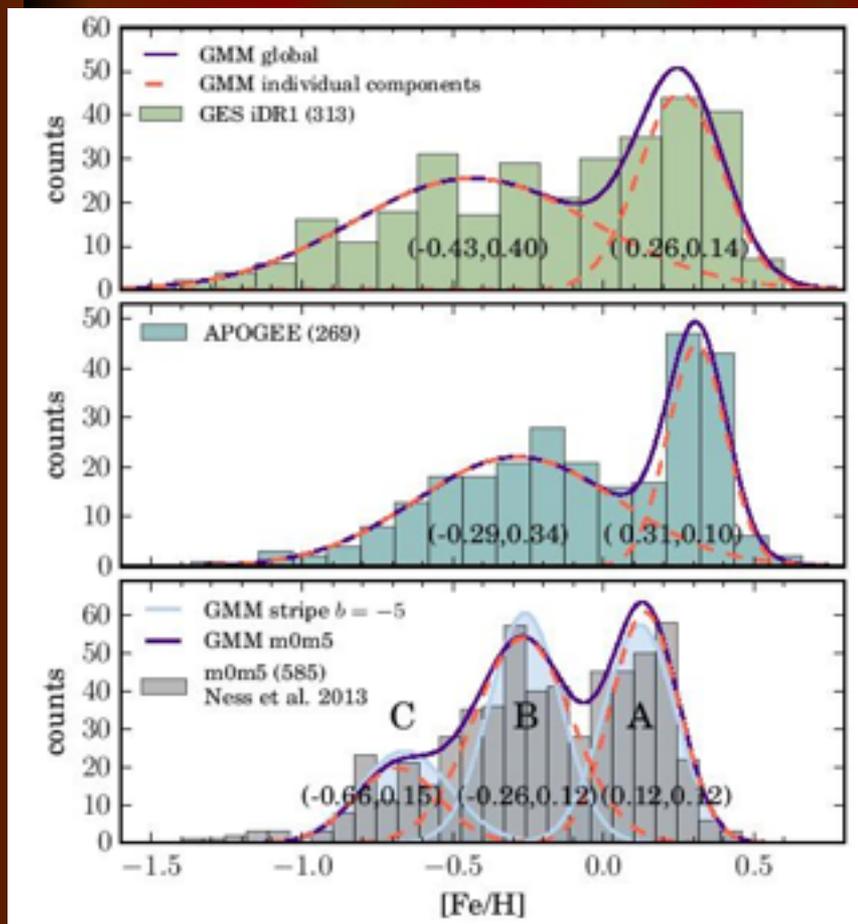


Fig. 12. Schematic edge-on view of the major components of the Milky Way. Illustration credit from R. Buser, www.astro.unibas.ch/forschung/rb/structure.shtml.

Два диска! Толстый диск образовался быстро и давно, тонкий образуется до сих пор



Балдж Галактики тоже из двух КОМПОНЕНТ:



Данные 2017 г

Один компактный, другой квадратный.

