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The Herschel ATLAS: the dust energy balance in the edge-on spiral galaxy UGC 4754

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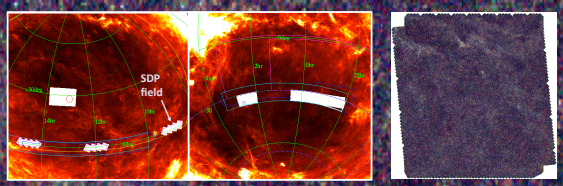
THE HERSCHEL-ATLAS

The Herschel-ATLAS (Eales et al. 2010) is the widest survey to be executed by Herschel (~550 deg^2). The survey fields will be covered in 5 bands (100, 160, 250, 350 and 500 μm) and are chosen to allow maximum overlap with existing and planned surveys. H-ATLAS is expected to detect some 100 000 sources up to redshift z = 3. Key science themes range from large-scale structure and high-z galaxies to Local Universe galaxies and Galactic star and planet formation.

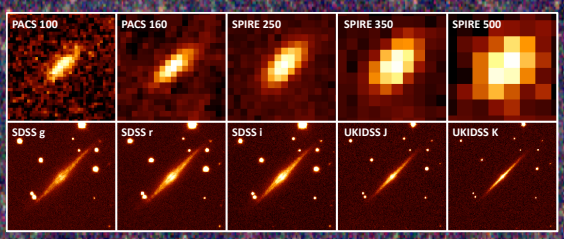


Left: the distribution of the H-ATLAS surveys fields. The survey consists of two large fields around the North and South galactic poles and a set of equatorial fields. The 16 deg^2 SDP field is indicated. Right: 3-color SPIRE image of the SDP field.

THE EDGE-ON SPIRAL UGC 4754 IN THE SDP FIELD

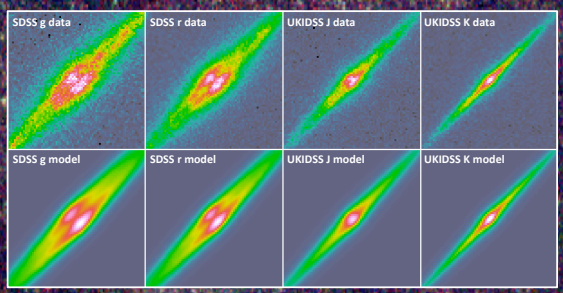
In the Science Demonstration Phase, a 64 deg^2 equatorial field was observed. This resulted in a 250 μm catalogue of 6600 sources (5σ).

Among the 10 brightest sources in all bands in the H-ATLAS SDP field is the edge-on spiral galaxy UGC 4754. Edge-on spiral galaxies are extremely interesting because the dust shows up prominently in the optical as dust lanes. Detailed radiative transfer modelling of optical images allows to determine the dust content in a way completely independent of FIR observations.



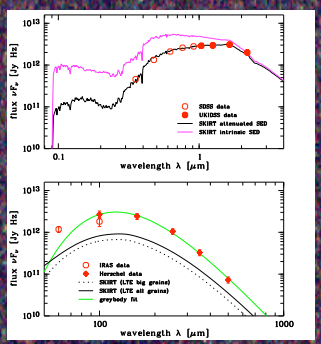
RADIATIVE TRANSFER MODELLING OF UGC 4754

We used the 3D Monte Carlo radiative transfer code SKIRT to model the stellar and dust distribution in UGC 4754. Our model includes a stellar disc, bulge and dust disc and fits the UV-optical-NIR SED and the optical (SDSS) and NIR (UKIDSS) surface brightness maps. The best fitting model contains 10^7 $M_\odot$ of dust, corresponding to a face-on optical depth of $\tau_g = 0.73$. Only 12% of the total bolometric stellar radiation is absorbed by the dust. Both the relative star-dust geometry and the modest values of the optical depth agree with similar radiative transfer models of other edge-on galaxies (e.g. Xilouris et al. 1999; Alton et al. 2004; Bianchi 2007).



Comparison of the observed g, r, J and K band images of UGC 4754 (top panels) and the results of our SKIRT radiative transfer modelling (bottom panels).

THE FAR-INFRARED EMISSION OF UGC 4754



The UV-optical-NIR (top) and FIR-submm (bottom) spectral energy distribution of UGC 4754. Our SKIRT radiative transfer model (black solid lines) reproduces the UV-optical-NIR SED and the optical and NIR surface brightness distributions very well, but underestimates the observed FIR-submm emission by a factor two to three.

Based on our radiative transfer model, we calculated the dust temperature distribution and the corresponding predicted far-infrared emission of UGC 4754. Our model underestimates the observed IRAS and Herschel fluxes by a factor two to three. Thanks to our wavelength coverage, we can exclude an increased dust emissivity as the origin of this dust energy balance problem. We argue that the most likely explanation is that a sizable fraction of the FIR/submm emission arises from additional dust that has a negligible extinction of the bulk of the starlight (in particular embedded star-forming clouds).

You want more information ? Contact me at maarten.baes@ugent.be or look at Baes et al. 2010, A&A Special Issue.