# Abstract

One of the key challenges in observational astronomy is to understand the complete picture of star formation rate density (SFRD) across cosmic time. In this thesis, we aim to build on our previous knowledge by analysing two fields, COSMOS and UDS, and combining them with far-infrared maps from the *Herschel* Space Observatory and James Clerk Maxwell Telescope (JCMT) to analyse, through stacking, approximately 100,000 $K$-band-selected galaxies.

Throughout this thesis, I analyse three key areas: presenting a new determination of the star-forming main sequence (MS); presenting a new determination of the evolving far-infrared (FIR) galaxy luminosity function (LF) and the resulting inferred evolution of dust-obscured star-formation rate density ($\rho_{\mathrm{SFR}}$) out to redshift $z \sim 6$; and presenting an evolution of dust attenuation in star-forming galaxies with UV slope, stellar mass, and redshift out to $z \sim 5$.

In the first part of the research, we apply the dust emission curve to the stacked FIR photometry to derive IR luminosities and their associated star formation rates (SFRs). We find that the function form of the MS is linear with the SFR–$M_\star$ relationship that flattens at high stellar mass and that normalization increases exponentially with redshift. We also show that the peak dust temperature increases steadily from 20 K at $z = 0.5$ to about 50 K at $z = 5$. Variability in the shapes of the MS is most likely related to the different dust temperatures assumed when deriving SFRs in the absence of FIR data.

In the second part, we estimate the contribution of faint and low-mass sources to the LF. By adding high-resolution ALMA follow-up study of the JCMT SCUBA-2 S2CLS submillimeter imaging, we estimate the contribution of bright and high-mass sources to the bright end of the LF. Our results find that the evolution of the characteristic luminosity ($L_\star$) increases monotonically with redshift, evolving as $L_\star \propto z^{1.38\pm0.07}$, while the typical number density ($\Phi_\star$) stays the same up to $z \simeq 2.24$ and then declines as $z^{-4.95\pm0.73}$ at higher redshift. By summing this evolving LF, we can directly measure the cosmic dust-obscured star-formation rate density up to $z \sim 6$.

The final part of this research is a calibration of the so-called infrared excess ($\mathrm{IRX} \equiv L_{\mathrm{IR}}/L_{\mathrm{UV}}$) with its dependence on the physical properties of galaxies. We find that the IRX–$\beta$ relationship matches a standard Calzetti-like curve for redder galaxies ($\beta \geq -1$), but the slope of this curve becomes less steep as stellar mass increases. We develop a mass-dependent $IRX - \beta$ calibration where the reddening law slope follows a tight quadratic function on stellar mass, $\mathcal{M} = \log(M_*/\mathrm{M}_\odot)$. We further identify a tight $IRX - M_*$ correlation that increases monotonically but exhibits a significant turnover at the highest masses for $z \leq 2 - 3$, consistent with the suppression of gas accretion and dust growth in the most massive systems.