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Do galaxies die? Different views from simulations and observations in the Local Universe

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ABSTRACT

For years, the extragalactic community has divided galaxies in two distinct populations. One of them, featuring blue colours, is actively forming stars, while the other is made up of "red-and-dead" objects with negligible star formation. Yet, are these galaxies really dead? Here we would like to highlight that, as previously reported by several independent groups, state-of-the-art cosmological numerical simulations predict the existence of a large number of quenched galaxies that have not formed any star over the last few Gyr. In contrast, observational measurements of large galaxy samples in the nearby Universe suggest that even the most passive systems still form stars at some residual level close to $sSFR \sim 10^{-12}$ yr^{-1}. Unfortunately, extremely low star formation poses a challenge for both approaches. We conclude that, at present, the fraction of truly dead galaxies is still an important open question that must be addressed in order to understand galaxy formation and evolution.

Сравнение гл. последовательности: наблюдения vs модели

- Наблюдения:
- SDSS/DR7: SFR по эмиссионным линиям (если есть), либо по скачку 4000A, либо по ugriz,
- GAMA/DR3: SFR по SED (21 полоса, 0.1-500 мкм),
- Переход от индивидуальных медианных оценок SFR к вероятностным.

Распределения вероятности сильно несимметричны у SDSS!

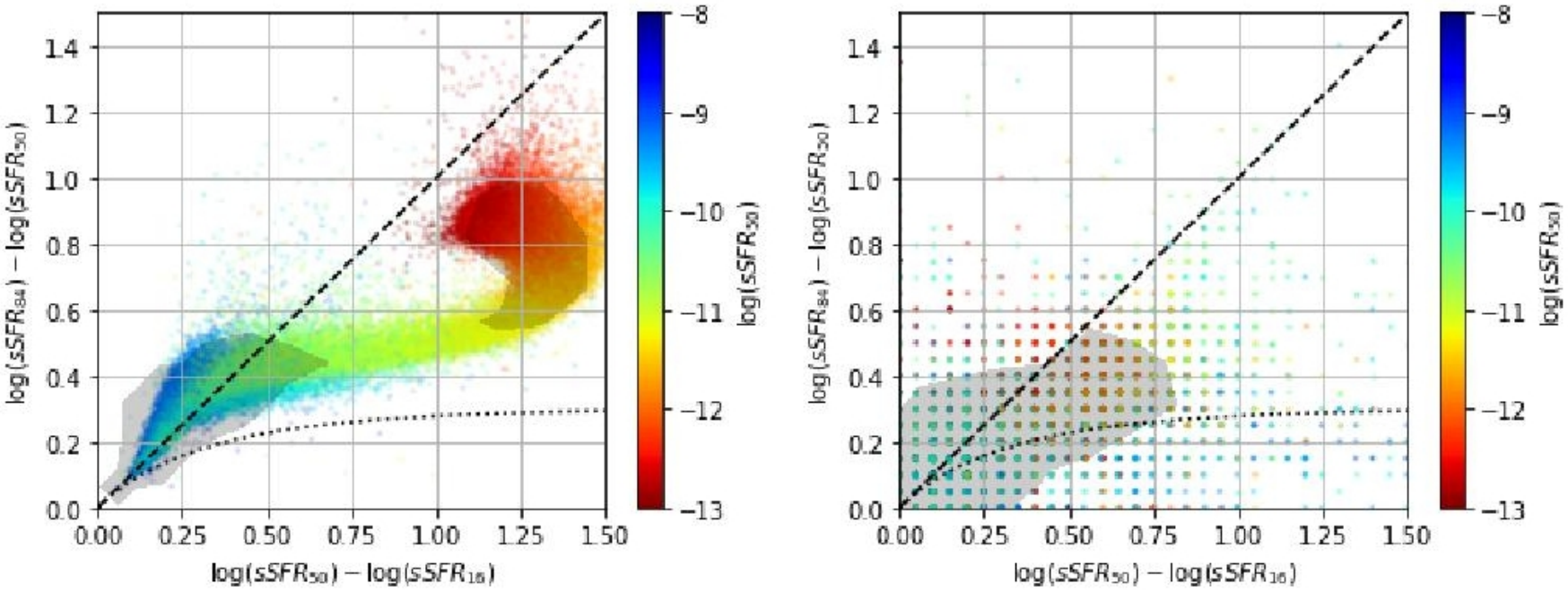


Figure 1. Difference between different percentiles of individual sSFR PDFs in SDSS (*left*) and GAMA (*right*) data, colored by the 50 percentile. Black dashed lines illustrate the log-symmetric case, and dotted lines denote the linear-symmetric scenario. Grey shaded areas enclose 95 percent of each sample.

