Обзор ArXiv/astro-ph, 3-8 декабря 2021

От Сильченко О.К.

ArXiv: 2112.01803

Formation of galactic bulges from the cold gas filaments in high-redshift dark matter halos

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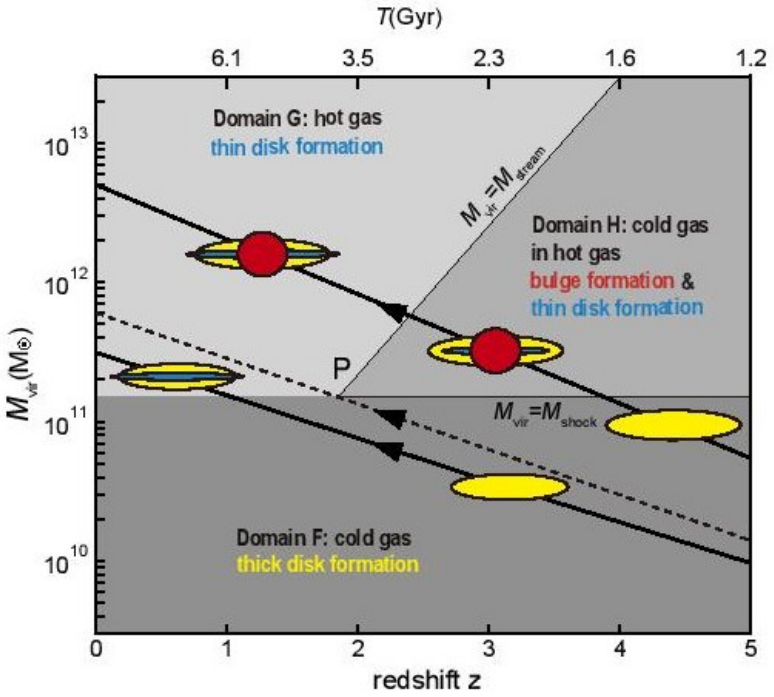
Accepted XXX. Received YYY; in original form ZZZ

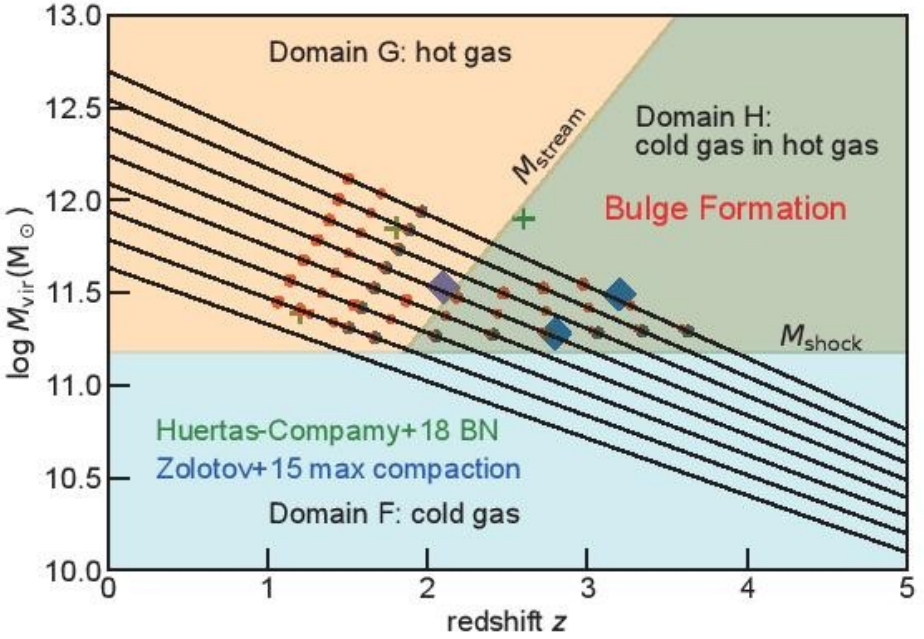
ABSTRACT

Formation process(es) of galactic bulges are not yet clarified although several mechanisms have been proposed. In a previous study, we suggested one possibility that galactic bulges have been formed from the cold gas inflowing through surrounding hot halo gas in massive dark matter halos at high redshifts. It was shown that this scenario leads to the bulge-to-total stellar mass ratio increasing with the galaxy mass, in agreement with the well-known observed trend. We here indicate that it also reproduces recent observational results that the mean stellar age of the bulge increases with the galaxy mass while the age gradient across

