Influence of dust and AGN activity on physical properties of early-type galaxies

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Introduction

Dust and cold interstellar medium (ISM) removal play a significant role in star formation (SF) quenching in galaxies (Saintonge&Catinella 2022). Efficient removal mechanisms are still under investigation, with active galactic nuclei (AGNs) being considered as one of the possible candidates (Man&Belli 2018).

Early-type galaxies (ETGs) are a great sample for studying dust removal processes and timescales, as they can demonstrate detectable amounts of dust (and therefore cold ISM) together with low dust production rates. Tracing the evolution of dust content as a function of age show timescales of ISM removal and processes responsible for SF quenching (Michałowski et al. 2019, 2024).

In this work we build upon dusty ETGs sample of Leśniewska et al. (2023), with the addition of dust-poor ETGs, to compare physical properties between the two subsamples.

Data, sample & classification

We make use of the GAMA DR4 survey data. The intersection of GAMA survey regions and *Herschel* sky coverage gives, in total, an area of over 160 deg^2 of available data, used in this work.

Sample selection:

- redshift range of 0.01 ≤ z < 0.32
- ETGs based on Sérsic profile index > 4 with SNR > 3

Dust classification

In this work, we consider galaxies as dusty when they are detected in any of the *Herschel* far-infrared filters (100, 160, 250, 350, 500 μm) with a SNR > 3.

WHAN classification

We use the diagnostic of equivalent width of Hα (EWHα) vs. [N II]/Hα, introduced by Cid Fernandes et al. (2010), to infer activity of galaxies. For simplicity of the poster, we divide our sample into four aggregate categories: RET(ired), SFG, AGN(s) and UNC(lear) based on the work done in Ryzhov et al. (2024).

After the selection process, this work introduces a sample of >18 000 ETGs in total, divided into dusty and dust-poor subsamples with >3 300 and >15 000 ETGs, respectively.

Results

Figures 1-3 show basic properties of studied ETGs ($M_{stellar}$, SFR, light-weighted age) obtained from SED fitting with MAGPHYS on LAMBDAR photometry GAMA data. Panels are showing the evolution of those properties with redshift.

In Figure 2 we see lower SFRs for dust-poor ETGs compared to their dusty counterparts. Dust-poor ETGs also exhibit older stellar populations than dusty ETGs – Figure 3.

Figure 4 presents SFR–$M_{stellar}$ relation. The majority of samples (regardless of dust classification) are below the MS line. Only around 30% of the dusty subsample is within or slightly above the MS line (±0.2 dex), and more than 90% of the dust-poor subsample lies below the MS.

In Figure 5 we investigate the same relation with WHAN classification. “Active” galaxies (SFG, AGN) occupy the MS region while RET(ired) galaxies lie clearly below the MS.

Figure 6 shows the domination of RET(iered) galaxies in dust-poor subsample. Around 30% of dusty galaxies can be considered “active” (SFG, AGN).

