Star formation Reference Survey

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The Survey: Star formation reference survey (SFRS) is a multi-wavelength, statistically robust study of 369 star-forming galaxies of different types. The SFRS legacy database aims to facilitate the understanding of the physical process of star formation, assess the role of AGN feedback, heating and cooling of the inter-stellar medium (ISM), environmental influence on the star formation rate (SFR) and model related global parameters of galaxies. SFRS galaxies are fully representative of the entire range of infrared (IR) luminosities, dust temperatures and stellar masses exhibited by the star-forming galaxies in the local Universe. These galaxies selected from the IRAS PSCz catalogue (lying 20° north of the galactic plane) in a 3d-space defined by 60 μm luminosity (proxy for SFR), F60/F100 colour (proxy for dust temperature) and Ks-60 colour (proxy for SFR/M*), also span a wide range of morphologies, sizes and environments. As seen in the table below, the SFRS aims at assimilating and analysing data for SFR indicators at as many wavelengths as possible, in order to understand the physical process of star formation in different modes.

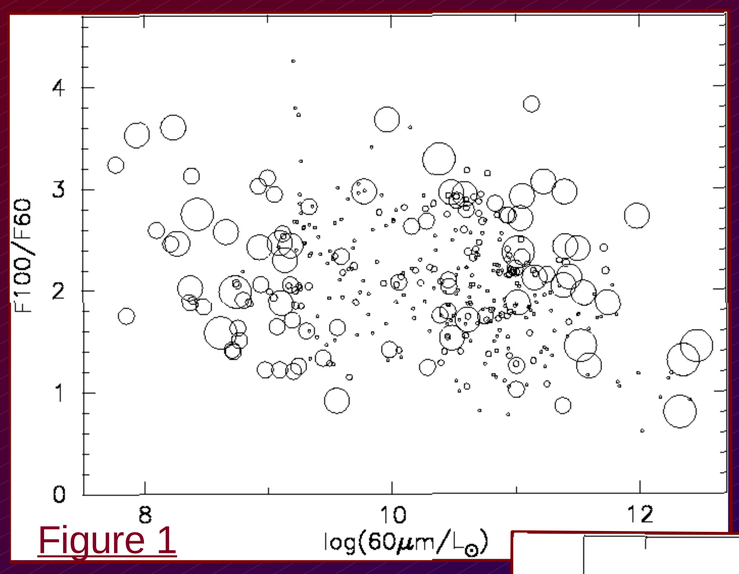

Figure 1

Existing & proposed observations for the 369 SFRS galaxies

BANDPASS	WAVELENGTH	FRACTION OF SAMPLE	OBSERVATORY
Radio	20 cm	100%	VLA/NVSS
far-IR	90-160 μm	95% (just completed)	*AKARI*/All-Sky Survey
mid-IR	12, 23 μm	100% (under way)	*WISE*
mid-IR	24 μm	70%	*Spitzer*/MIPS
mid-IR	3.6–8 μm	100%	*Spitzer*/IRAC GTO Cycle 5
near-IR	JHK_s	70% (campaign ongoing)	PAIRITEL
Optical Spectra	0.35–0.9 μm	205/369	SDSS
Optical Spectra	0.35–0.8 μm	50/369 (campaign ongoing)	FAST
Optical Imaging	Hα	10% (campaign ongoing)	CNAO
Ultraviolet	0.13–0.28 μm	90% to date	*GALEX*
X–ray	0.5-8.0 keV	$>$ 50%	*Chandra, XMM*