Новый сценарий



Noguchi 2020



Noguchi 2021
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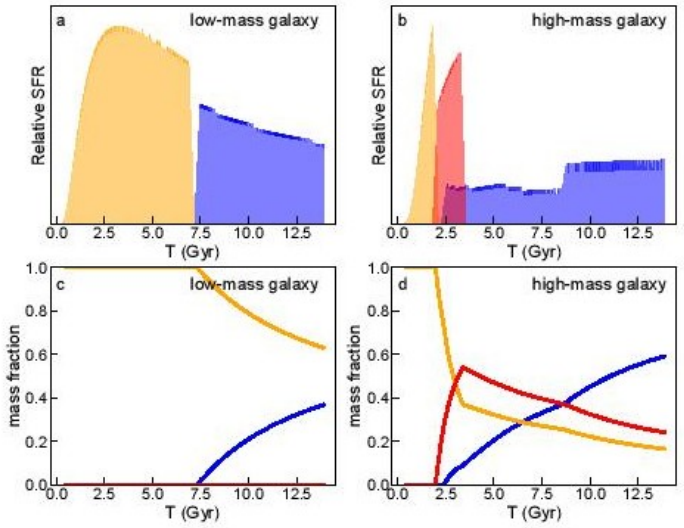


Figure 2. Panels a,b: Star formation rate (SFR) in the least massive and the most massive galaxies. Blue, orange, and red indicate SFR for thin disc, thick disc, and bulge, respectively. SFR is averaged over 20 successive time steps (0.28 Gyr) to smooth out the short timescale fluctuations arising in the model calculation, and given in arbitrary units. Panels c,d: Time variation of the mass fraction relative to the total stellar mass of thin disc (blue), thick disc (orange), and bulge (red).

Noguchi 2020

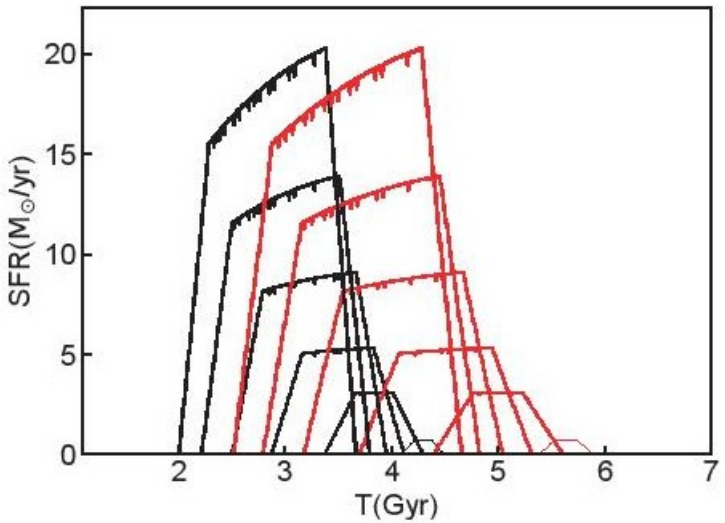


Figure 2. Star formation rate for the bulge component as a function of time, with thicker black lines indicating models with larger virial masses at present. Plotted values are running means with the width of 0.28 Gyr. Tiny spikes are caused by the numerical method used in the evolution model and do not affect our conclusions. Red lines indicate the star formation history for which delay of twenty dynamical times is taken into account.

Noguchi 2021
(present)