Модели:

Label [a]	Run [b]	$L^{c}_{\rm box}$	m^{d}_{g}
EAGLE100	Ref-L0100N1504	100	1.81×10^{6}
EAGLE50	Ref-L0050N0752	50	1.81×10^{6}
EAGLE25	Ref-L0025N0752	25	2.26×10^{5}
TNG300	TNG300-1	302	1.1×10^{7}
TNG100	TNG100-1	111	1.4×10^{6}
MAG500	Box2	520	1.4×10^{8}
SIMBA150	m100n1024	148	1.82×10^{7}
SIMBA75	m50n1024	74	2.28×10^{6}
SIMBA35	m25n1024	37	2.85×10^{5}

Table 1. Simulation suites. [a] Label adopted in this work. [b] Original run name given by the collaboration. [c] Box length in comoving Mpc. [d] Gas element resolution in $M_{\odot}$.

Сравнение главных последовательностей: набл. Vs sim.

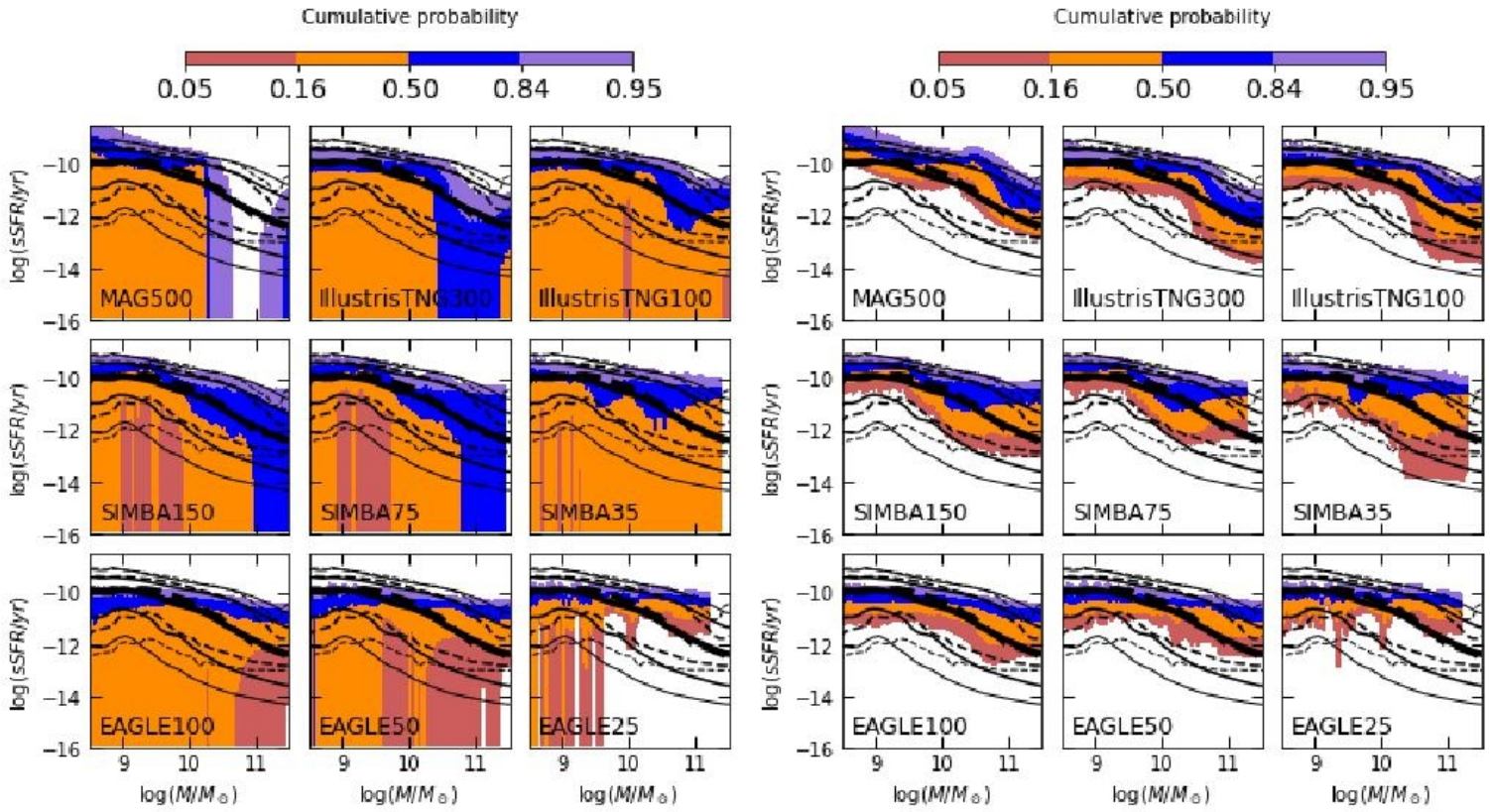
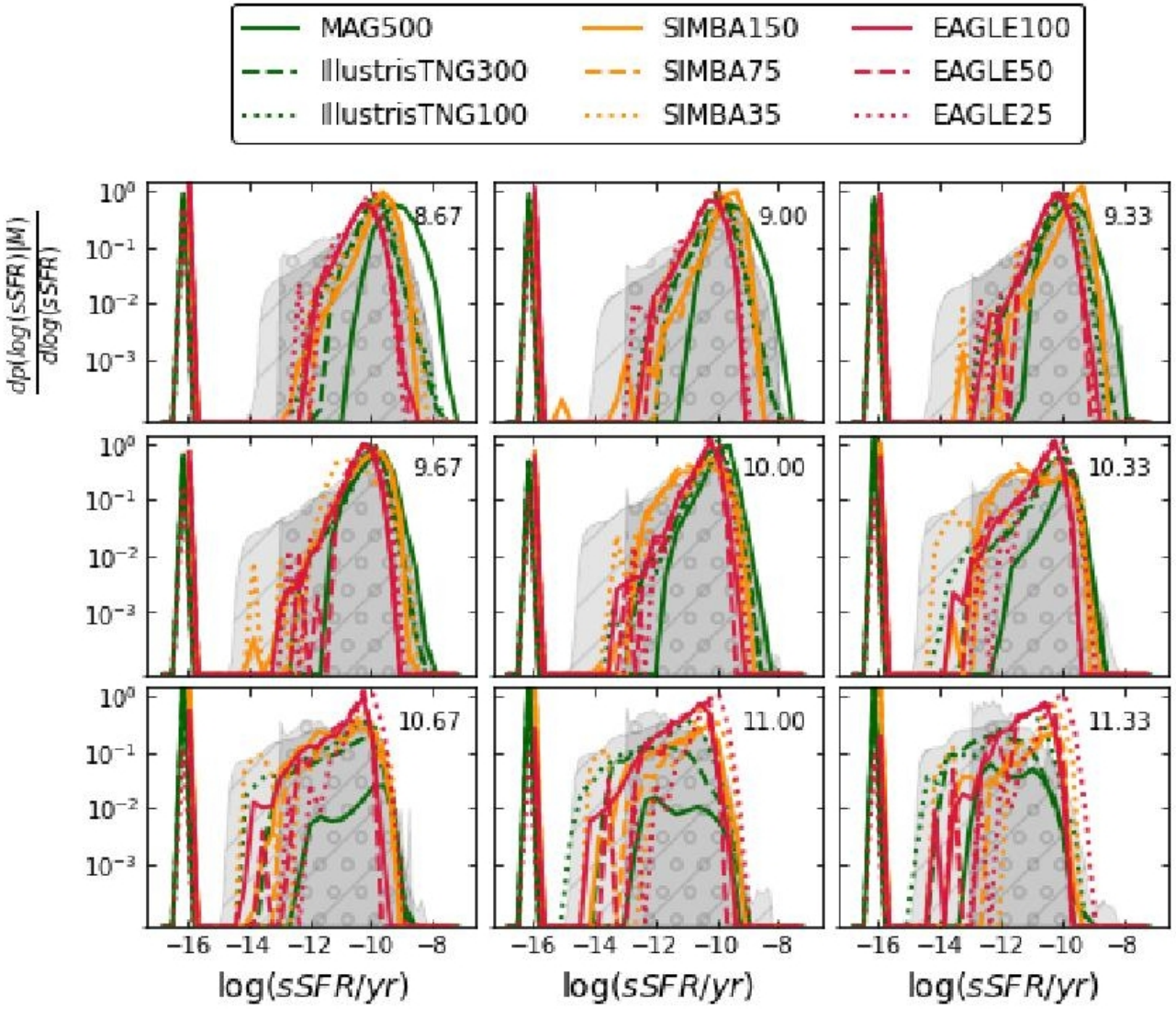