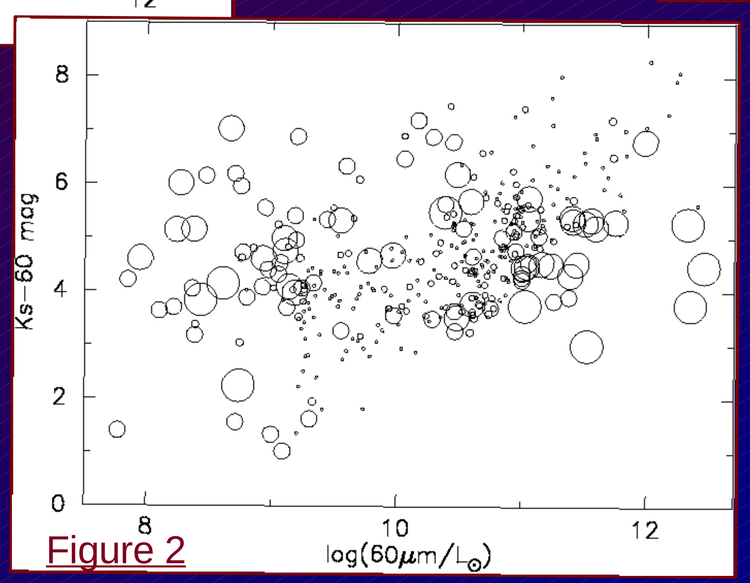

Figure 2

Figures 1 & 2: The 369 SFRS galaxies span 5 orders of magnitude in 60 μm luminosity (and thus SFR), and a wide range of dust temperatures (F100/F60) *(left)* and specific star formation rate (SFR/M*) *(right)*, thus forming a statistically complete sample of local star-forming galaxies ideal for understanding the physical process of star formation and its dependence on other global galaxy properties. The symbol sizes in both the figures represent the relative weight of the galaxy in the cell of the 3-d space defined above. The galaxies in the sample are selected from a parent sample after weighting them in the individual cells defined by the 3-d space defined above. Figures 1 & 2 show the final sample in the selection space, and the corresponding weights.