Соотношение звездных масс балджа и всей галактики

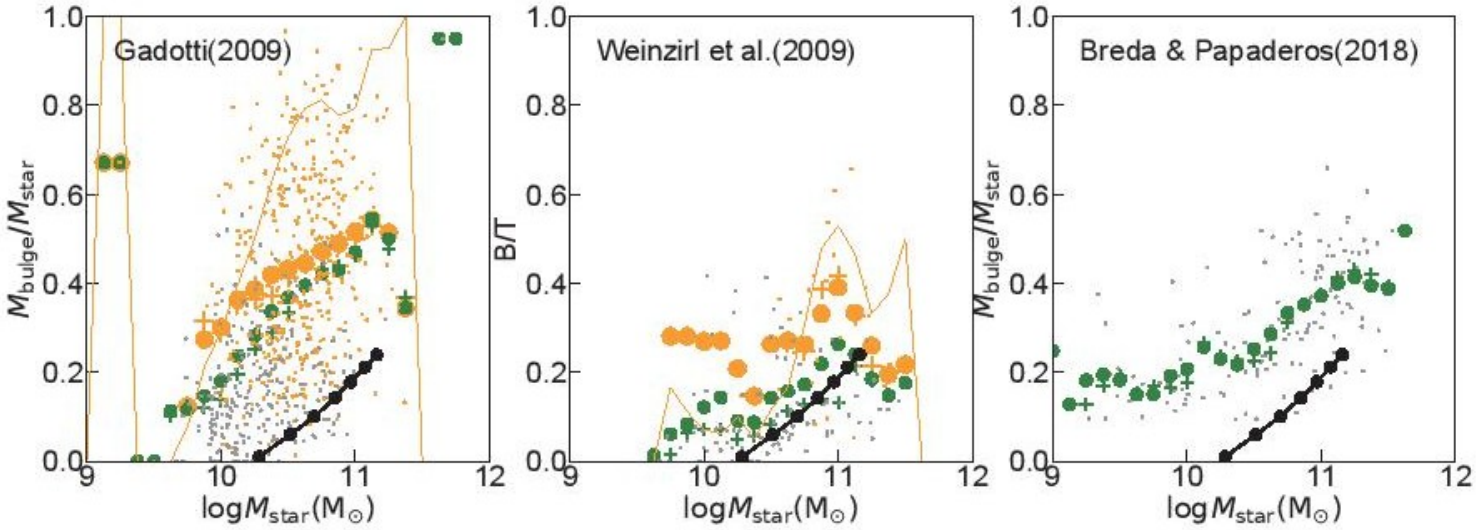
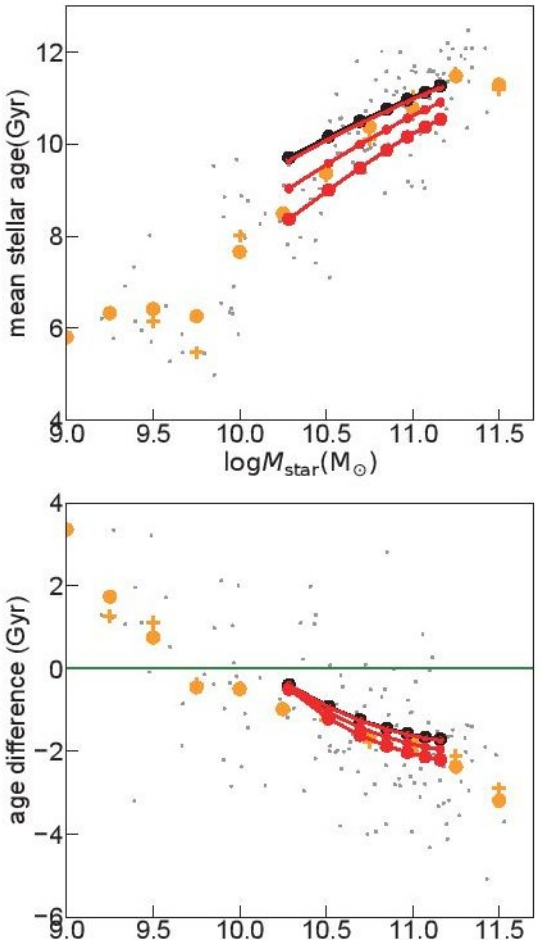


Figure 3. Model bulge fractions compared with three sets of observations. Black dots connected by solid lines are model results, whereas observational data are represented by small dots. Green circles and pluses indicate, respectively, the running mean and median in the mass bin having the width of 0.25 dex and moved by every 0.125 dex in the galaxy total stellar mass. In the left and central panels, orange symbols denote means and medians only for classical bulges (orange small dots) defined to have the Sersic index larger than 2 in i-band and H-band, respectively. The orange lines indicate the number fraction of classic bulges in each mass bin. Breda & Papaderos (2018) do not derive the Sersic index and no classification of bulges is possible.