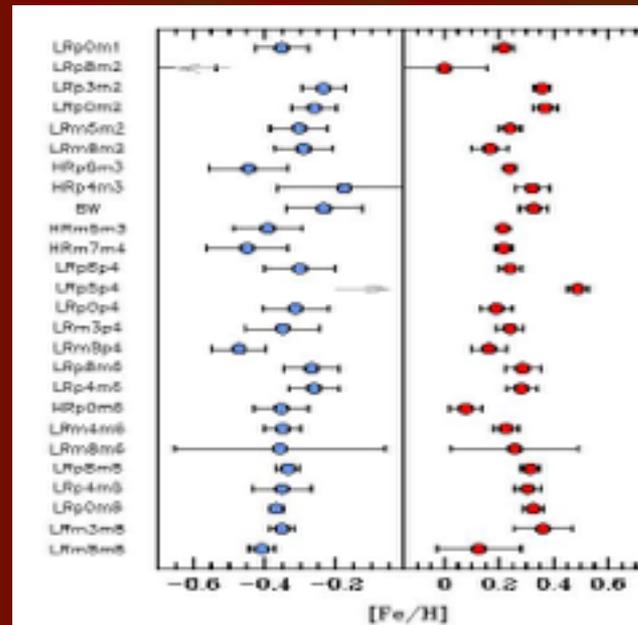
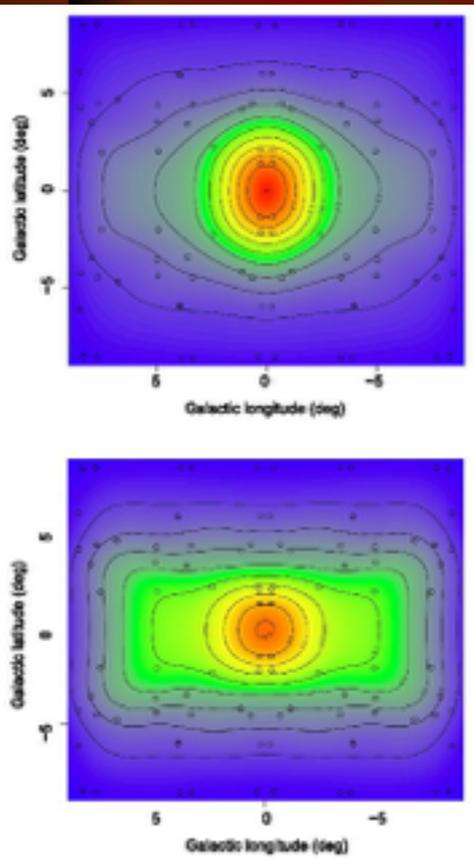
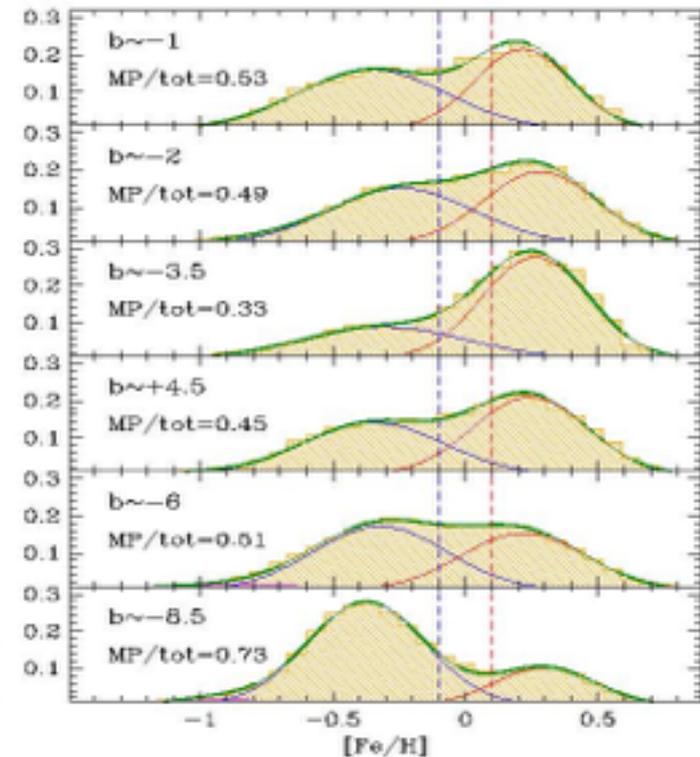


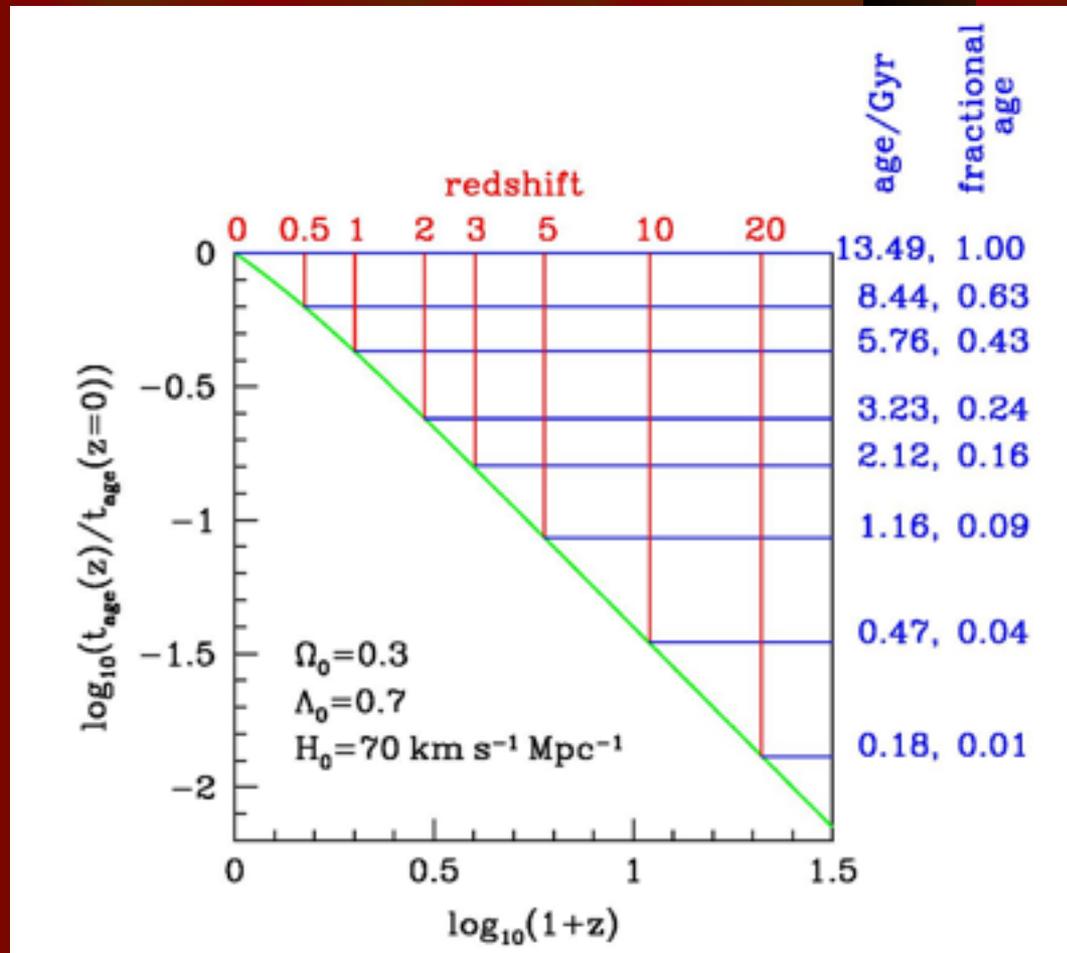
Fig. 6. Peak metallicity of the metal-poor (blue) and metal-rich (red) Gaussians fitted in Fig. 4. The names of the fields are listed on the left, from the closest to the plane at the top, to the ones in the outer bulge at the bottom.