Figure 2. Cumulative probability distribution $P(\log(\frac{sSFR}{\mathrm{yr}^{-1}}) \mid M_*)$. For each simulation run there are two panels: considering all galaxies (*left*) and excluding galaxies with $SFR = 0$ (*right*). Colored contours denote the cumulative probability for simulated data. Black lines denote SDSS (solid) and GAMA (dashed) 50 (thickest), 84 and 16 (mid-thickness), 5 and 95 (thinnest) percentiles.

согласие по медианам УХОДИТ, если перейти к PDF

…это оттого, что в моделях много галактик с нулевым SF



Эффекты селекции обзоров? НЕТ

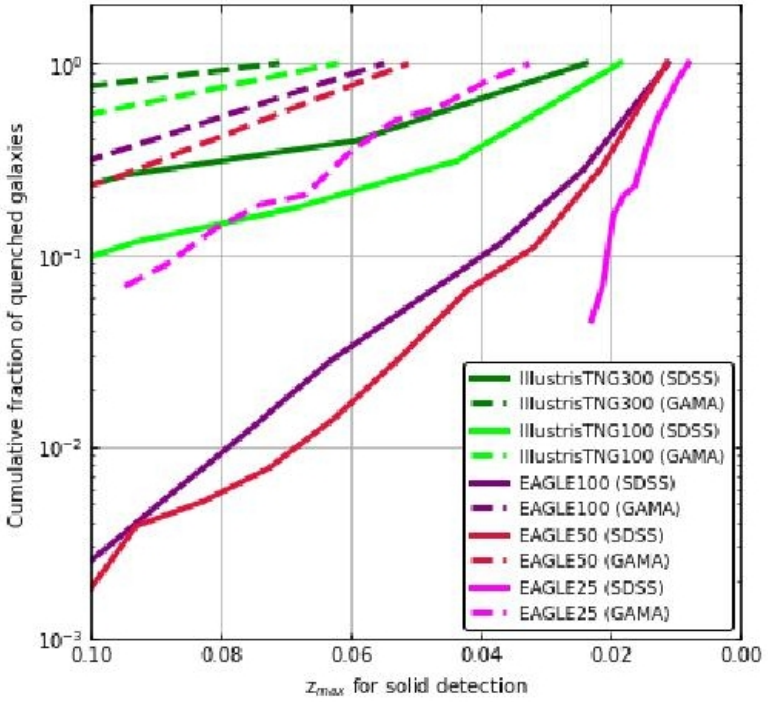


Figure 4. Survey detection. Cumulative fraction of quenched (passive) galaxies as function of the maximum redshift for detection in SDSS and GAMA surveys.