Корреляция масса-возраст



Katkov et al.: NGC 254

Star formation in outer rings of S0 galaxies.

IV. NGC 254 – a double-ringed S0 with gas counterrotation

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Received .., 2021; accepted .., 2021

ABSTRACT

Aims. Though S0 galaxies are usually considered "red and dead", they often demonstrate star formation organized into ring structures. We try to clarify the nature of this phenomenon and its difference from star formation in spiral galaxies.
Methods. Here we investigate the nearby moderate luminosity S0 galaxy NGC 254 using long-slit spectroscopy taken with the South African Large Telescope and publicly available imaging data. Applying a full spectral fitting, we analyzed gaseous and stellar kinematics as well as ionized gas excitation and metallicity and stellar population properties resolved by radius. An advanced approach of simultaneous fitting spectra and photometric data allowed us to quantify the fraction of hidden counter-rotating stars in this galaxy.
Results. We found that the ionized gas is counter-rotating with respect to the stars throughout NGC 254 disk, indicating an external origin of the gas. **We argue the gas-rich galaxy merger from retrograde orbit as a main source of counter-rotating material.** The star formation fed by this counter-rotating gas occurs within two rings, an outer ring at $R = 55'' - 70''$ and an inner ring at $R = 18''$. The star formation rate is weak, 0.02 solar mass per year in total, the gas metallicity is slightly subsolar. **We estimated that the accretion of the gas occurred about 1 Gyr ago, and about 1% of all stars have formed in situ from this gas being also counter-rotating.**

Key words. galaxies: structure – galaxies: evolution – galaxies, elliptical and lenticular – galaxies: star formation

NGC 254, Legacy Survey

А есть ли бар?

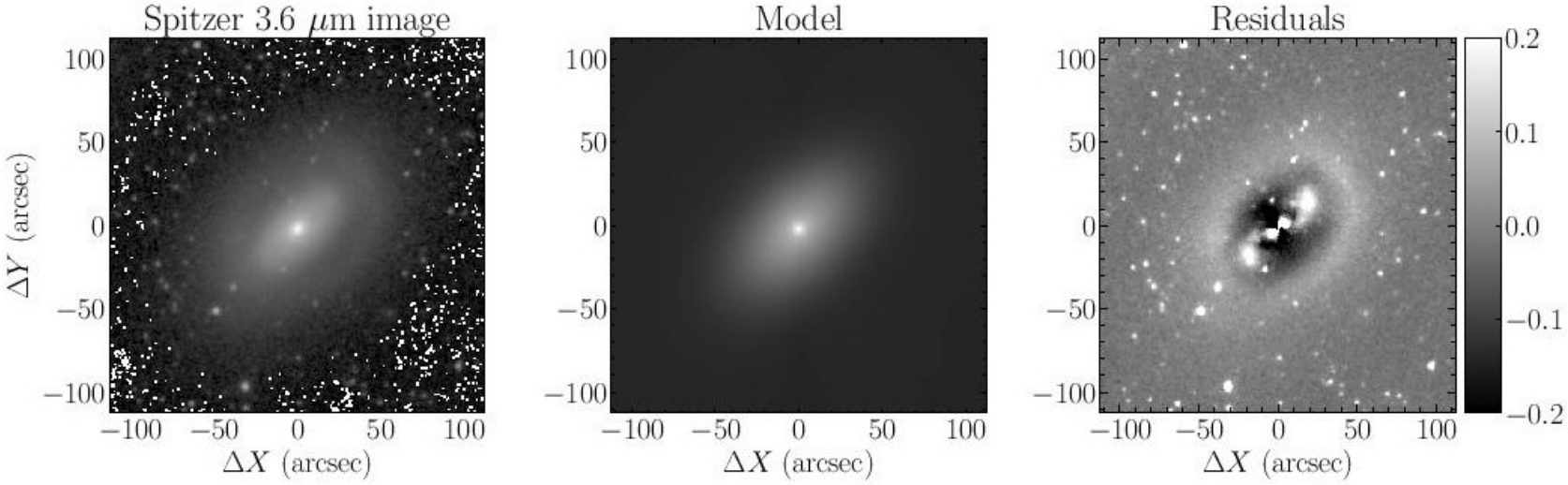


Fig. 3. GALFIT **modelling of 3.6 μm image of NGC 254. From left to right – galaxy image, model and residuals. Note that galaxy image and model are shown in logarithmic scale, while residuals in the linear scale.**