Наблюдательное исследование эволюции Вселенной

- На больших 8-10 метровых телескопах мы видим всю Вселенную после рекомбинации на просвет...

Космологическая модель пространства-времени связывает красное смещение и время, затраченное светом, чтобы пройти это расстояние



Возраст
Вселенной на
разных красных
смещениях

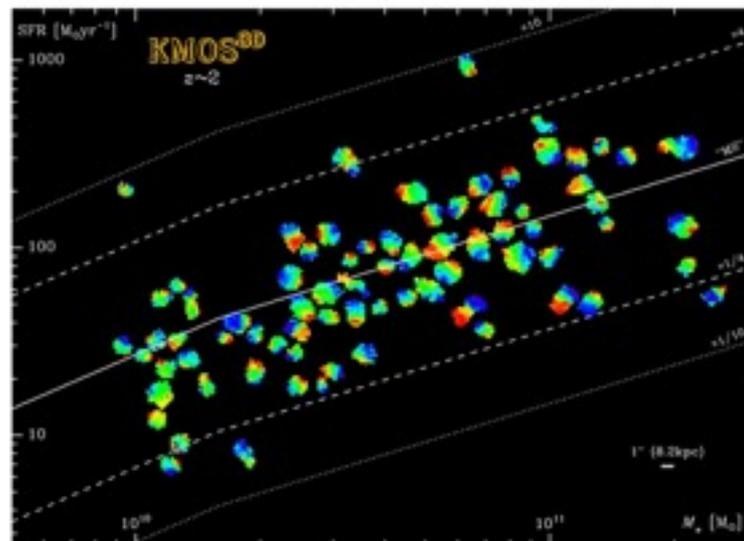
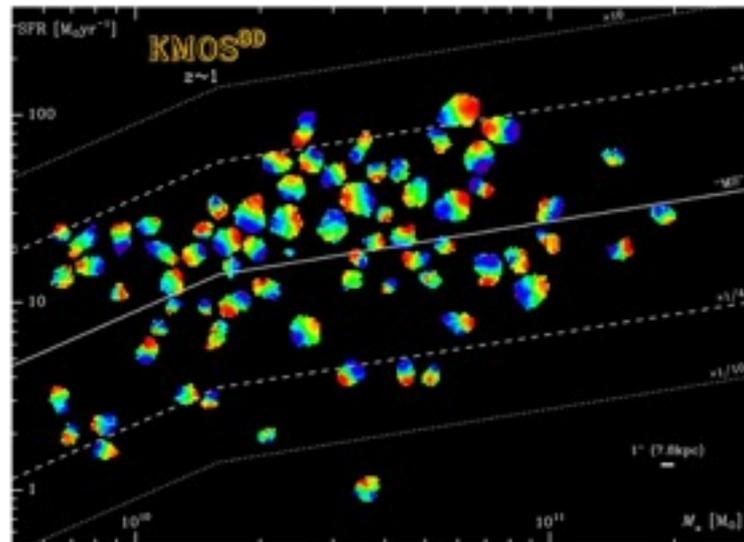
На красных смещениях $z > 1.5$ (9 млрд лет назад)
морфологическая последовательность нарушается...
(галактики в северном Глубоком Хаббловском поле)