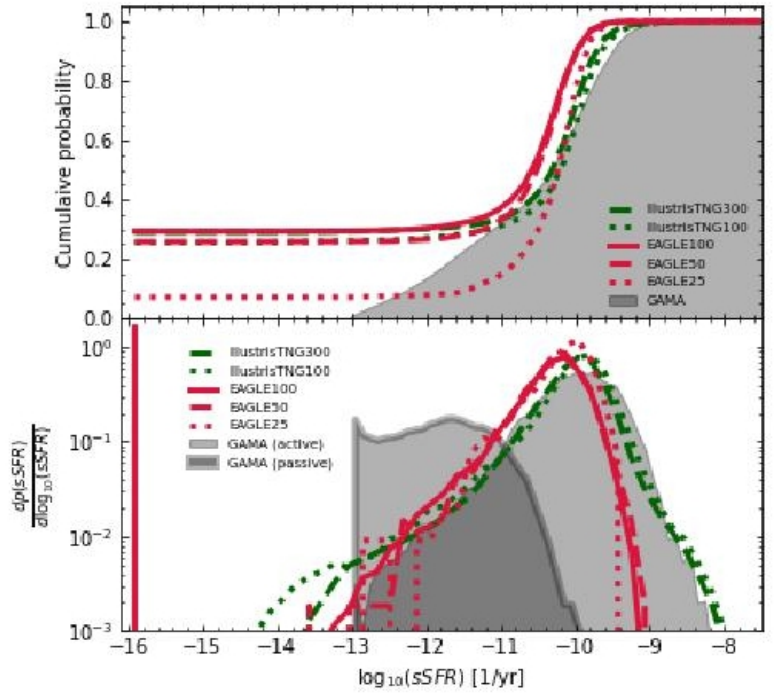


Figure 5. Probability distributions at $z \leqslant 0.05$. (*left*) Cumulative probability distribution $P(sSFR < sSFR_i)$. Grey shaded region denotes observational data from GAMA (restricted to $z \leqslant 0.05$) and colored lines correspond to simulation runs (see legend). (*right*) Probability density distribution of $sSFR$. Grey shades denote the GAMA star-forming (non-contoured) and passive (black contoured) distributions ($z \leqslant 0.05$).

