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Dynamical evidence for a morphology-dependent relation between the stellar and halo masses of galaxies

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ABSTRACT

We derive the stellar-to-halo mass relation (SHMR), namely $f_\star \propto M_\star/M_\mathrm{h}$ versus $M_\star$ and M_h, for early-type galaxies from their near-infrared luminosities (for $M_\star$) and the position-velocity distributions of their globular cluster systems (for M_h). Our individual estimates of M_h are based on fitting a flexible dynamical model with a distribution function expressed in terms of action-angle variables and imposing a prior on M_h from the correlation between halo concentration and mass in the standard Λ Cold Dark Matter (ΛCDM) cosmology. We find that the SHMR for early-type galaxies declines with mass beyond a peak at $M_\star \sim 5\times10^{10}M_\odot$ and $M_\mathrm{h} \sim 1\times10^{12}M_\odot$ (near the mass of the Milky Way). This result is consistent with the standard SHMR derived by abundance matching for the general population of galaxies, and with previous, less robust derivations of the SHMR for early-type galaxies. However, it contrasts sharply with the monotonically rising SHMR for late-type galaxies derived from extended HI rotation curves and the same ΛCDM prior on M_h as we adopt for early-type galaxies. We show that the SHMR for massive galaxies varies more or less continuously, from rising to falling, with decreasing disc fraction and decreasing Hubble type. We also show that the different SHMRs for late-type and early-type galaxies are consistent with the similar scaling relations between their stellar velocities and masses (the Tully-Fisher and the Faber-Jackson relations). As we demonstrate explicitly, differences in the relations between the stellar and halo virial velocities account for the similarity of the scaling relations. We argue that all these empirical findings are natural consequences of a picture in which galactic discs are built mainly by relatively smooth and gradual inflow, regulated by feedback from young stars, while galactic spheroids are built by a cooperation between merging, black-hole fuelling, and feedback from active galactic nuclei.

Key words. galaxies: kinematics and dynamics – galaxies: elliptical – galaxies: spiral – galaxies: structure – galaxies: formation