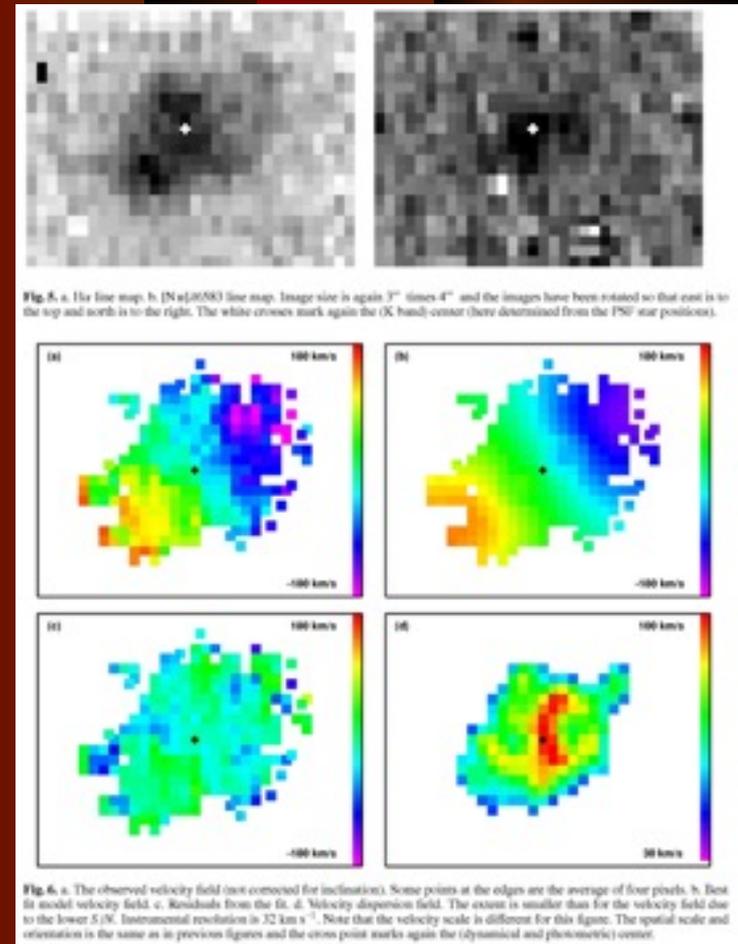
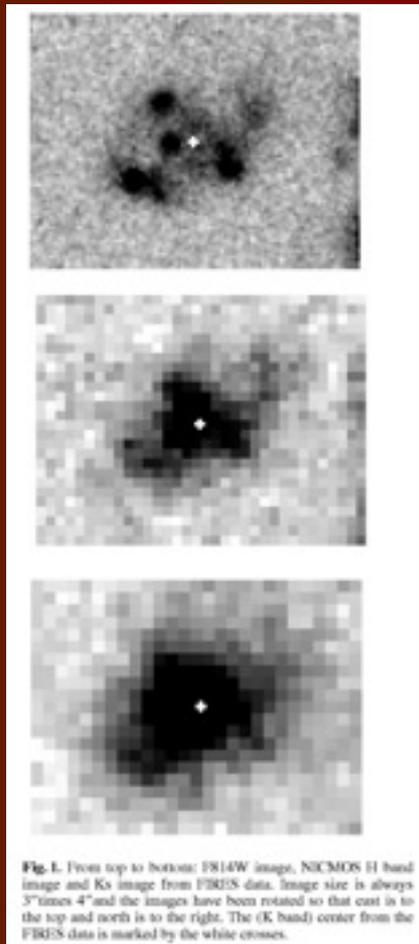
Что значит клочковатость далеких галактик?

- Звездообразование идет в крупных комплексах?
- Большие галактики на глазах образуются слиянием малых галактик?

