A MIR spectroscopic atlas of starburst galaxies

We have consolidated detailed mid-infrared (MIR) spectroscopic data on a sample of nearby starbursts observed by the *Infrared Space Observatory* (ISO) to provide a spectroscopic atlas of MIR emission features (2.4-45.2μm). The spectra are rich in fine structure (FSL) and hydrogen recombination lines and thus are excellent probes to investigate the nature of starbursts. We use FSL ratios of neon, argon and sulphur to construct diagnostic excitation diagrams and, in combination with H-recombination line data, we determine their elemental abundances. The derived Ne abundances span approximately an order of magnitude, up to values of $\sim$3 times solar. The excitation ratios measured from the Ne and Ar lines correlate well with each other (positively) and with abundances (negatively) (see figure below). The FSL data have been combined with a similar study of active galaxies to construct diagnostic diagrams that discriminate the two types of activity based upon their MIR spectra (Sturm et al. 2002 A&A 393 821).

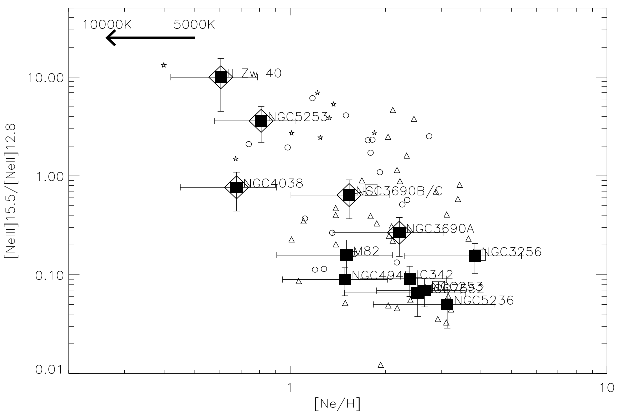

Figure: Abundance against excitation for the starbursts (filled squares) showing a clear anti-correlation of the lower excitation of metal-rich galaxies than H II regions (small open circles, triangles and stars). Also, low metallicity and high excitation WR galaxies (squares enclosed by diamonds) are separated.

Low excitation of starbursts Ratios of FSLs of different ionisation states of the same species are a measure of the excitation of a galaxy's ISM. Our results show a clear dependence od excitation upon metallicity We confirm earlier results finding that for a given abundance (Ne, Ar or S), the starbursts are of relatively lower excitation than a comparative sample of Galactic HII regions. The low excitation has been ascribed to low upper-mass cut-offs to the IMF or ageing of the stellar population. The presence of massive star in starburst systems is well known and thus ageing of the stellar population and dilution of the excitation ratio as a result are the preferred explantion. The excitation is hence governed by a combination of metallicity and other effects like ageing of the population, which should be accounted for in modelling starbursts as composite HII regions.

Underabundance of Sulphur We find sulphur abundances that are consistently lower than Ne or Ar by up to an order of magnitude in metal rich & dusty objects. While raising practical limitations on the use of S lines as tracers of star forming activity, we cannot determine the precise origin of this deficit although favour depletion onto dust grains as the most likely cause. Our results imply that (a) the FSL transitions of neon are favoured over FSL of sulphur as a star formation indicator for future spectroscopic surveys of faint galaxies and (b) sulphur is a unsuitable tracer of metallicity.

Wolf-Rayet Galaxies Both in excitation and abundance, a separation of objects with visible Wolf-Rayet (WR) features (high excitation, low abundance) is noted from those without (low excitation, high abundance). This is contrary to expectations of higher Wolf-Rayet fractions at higher metallicity from stellar evolutionary models. The most plausible reasons for this behaviour include obscuration coupled with a lack of convincing MIR Wolf-Rayet tracers, dilution by less obscured regions in the optical spectrum and changes in the spectral signatures of Wolf-Rayet stars at higher metallicity.

A. Verma, D. Lutz, E. Sturm, R. Genzel, A. Sternberg, W. Vacca (2003, A&A, 403, 829)