SLUGGS: шаровые скопления вокруг 25 E и S0

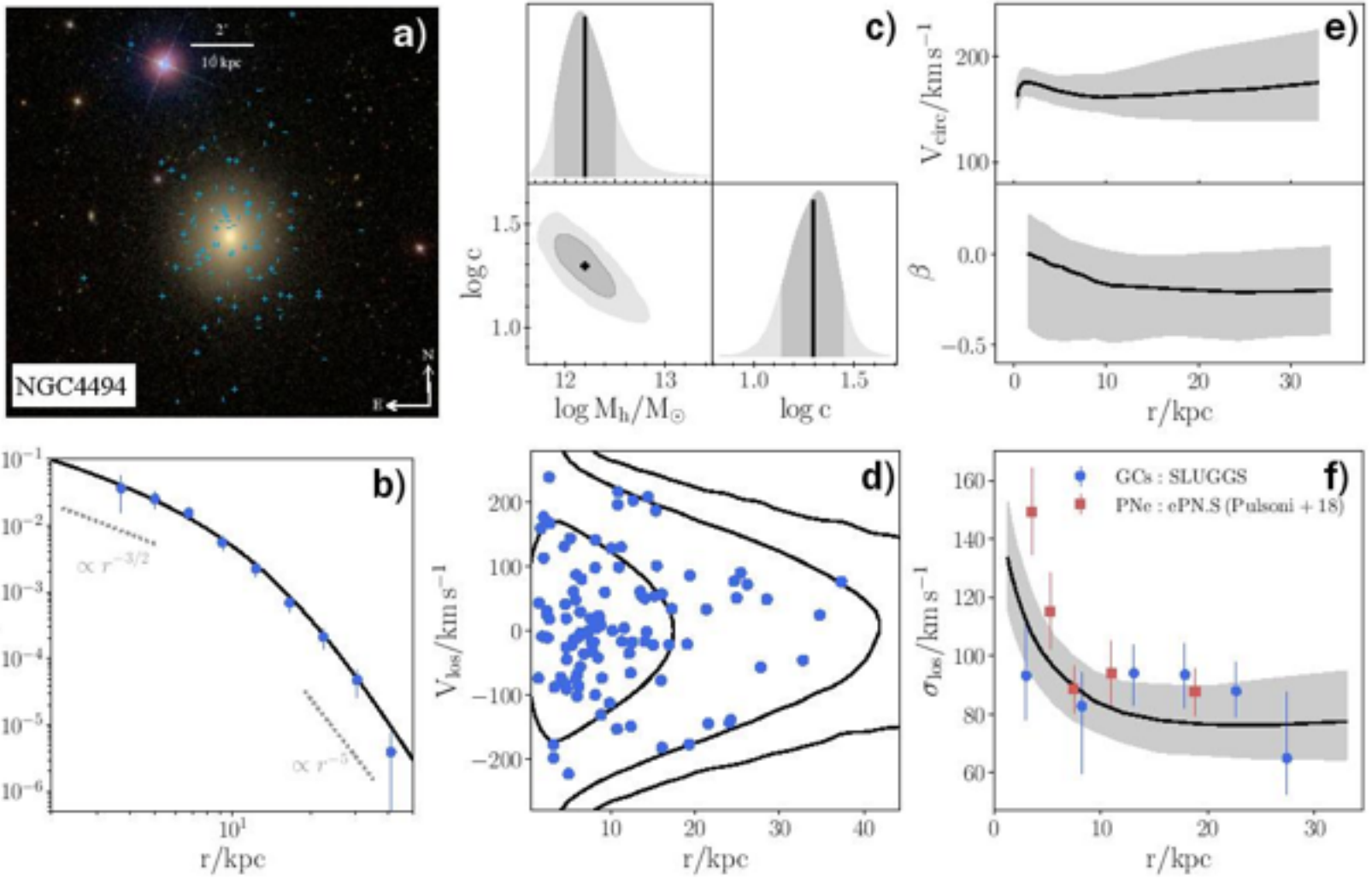
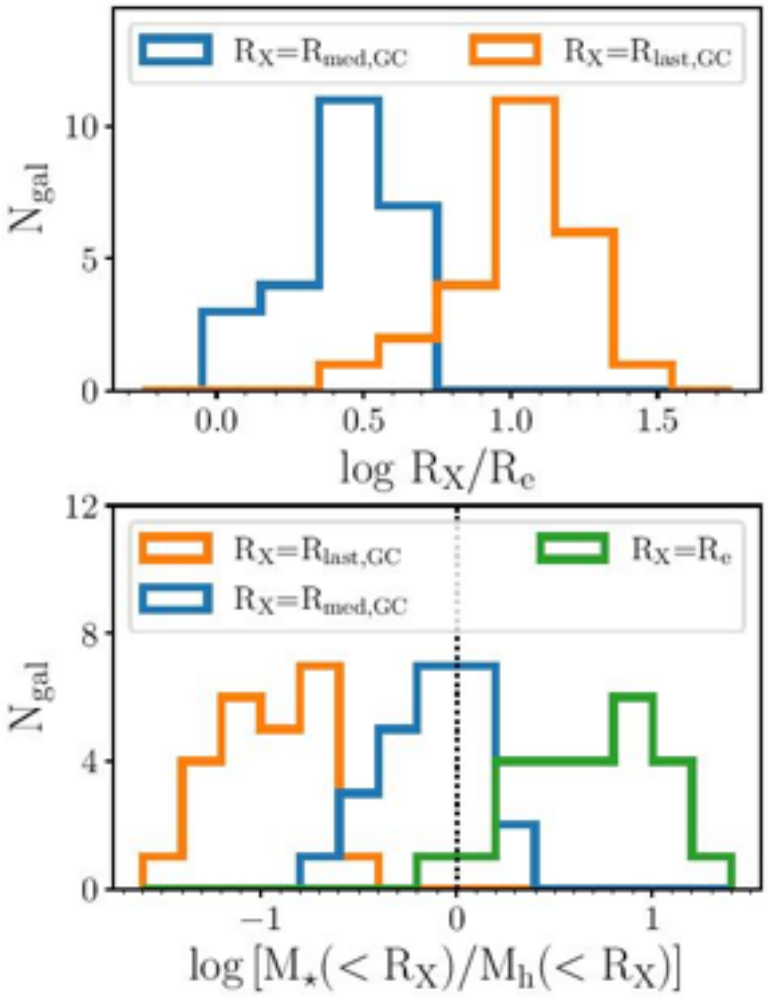


Fig. 1. Illustration of our modelling technique using NGC 4494 as an example. In all panels, GC data are shown as blue points, the DF model is

Все равно вся динамика – сильно внутри вириального радиуса



- Максимальный радиус, проверяемый системой шаровых скоплений – от 8 до 98 кпк.