Разные шкалы SF? НЕТ

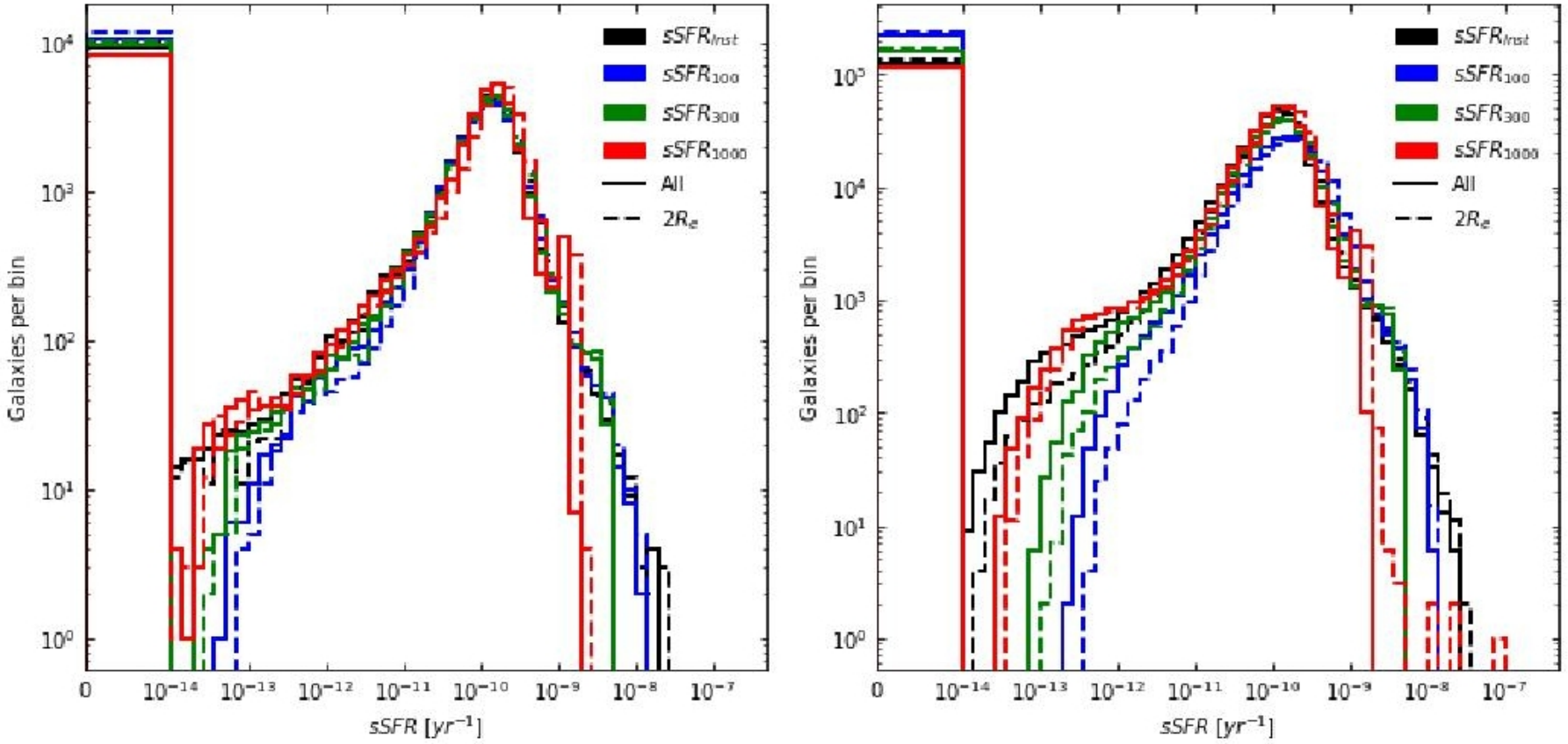


Figure 6. IllustrisTNG sSFR distributions for TNG100 (*left*) and TNG300 (*right*). Colored lines denote different $sSFR$ timescales: instantaneous (black), 100 Myr (blue), 300 Myr (green) and 1000 Myr (red). Continuous lines represent values computed for the whole extent of each galaxy while dashed lines denote values restricted to two effective radii.

Доля пассивных галактик совпадает, но это РАЗНЫЕ пассивные галактики

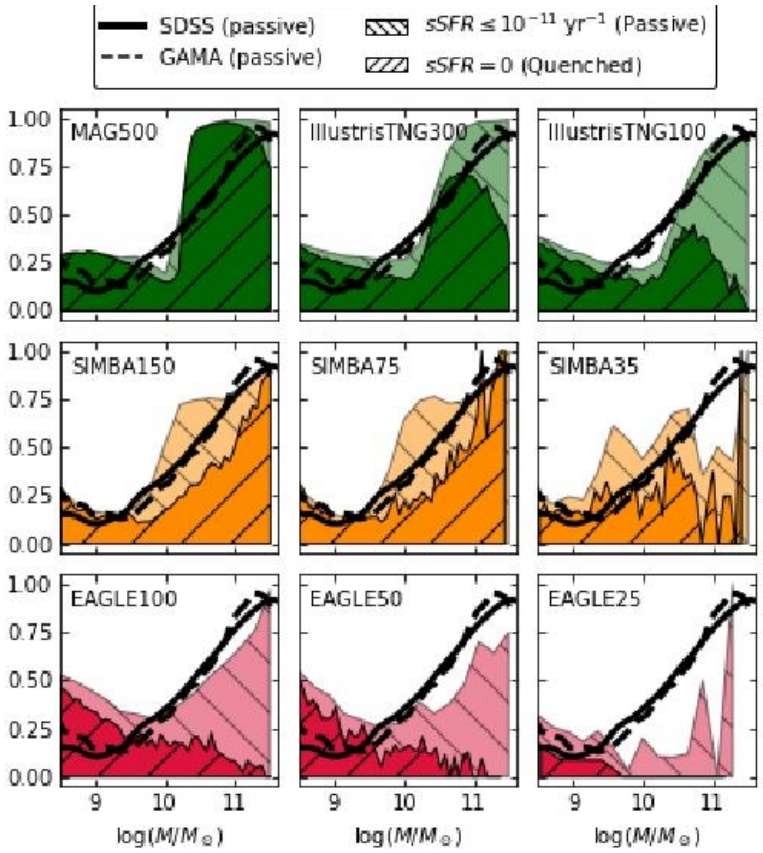


Figure 8. Quenched and passive fraction. Relative fraction of passive/quenched galaxies in simulations as function of total stellar mass. Black solid and dashed lines denote the SDSS and GAMA passive fraction ($sSFR \leq 10^{-11}$) respectively.