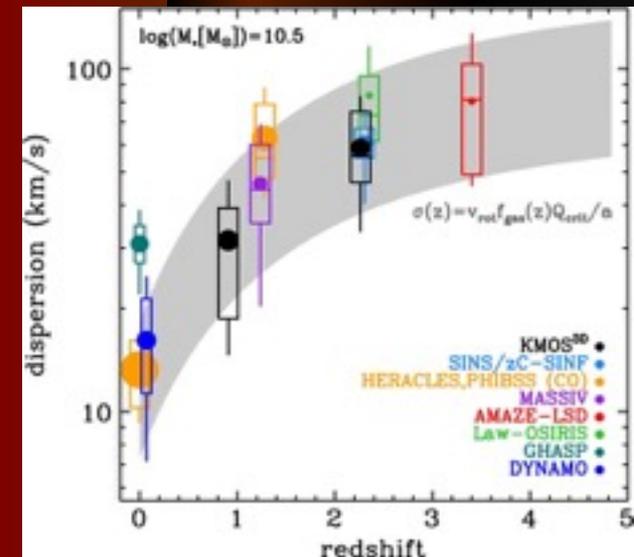
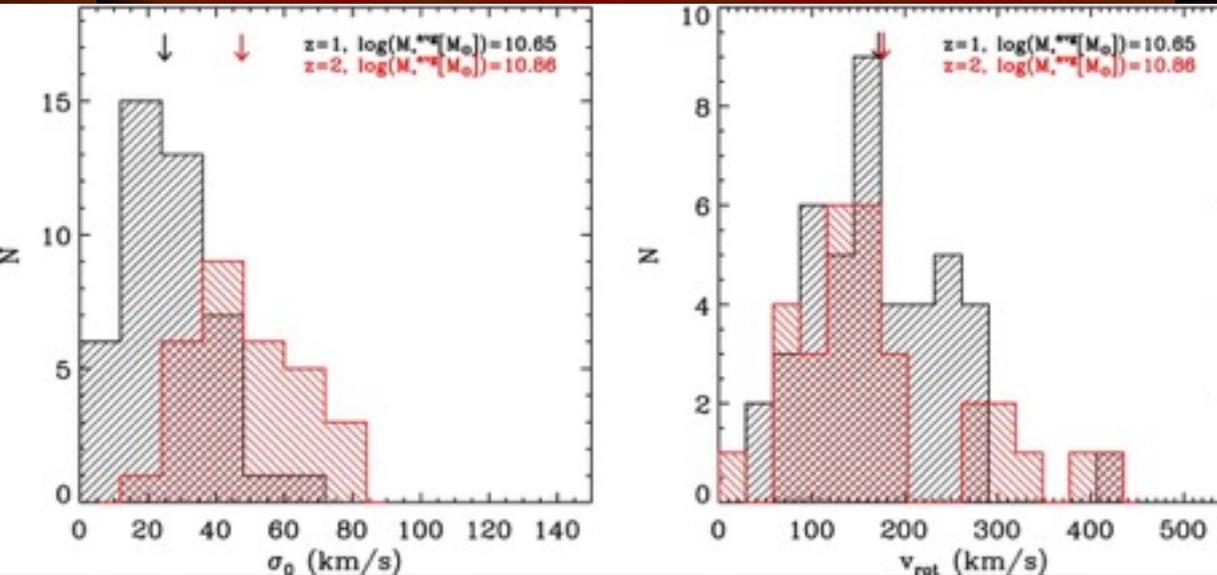
Обзор KMOS-3D: $z=0.7-2.7$, панорамная спектроскопия на VLT



Как оказалось, все клочки участвуют в едином вращении:



83% -Массивные, быстро вращающиеся диски, но ТОЛСТЫЕ И ГОРЯЧИЕ динамически



Кривые вращения

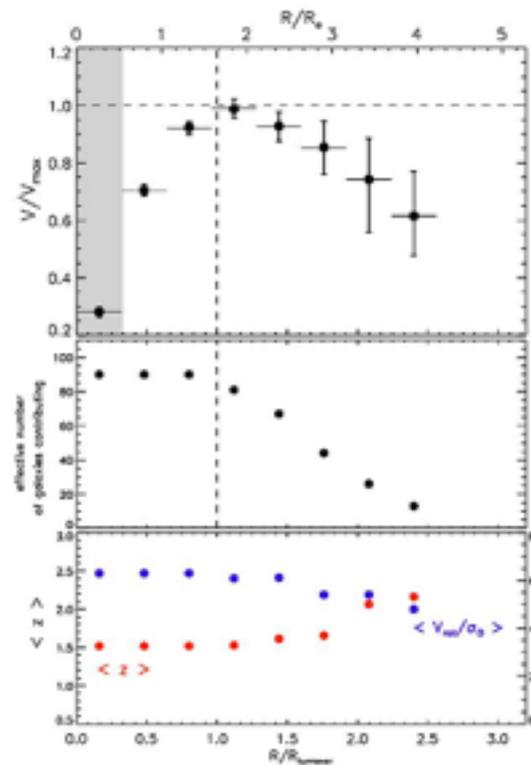
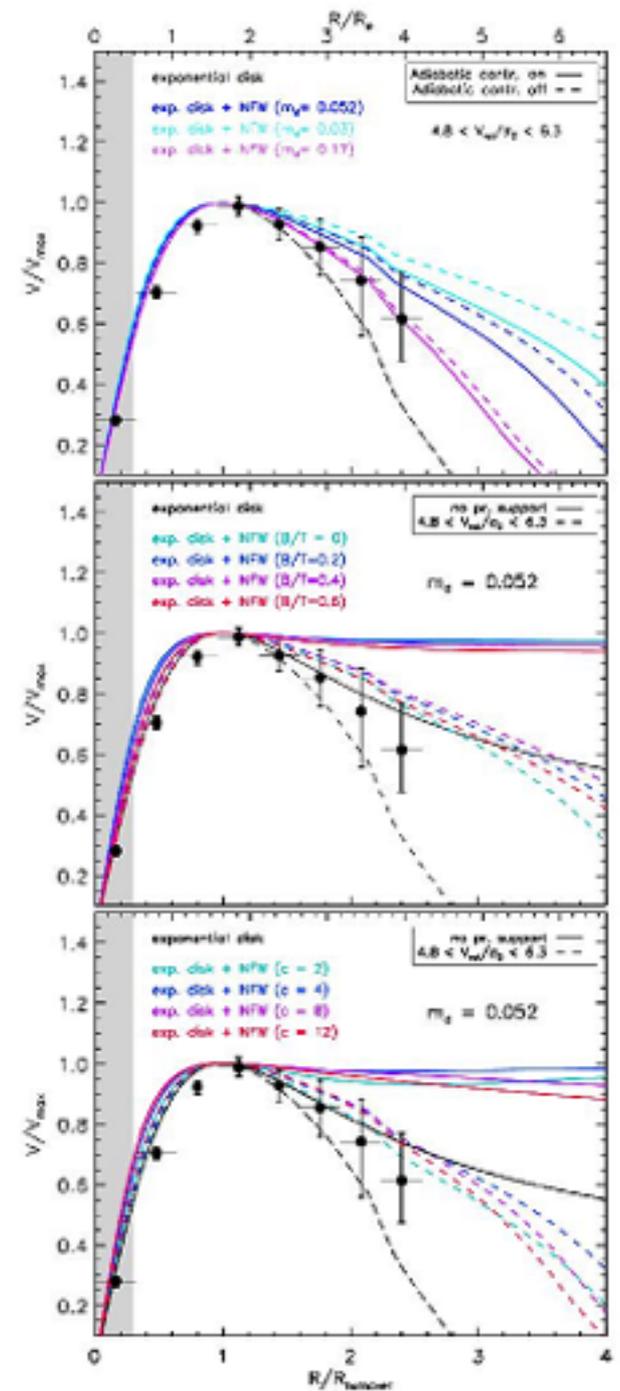