Правая ветвь для галактик ранних типов - ПАДАЕТ

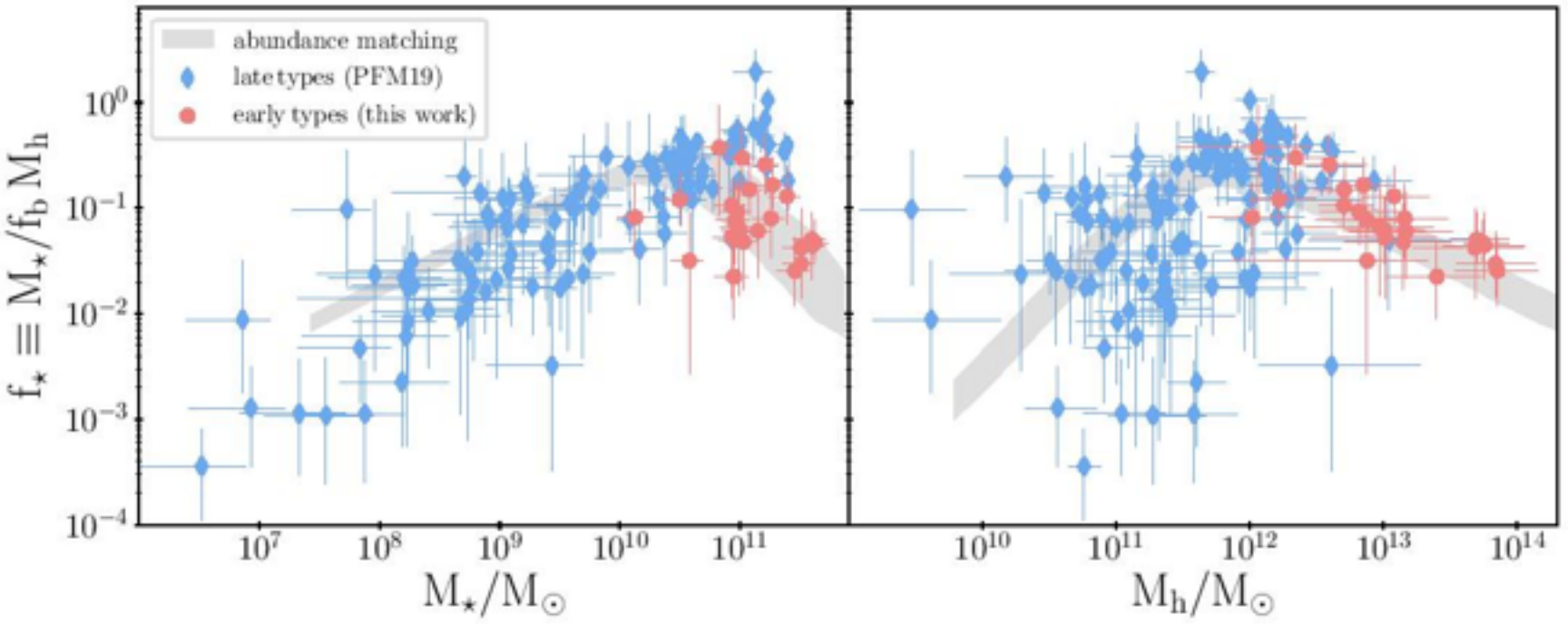


Fig. 3. SHMR in the form of the ratio $f_\star \equiv M_\star / f_b M_h$ as a function of stellar mass (left) or halo mass (right) for the sample of spiral galaxies in SPARC (blue diamonds, PFM19) and for the sample of ellipticals and lenticulars in SLUGGS (red circles, this work). The halo masses of late types are estimated from HI rotation curves, those of early types from the kinematics of the GC system. We compare to the SHMR from the abundance matching model by Moster et al. (2013, grey band).