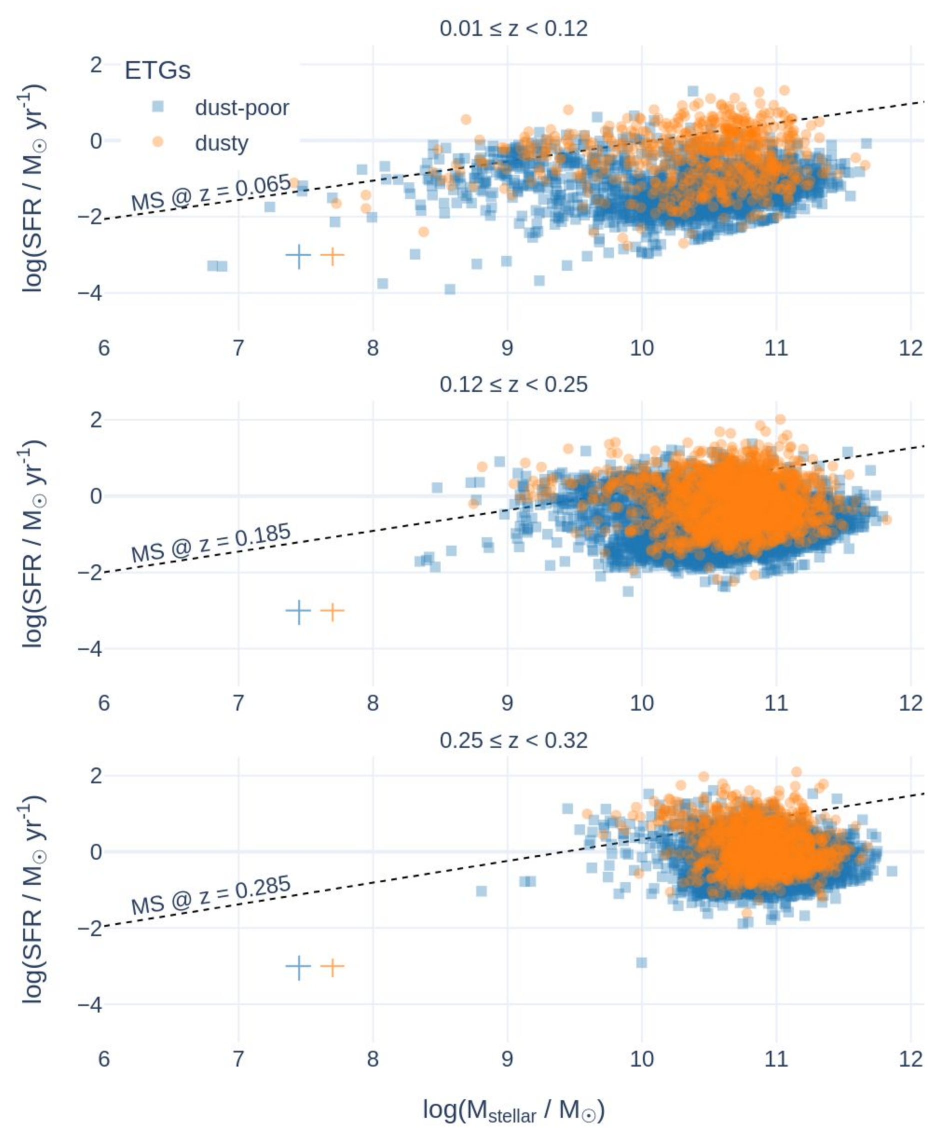

Fig. 4. SFR as a function of stellar mass, grouped by dust classification. Panels divide the whole sample by redshift ranges. Dashed lines show star-forming main sequence, based on Speagle et al. (2014), calculated for the middle of given redshift bin (z = 0.065, 0.185 and 0.285). Mean 1σ uncertainties for dust subsamples are shown.

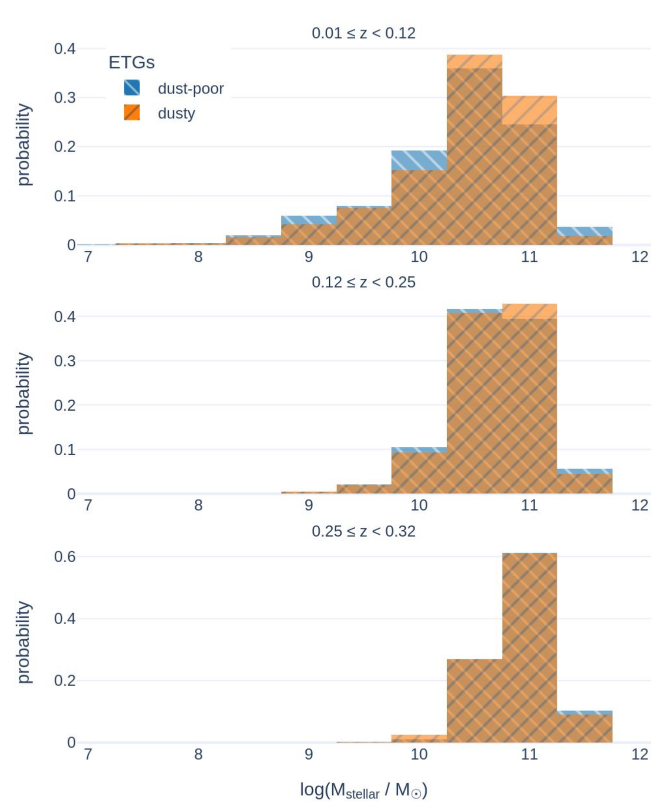

Fig. 1. Fraction of samples in stellar mass bins, grouped by dust classification. Panels divide the whole sample by redshift ranges.