В обоих кольцах есть газ и идет звездообразование

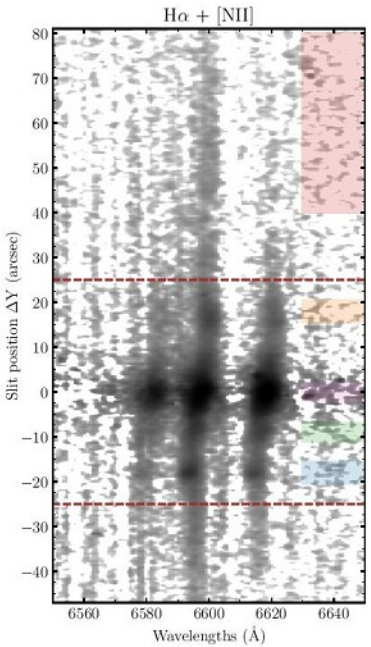
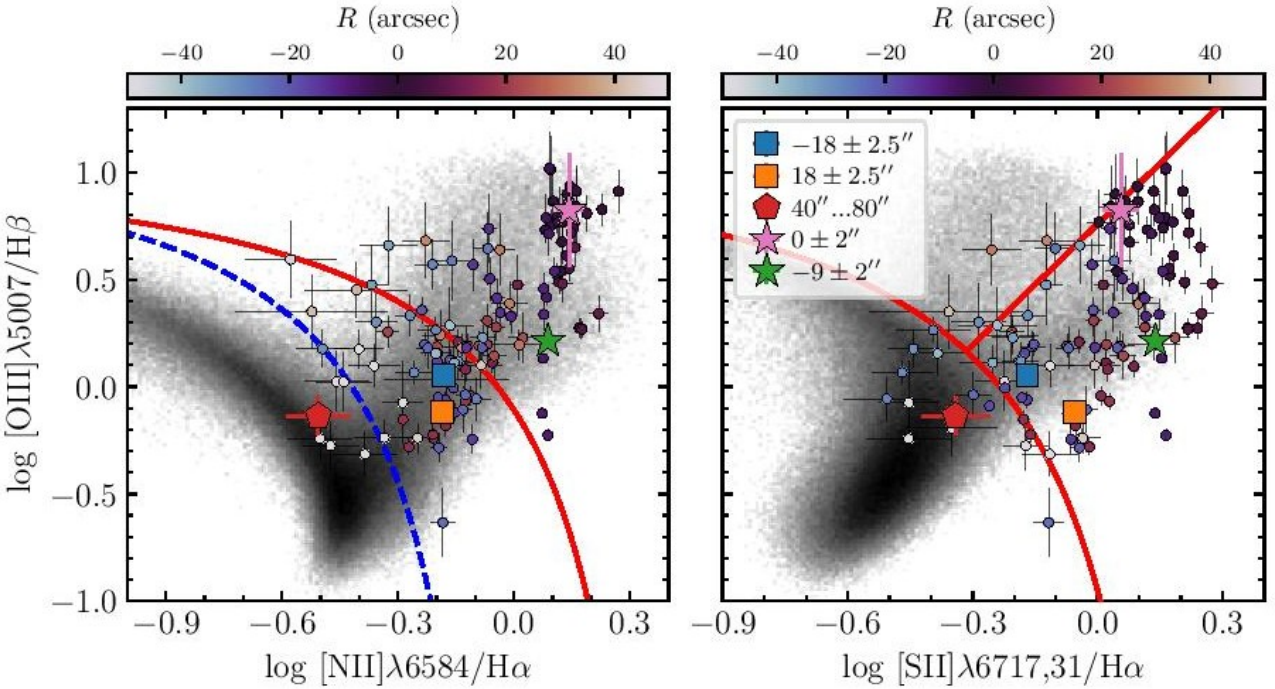


Fig. 8. Emission line flux distribution along the slit. Starlight contribution is removed. Brown dashed lines show locations of the stellar inner ring $R = \pm 25''$. **Color stripes correspond to the same radial ranges as shown in Fig. 7.**



Пытаемся найти результаты этого звездообразования…