Figure 5. Top: Stacked rotation curve (black dots) plotted in units of normalized velocity (V/V_{max}), normalized radius (R/R_{max}), and intrinsic effective radius (R/R_e). The error bars are derived from bootstrapping and include both sample variance as well as RMS noise in the spectra. The shaded area marks the half-light beam size of the average PSF observed for our sample. Middle: Effective number of galaxies contributing to the stack, accounting for masking out noisy pixels in the pv diagrams. The decrease in the number of contributing galaxies with increasing radius is driven by FCV limitations. Bottom: Median redshift and V_{max}/σ_v of contributing galaxies for a given radial bin.



Главный результат: отсутствие темной материи – признак раннего типа галактики?

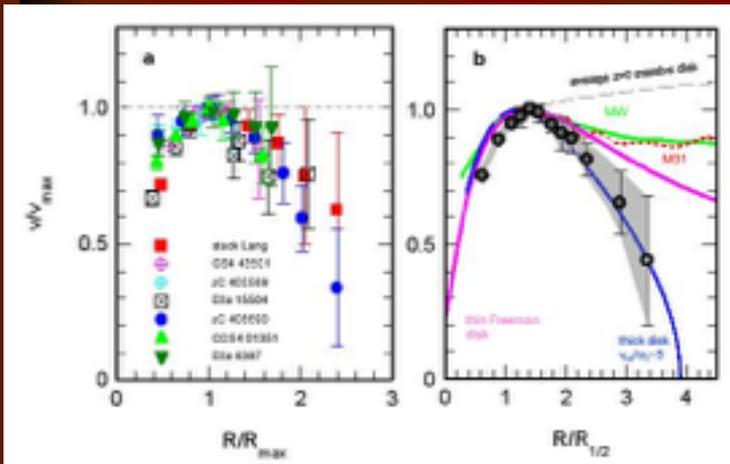


Figure 2. Normalized rotation curves. (a): The various symbols denote the folded and binned rotation curve data for the six galaxies in Figure 1, combined with the stacked rotation curve of 97 $z=0.6-2.6$ star-forming galaxies¹⁵ (Methods). For all rotation curves we averaged data points located symmetrically on either side of the dynamical centres, and plot the rotation velocities and radii normalized to their maximum values. Error bars are ± 1 rms. (b): The black data points