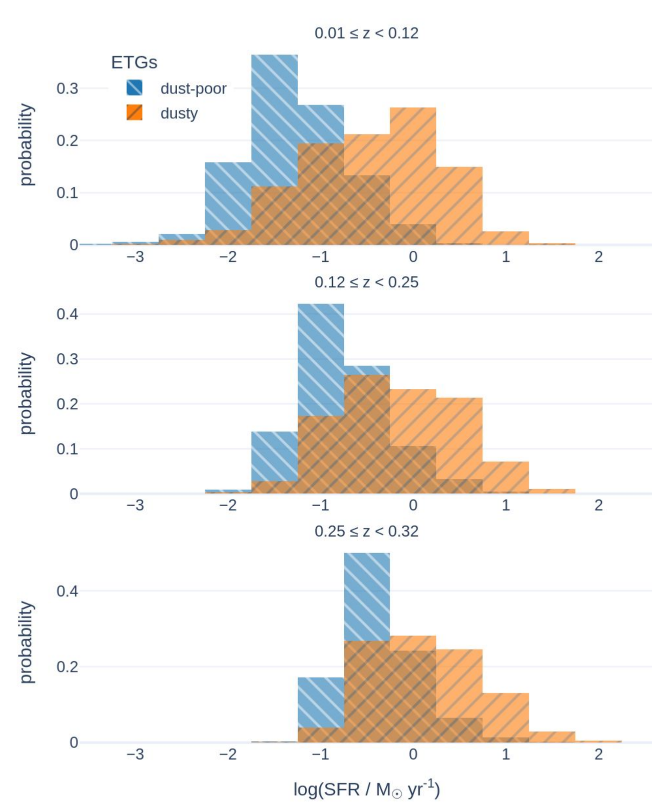

Fig. 2. Fraction of samples in SFR bins, grouped by dust classification. Panels divide the whole sample by redshift ranges.

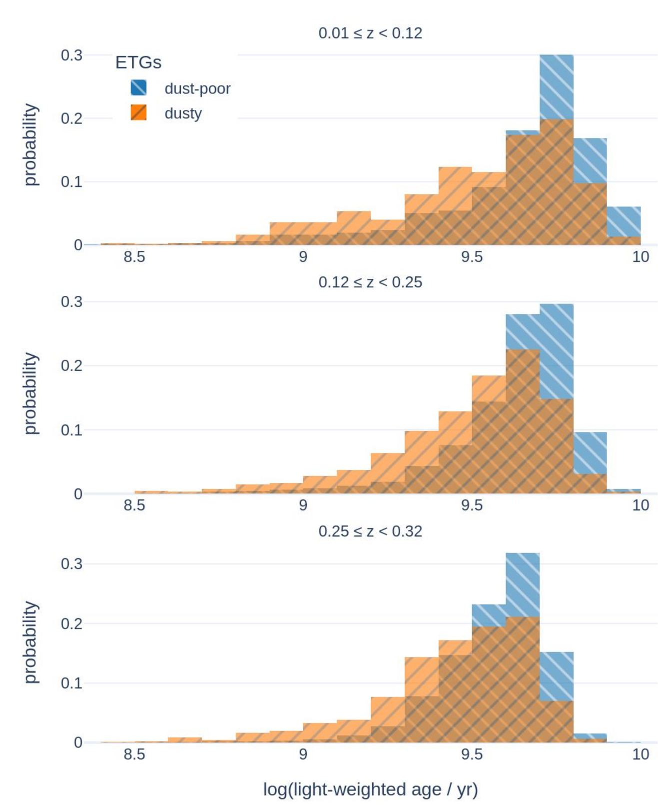

Fig. 3. Fraction of samples in light-weighted age bins, grouped by dust classification. Panels divide the whole sample by redshift ranges.

Conclusions

Based on presented results, we conclude that:

- dust-poor ETGs, in our sample, are older and retired, they already lost their ISM and are not able to rejuvenate SF processes.
- the vast majority of ETGs lie below the MS relation, with the exception of SFG and AGN classified ETGs that are found more often in the dusty subsample.

Those results confirm the impact that dust and ISM evolution have on the physical properties of ETGs and quenching of SF therein.

