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ORIGINAL ARTICLE

Spaxel analysis: probing the physics of star formation in ultraluminous infrared galaxies

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Abstract This paper presents a detailed spectral pixel (spaxel) analysis of the ten Luminous Infrared Galaxies (LIRGs) previously observed with the Wide Field Spectrograph (WiFeS), an integral field spectrograph mounted on the ANU 2.3 m telescope, and for which an abundance gradient analysis has already been presented by Rich et al. (Astrophys. J., 753:5, 2012). Here we use the strong emission line analysis techniques developed by Dopita et al. (Astrophys. J. Suppl. Ser., accepted, 2013) to measure the ionisation parameter and the oxygen abundance in each spaxel. In addition, we use the observed Hα flux to determine the surface rate of star formation ($M_{\odot}yr^{-1}kpc^{-2}$) and use the [S II] $\lambda\lambda$6717/6731 ratio to estimate the local pressure in the ionised plasma. We discuss the correlations discovered between these physical quantities, and use them to infer aspects of the physics of star formation in these extreme star forming environments. In particular, we find a correlation between the star formation rate and the inferred ionisation parameter. We examine the possible reasons for this correlation, and determine that the most likely explanation is that the more active star forming regions have a different distribution of molecular gas which favour higher ionisation parameters in the ionised plasma.

Keywords Stars: star formation · Interstellar medium: HII regions · Galaxies: starburst, Chemical abundances

1 Introduction

The Ultraluminous Infrared Galaxies (ULIRGs) provide a vital link between star formation processes occurring in the local universe, and star formation in high redshift galaxies. Although rather rare in the local Universe, ULIRGs account for a much greater fraction of star formation by $z \sim 1$ when encounters between galaxies was much more frequent (Le Floc'h et al. 2005; Magnelli et al. 2011). By the study of ULIRGs, we hope to understand the physics triggering star formation in merging systems, and to discover whether, for example, the initial mass function (IMF) is biased towards more massive stars (Hoversten and Glazebrook 2008; van Dokkum 2008; Meurer et al. 2009; Treu et al. 2010; Cappellari et al. 2012; Andrews et al. 2013; Bekki and Meurer 2013), or discover whether the mass distribution of stellar clusters themselves is somehow different in regions of very high star formation rates (Portegies et al. 2010; Chandar et al. 2010; Adamo et al. 2010; Weidner et al. 2011). Although these issues have been studied through surface photometry, the advent of integral field spectrographs is relatively recent, and the use of these to simultaneously measure the relationship of star formation, metallicity, gas pressure and the excitation of the H II regions surrounding the newly formed star clusters is only in its infancy.

In this paper, we investigate the utility of spaxel (spectral pixel) analysis for the study of local ULIRGs which are not

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