PROCEEDINGS OF SCIENCE

A Blind Survey of the Local Dusty Universe with Herschel-ATLAS

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A blind survey of the nearby dusty galaxies detected by *Herschel*-ATLAS reveals that 75% are, unexpectedly, irregular and/or highly flocculent in morphology. They also tend to exhibit extremely blue UV-NIR colour; these galaxies are bluer than 90% of galaxies seen in targeted dust surveys. They are also colder, with a median dust temperature of only 17 K, and are 3 times dustier. Most have greater gas mass than stellar mass, with a median atomic gas fraction of 51%, with values ranging as high as 99%.

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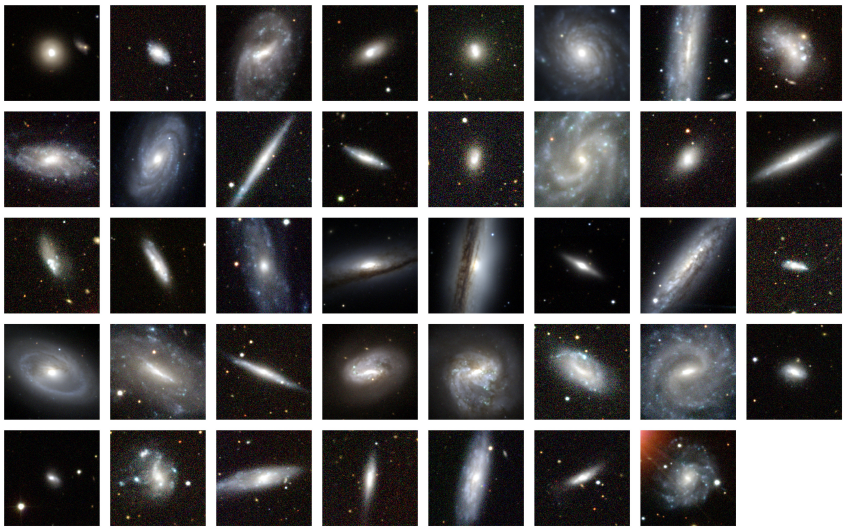

Figure 1: Optical SDSS *gri*-band three-colour imagery of the HAPLESS galaxies. Each thumbnail is 100" on a side. Note the blue colours, and preponderance of irregular and flocculent morphologies.

1. Introduction and The HAPLESS Sample

The *Herschel*-ATLAS[1] is a blind survey of 550 square degrees of sky, at five far-infrared (FIR) wavelengths between 100-500 μm. *H*-ATLAS gives us the best of both worlds: a blind and unbiased coverage of a large area of sky, but with resolution and sensitivity previously only found in small-area, targeted FIR surveys.

Using the *H*-ATLAS internal phase-1 data release (162 square degrees), we created a local, volume-limited sample of all 39 galaxies detected by *Herschel*[2] in a distance range of 15-45 Mpc. We named this sample **HAPLESS**: the **H**erschel-**A**tlas **P**hase-1 **L**imited **E**xtent **S**patial **S**urvey. The HAPLESS galaxies are shown in Figure 1 as they appear in the optical (Clark et al., in prep).

2. Peculiar Blue Galaxies

A surprisingly large number of the HAPLESS galaxies exhibit "atypical" morphologies, with classifications from EFIGI [3]. We find that 54% of our blind sample are irregular (Hubble type T >8), compared to 25% in targeted surveys such as KINGFISH[3] and the *Herschel* Reference Survey[5] (HRS, see Section 3). Furthermore, many of the HAPLESS galaxies exhibit a high degree of flocculence. In total, 75% were designated by EFIGI to be either irregular, highly flocculent, or both.

A majority of the HAPLESS galaxies have extremely blue UV-NIR (ultraviolet minus near-infrared) colour. These very blue galaxies tend to be the ones that have non-standard morphologies. We find a colour criterion of FUV-K_s < 3.5 reliably identifies these very blue interesting objects. The submm and UV brightness of these galaxies indicates large dust masses and high rates of star formation, whilst NIR faintness suggests a relatively modest evolved stellar population. Multi-wavelength imagery of four of the these galaxies can be found in Figure 2.

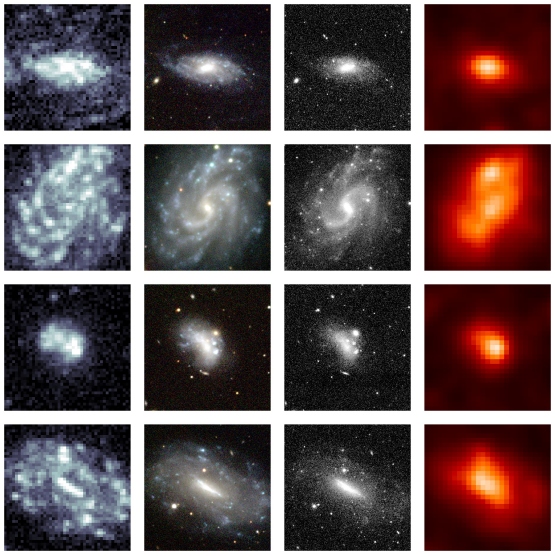

Figure 2: Multiwavelength imagery of four examples of the UV- and submm-luminous ,very blue, flocculent galaxies found in the HAPLESS sample. The bands displayed, from top-to-bottom, are: GALEX FUV, SDSS *gri*-band three-colour, VIKING K_s-band, and PSF-filtered *Herschel* 250 μm. Each image is 150" on a side. Note the blue optical colours, flocculent morphologies, NIR faintness, and bright extended UV emission.