При одной и той же звездной массе у галактик поздних типов МЕНЬШЕ гало

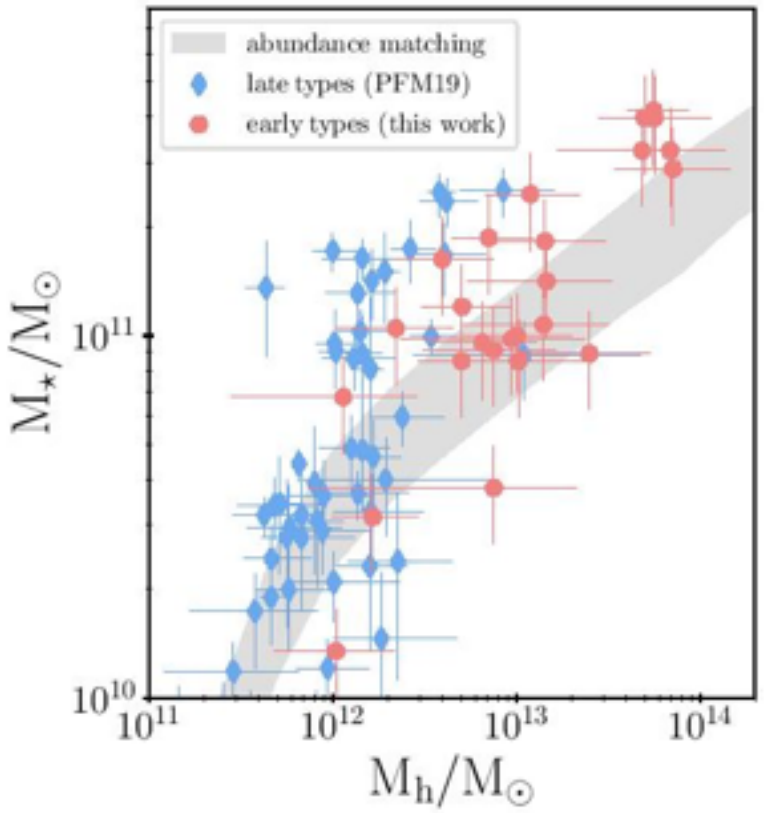


Fig. 4. SHMR in the form of stellar mass ($M_\star$) as a function of halo mass (M_h). Symbols are as in Fig. 3, however here we zoom in on the high-mass regime of the SHMR.