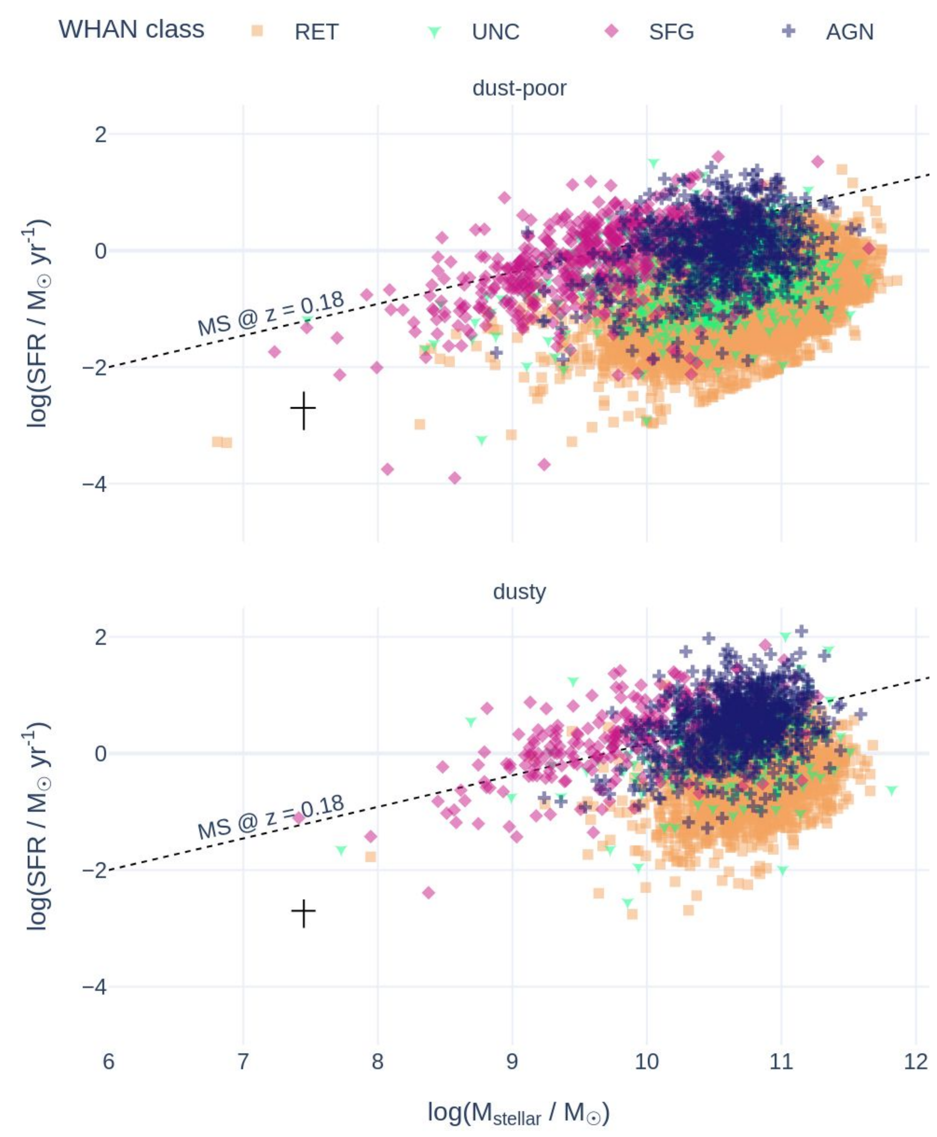

Fig. 5. SFR as a function of stellar mass, grouped by WHAN classification. Dashed lines show star-forming main sequence, based on Speagle et al. (2014), calculated for the middle of the whole sample redshift (z = 0.18). Mean 1σ uncertainties in every panel are presented.

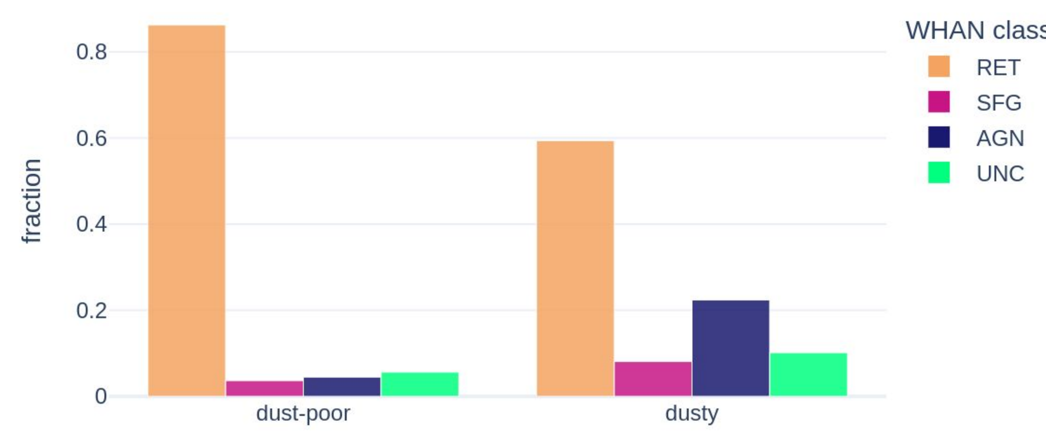

Fig. 6. Distribution of ETGs between WHAN classes within dust-related subsamples. Results normalised to subsample's sizes.

References

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This work is in preparation for release as part of “The fate of the ISM” series:

Funded by NCN, Poland (2018/30/E/ST9/00208)