3. Comparisons with a Targeted Survey

In Figure 3, we compare the HAPLESS galaxies to the 323 galaxies of the HRS. the largest targeted FIR nearby galaxy survey, a volume-limited sample selected by K_s-band apparent magnitude. To ensure a valid direct comparison, we use the same spectral energy distribution (SED) fitting procedure on both samples, where we attempt χ^2-minimising fits with both one- and two-component modified blackbody models.

The upper left plot of Figure 3 shows that the dust in an average HAPLESS galaxy is colder (with median T_{dust} = 17 K) than the dust in 80% of the galaxies of the HRS, and bluer than 90%; the HRS undersampled the cold blue galaxies seen in a blind survey. This is reinforced by the upper right plot, which demonstrates the different cold dust temperature distributions of the two samples, showing the prevalence of galaxies with T_{dust} <15 K in a blind sample.

In the lower left plot of Figure 3, the HAPLESS galaxies are shown to have dust masses which are on average 3 times greater than the HRS for a given stellar mass. Whilst it is unsurprising that a sample selected by dust emission will generally contain more dust-rich objects than a sample selected by stellar emission, the nature of this dusty population is particularly interesting.

The HAPLESS galaxies, particularly those with FUV-K_s < 3.5, exhibit high gas fractions, which are plotted against FUV-K_s in the lower right plot of Figure 3 (HI masses derived from literature 21 cm observations where available, else from HIPASS[6]). Most are dominated by their gas component (median gas fraction 51%), with gas fractions as high as 94 and 99%. The majority of the gas-rich HAPLESS galaxies have FUV-K_s < 3.5, suggesting that these are objects that have simply converted less of their gas into stars.

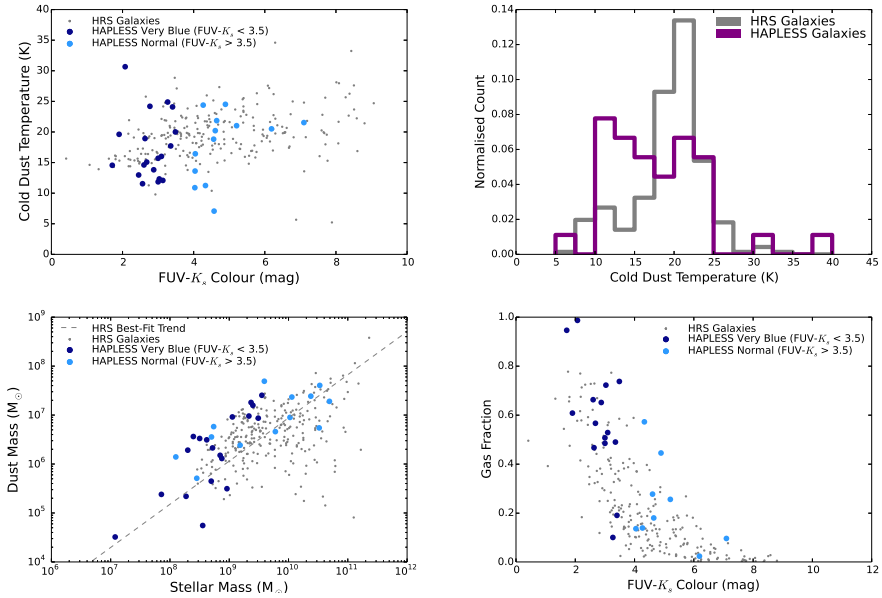

Figure 3: Plots comparing our blind HAPLESS sample with the targeted HRS sample. HAPLESS galaxies are marked in colour; in the scatter plots, point colour indicates whether a galaxy is bluer than the FUV-K_s <3.5 colour criterion. The HRS galaxies are marked in grey. *Upper left*: Plot of FUV-K_s colour against cold dust temperature. *Upper right*: Histogram of cold dust temperatures. *Lower left*: Plot of stellar mass against dust mass. *Lower right*: Plot of FUV-K_s colour against (atomic) gas fraction.

Conclusion

HAPLESS, the first submm-selected sample of nearby galaxies, reveals that cold dust temperatures and high gas fractions appear to be the norm amongst dusty galaxies - a fact missed by targeted surveys. Along with their very blue UV-NIR colours, this suggests that these are younger systems that have nonetheless processed a lot of their gas into dust. This should allow us to use these galaxies to probe the origins of dust, and put constraints upon chemical evolution.

References

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