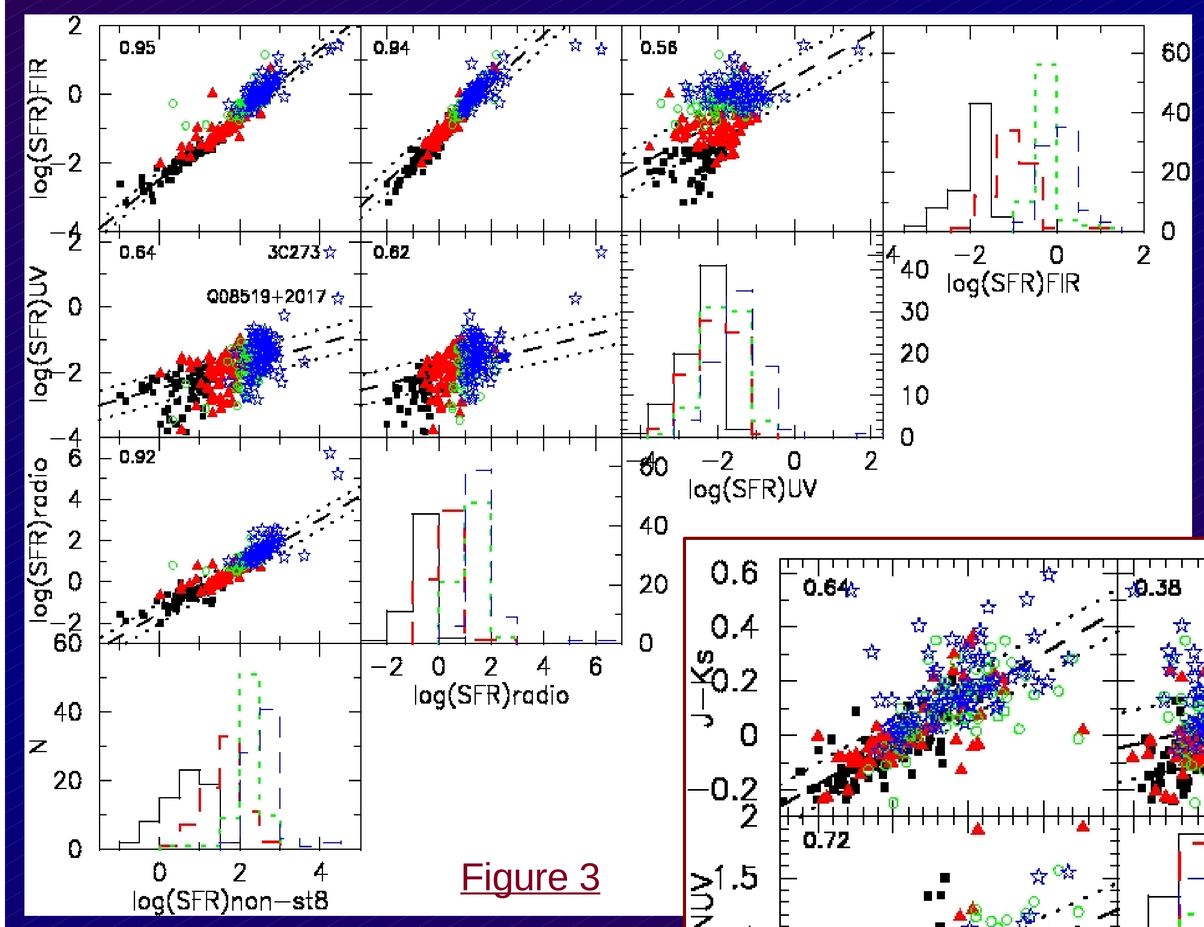

Figure 3

Figure 3: The distribution and correlation between suite of SFR indicators at different wavelengths, for 294 SFRS galaxies for which UV data are available from the *GALEX* archive. The points are colour-coded by 60 μm luminosity so as to have almost equal number of galaxies in each of the four bins. The dashed line in each panel is the least absolute deviation fit to the data, while the dotted lines represent +/- mean absolute deviation. The product moment correlation coefficient for each dataset is indicated in the upper left corner of the panel. The PAH, radio, FUV, and FIR SFRs are evaluated using the relations given by Wu et al. (2005), Yun et al. (2001), Takeuchi et al. (2010) and Kennicutt (1998) respectively. The well known radio-FIR correlation manifests itself in the very tight correlation seen between radio and FIR, and radio and PAH SFRs.