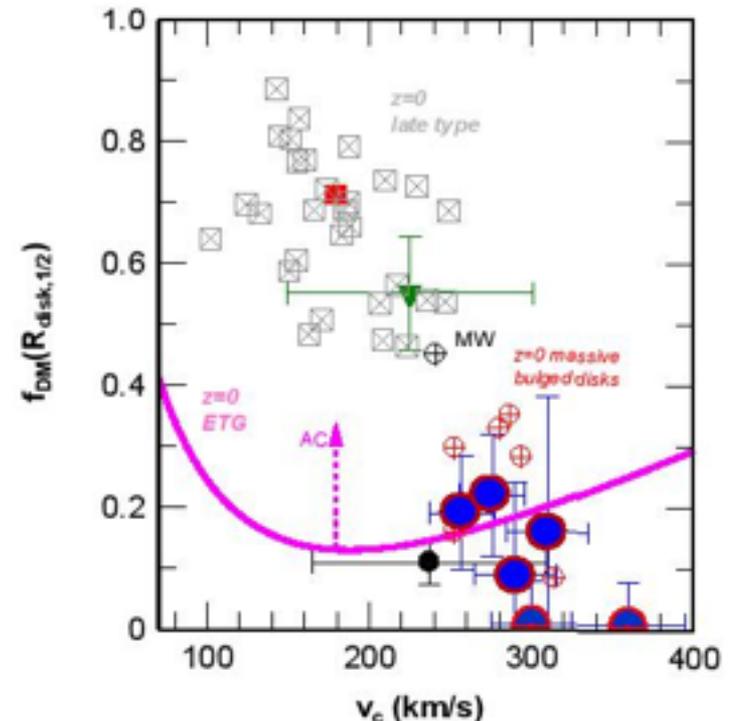
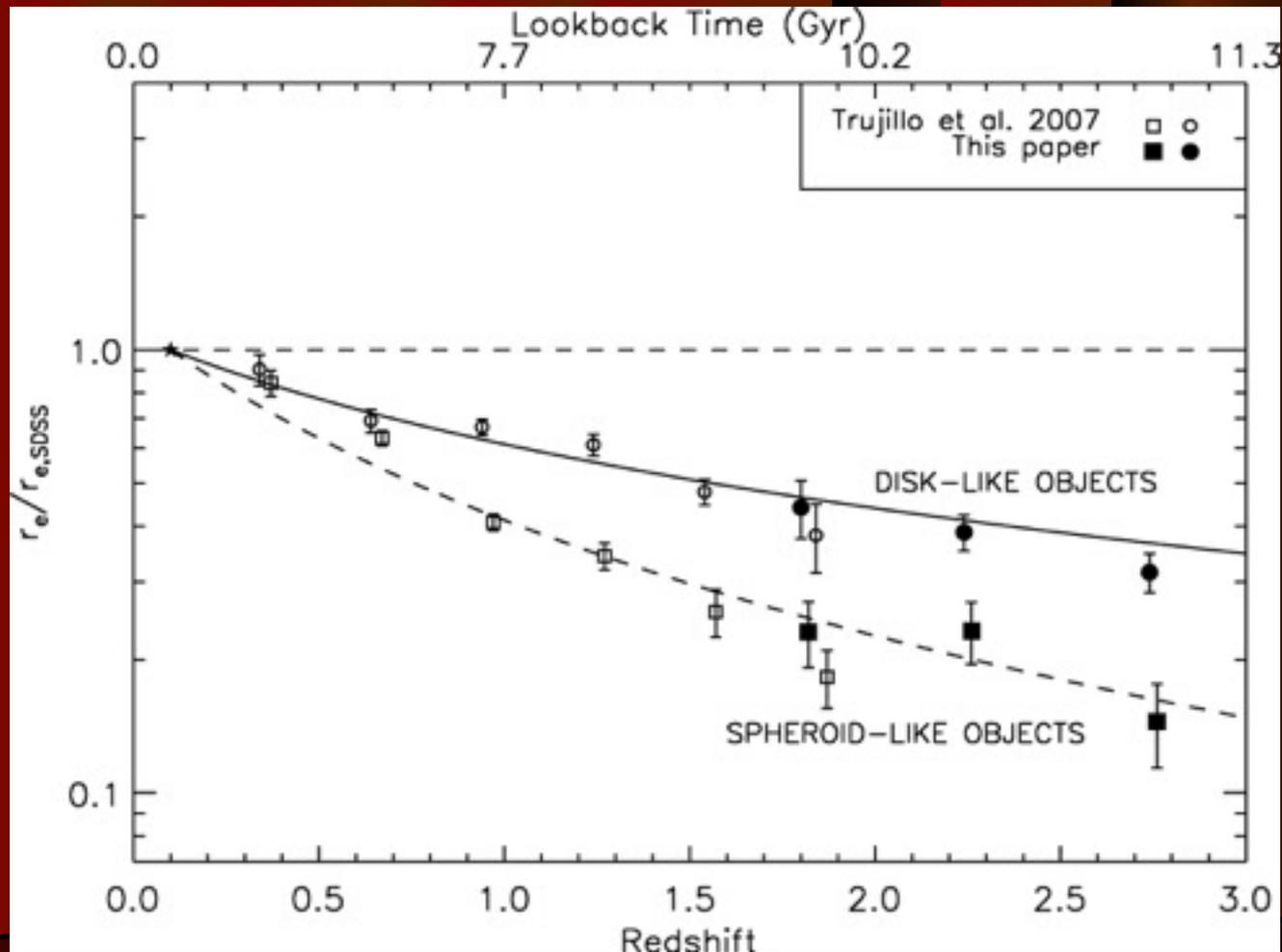
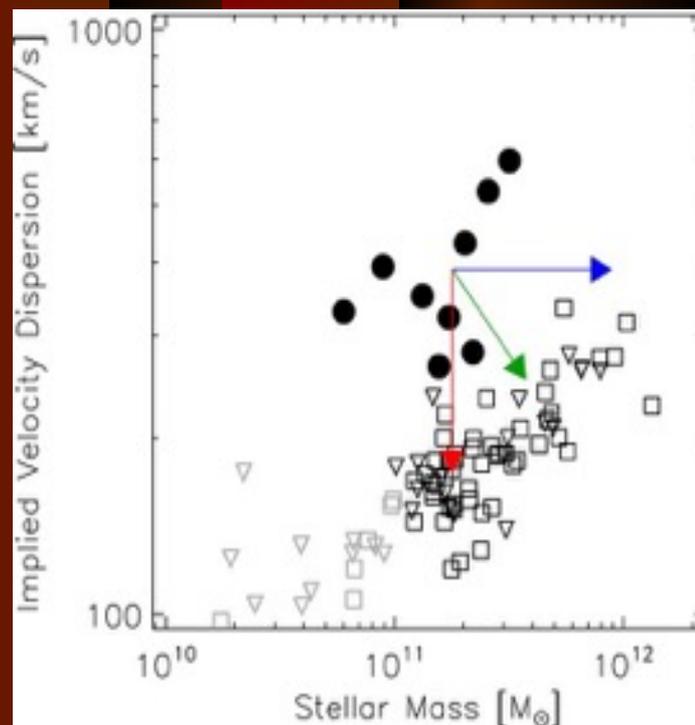
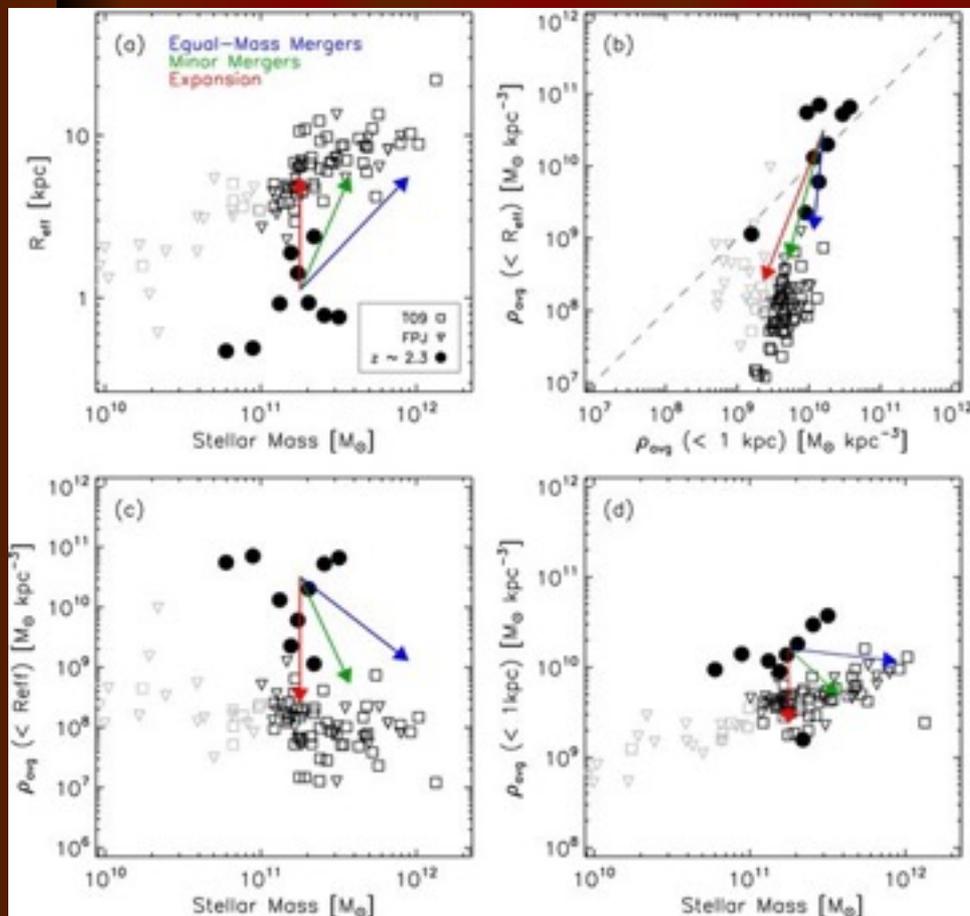


Figure 3. Dark matter fractions. Dark matter fractions from different methods are listed as a function of the circular velocity of the disk, at the half mass/light radius of the disk, for galaxies in the current Universe and ~ 10 Gyr ago. The large blue circles with red outlines indicate the dark matter fractions derived from the outer-disk rotation curves of the six high- z disks presented in this paper (Table 1), along with the ± 2 rms

Эволюция размеров: особенно сильная у сфероидов



Аргументы в пользу малого мерджинга: эволюция размера E-галактик



Все-таки много малых слияний

Development of Massive Elliptical Galaxies