Они пытаются продвинуть мысль, что на D/T=0.6 виден качественный перелом

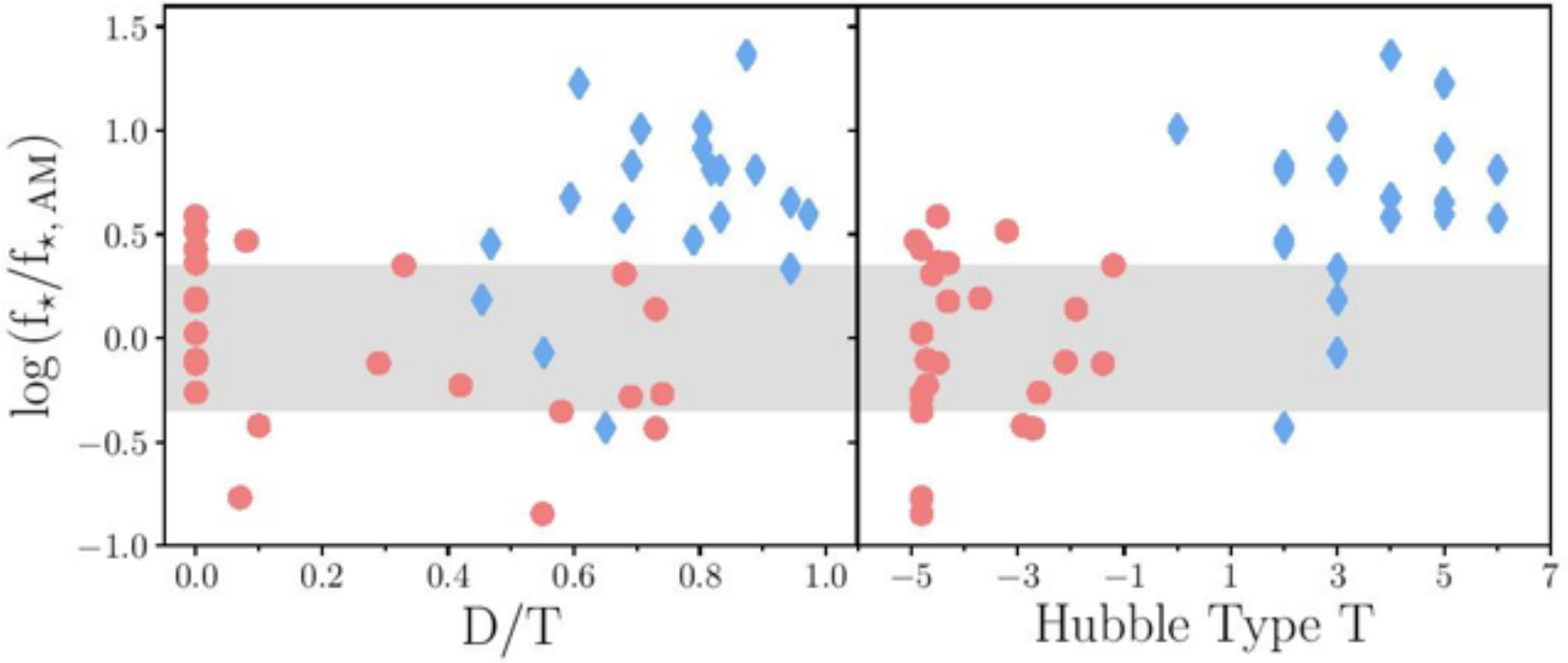


Fig. 6. Residuals of our dynamical estimate of $f_\star$ relative to the abundance-matching value $f_{\star,\mathrm{AM}}$ at the same stellar mass from Moster et al. (2013) versus the disc-to-total ratio D/T (left) and Hubble type T (right), for massive late types ($M_\star > 5 \times 10^{10} M_\odot$, blue diamonds) and early types (red circles). The grey area shows the scatter of the Moster et al. (2013) SHMR around $M_\star \sim 10^{11} M_\odot$. Several early types pile up at D/T=0 since no disc component could be clearly identified from their photometry.

А вот наконец и список объектов!

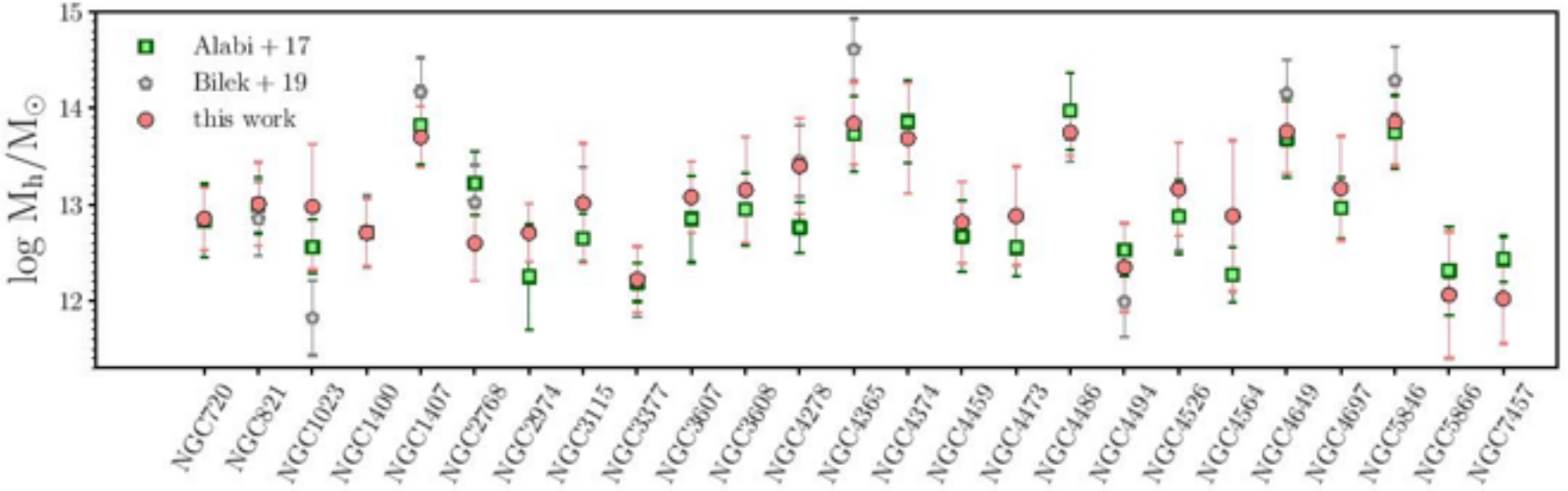


Fig. 8. Comparison of our estimates of halo masses for early-type galaxies in SLUGGS based on $f(\mathbf{J})$ models (red circles) with those of Alabi et al. (2017), using the TME (green squares), and those of Bílek et al. (2019), based on a Jeans analysis (grey pentagons).

Почему же все-таки Талли-Фишер и Фабер-Джексон одинаковые, а массы гало разные??