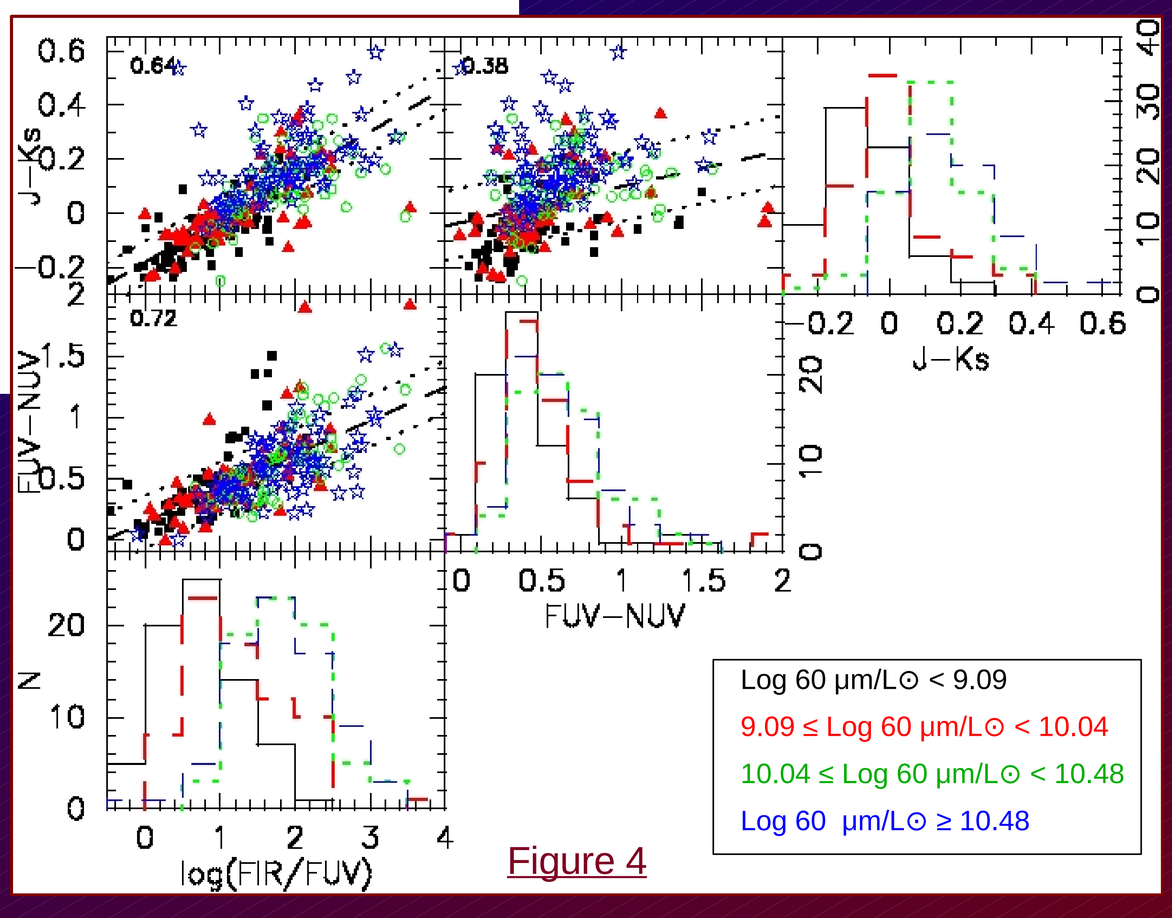

Figure 4

Figure 4: The luminosity-dependent distributions and relations between three different extinction indicators. While log(FIR/FUV) and J-Ks colour are well correlated with 60 μm luminosity, the UV colour shows a very weak dependence only. Interestingly, most of the scatter in all correlations, especially the FUV-NUV vs J-Ks is introduced by the most luminous galaxies (blue and green symbols).

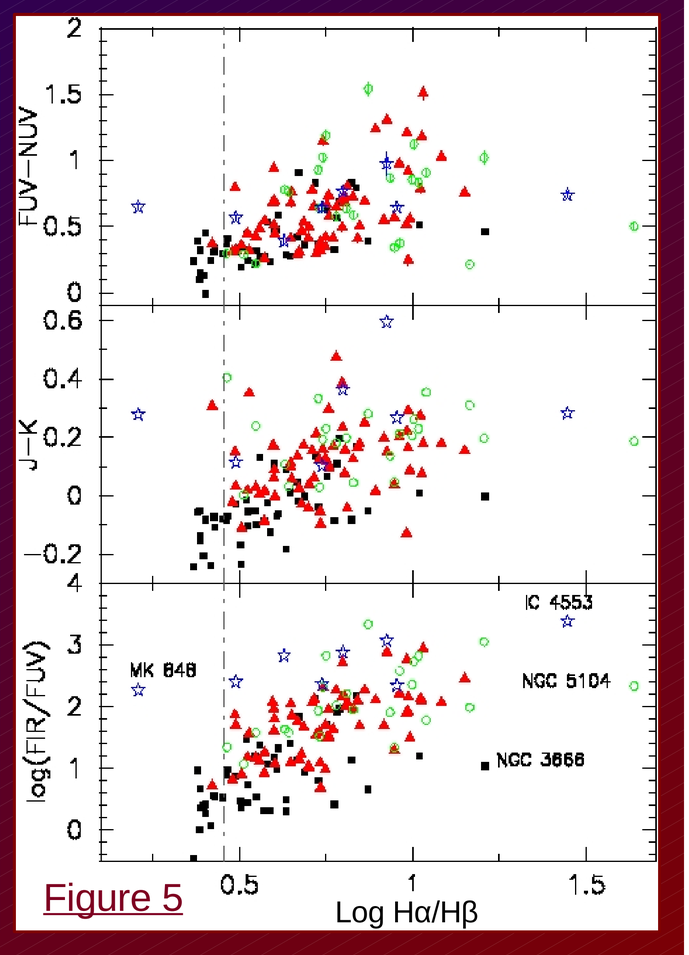

Figure 5

Figure 5: A correlation between the Balmer decrement and 'global extinction' indicators is seen for the 152 galaxies for which optical spectra are available from the SDSS. The vertical grey line marks the theoretical value for Hα/Hβ ratio. However, since the SDSS spectra are obtained using a 3" diameter fibre, they are not a fair representation of the total light of the galaxy for most of the galaxies in this sample.

References:
Kennicutt R.C., Jr., 1998, ARA&A, 36, 189
Takeuchi T.T., et al., 2010, A&A, 514, A4
Wu H., et al., 2005, ApJ, 632, L79
Yun M.S., Reddy N.A., Condon J.J., 2001, ApJ, 554, 803

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