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Herschel-ATLAS: Dusty early-type galaxies

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Early-type galaxies (ETGs) are thought to be devoid of dust and star-formation, having formed most of their stars at early epochs. We present the detection of the dustiest ETGs in a large-area blind submillimetre survey with *Herschel* (H-ATLAS, Eales *et al.* 2010), where the lack of pre-selection in other bands makes it the first unbiased survey for cold dust in ETGs. The parent sample of 1087 H-ATLAS galaxies in this study have a $\geqslant 5\sigma$ detection at 250μm, a reliable optical counterpart to the submillimetre source (Smith *et al.* 2011) and a spectroscopic redshift from the GAMA survey (Driver *et al.* 2011). Additionally, we construct a control sample of 1052 optically selected galaxies undetected at 250μm and matched in stellar mass to the H-ATLAS parent sample to eliminate selection effects. ETGs were selected from both samples via visual classifications using SDSS images. Further details can be found in Rowlands *et al.* (2012). Physical parameters are derived for each galaxy using the multiwavelength spectral energy distribution (SED) fitting code of da Cunha, Charlot and Elbaz (2008), Smith *et al.* 2012, using an energy balance argument. We investigate the differences between the dusty ETGs and the general ETG population, and find that the H-ATLAS ETGs are more than an order of magnitude dustier than the control ETGs. The mean dust mass of the 42 H-ATLAS ETGs is $5.5 \times 10^7 \mathrm{M}_\odot$ (comparable to the dust mass of spirals in our sample), whereas the dust mass of the 233 control ETGs inferred from stacking at optical positions on the 250μm map is $(0.8 - 4.0) \times 10^6 \mathrm{M}_\odot$ for 25-15 K dust. The average star-formation rate of the H-ATLAS ETGs is 1.0 dex higher than that of control ETGs, and the mean r-band light-weighted age of the H-ATLAS ETGs is 1.8 Gyr younger than the control ETGs. The rest-frame $NUV - r$ colours of the H-ATLAS ETGs are 1.0 magnitudes bluer than the control ETGs, and some ETGs may be transitioning from the blue cloud to the red sequence. Some H-ATLAS ETGs show signs of morphological disturbance and may have undergone recent rejuvenation of their ISM via gas and dust delivered by mergers. It is found that late-type stars cannot produce enough dust to account for that observed in the H-ATLAS ETGs. This indicates that either an external source of dust from mergers is required, a substantial amount of dust grain growth must occur in the ISM, or dust destruction by hot X-ray gas is less efficient than predicted.

Keywords. galaxies: evolution, galaxies: elliptical and lenticular, cD, (ISM:) dust, extinction, infrared: galaxies, submillimeter

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