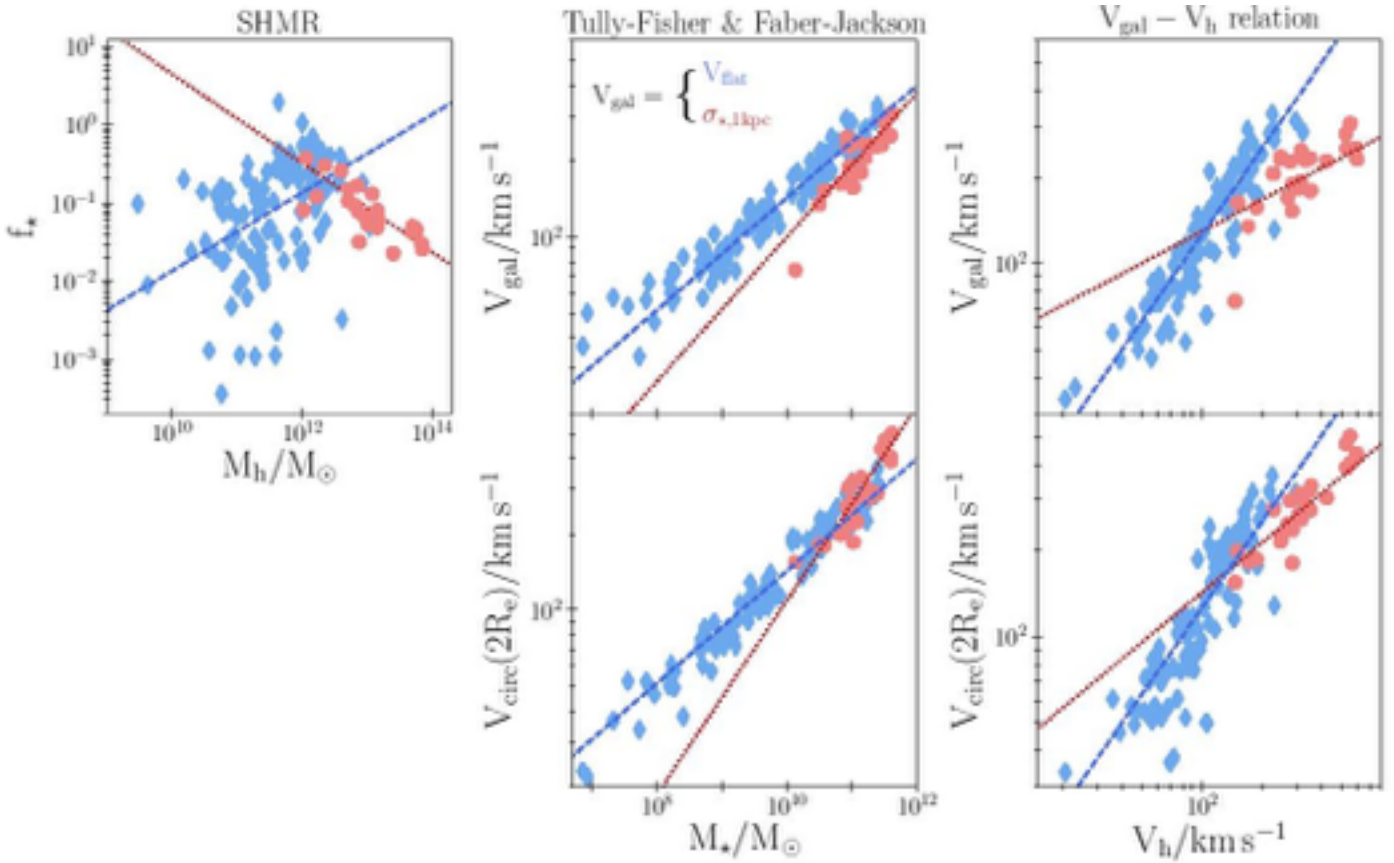


Fig. 10. SHMR ($f_* - M_h$, left), stellar mass-velocity scaling law ($M_* - V_{gal}$, middle) and relation between galaxy velocity and halo velocity ($V_{gal} - V_h$, right) for the population of late types (blue) and early types (red). In the top-middle and top-right panels, the characteristic velocity

Намек на разное происхождение:

- « В плотном окружении галактики часто сталкиваются и сливаются… Это понижается энергию связи»
- А ничего, что в их конкретной выборке треть – изолированные S0?!