A VLT VIMOS-IFU study of the cometary extremely metal-poor galaxies Tol 65 and UM 461

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Goals and Sample:

Blue compact Dwarf galaxies (BCD), also known as HII galaxies, are low luminosity, low metallicity (7.0<12+log(O/H)<8.4), gas-rich objects with optical spectra resembling those presented by HII regions. A small fraction of these galaxies fall in the regime of very low metallicity (12+log(O/H) < 7.6) and are commonly refereed as extremely metal-poor (XMP) BCD galaxies. According to the hierarchical paradigm of structure formation, massive galaxies assemble through mergers or interactions of smaller systems. In this scenario, XMP galaxies should be common in the early Universe, whereas they should be very rare at low redshift (Kunth & Ostlin 2000). Many questions remain about the star formation (SF), metal content and the mechanism involved in the transport and mixing of metals in HII/BCD galaxies. The morphologically diverse nature of BCD, in particular XMP galaxies, allows us to consider the role played by galaxy interactions and the feedback between the SF and the Interstellar medium (ISM) in the observed metal distributions. In this sense, these galaxies are the best nearby candidates for cosmologically young objects, as various arguments imply that they have formed most of their stellar mass in the past 1–3 Gyr (Papaderos et al 2008).

Our main goal is to carry out a spatial study of the warm gas properties in the ISM of some cometary XMP BCD galaxies using Integral Field Unit (IFU) spectroscopy, in order to investigate its physical conditions, laying special emphasis on the oxygen and nitrogen abundance pattern, kinematics and the relation on the intrinsic properties of SF as well as possible evolutionary effects. In this contribution we present preliminary results from our analysis of the cometary XMP galaxies Tol 65 and UM 461, based on VLT VIMOS-IFU spectroscopy. The main properties of these galaxies are showed in Table 1.

Name	M_B (mag)	D (Mpc)	12+log(O/H)	Scale (pc/")
UM 461	-14.36	14.2	7.72	60
Tol 65	-15.44	38.5	7.55	184

Table 1. Main properties of our sample galaxies.

Observations:

The VIMOS-IFU observations were obtained using the gratings HR_blue and HR_orange covering a spectral range from ~3,710 to ~7,700 angstroms. Our data yield a scale on the sky of 0."33 per fiber, and cover a Field-of-View (FoV) of 13" X 13". In Figure 1 (left panels) we show Hubble Space Telescope (HST, filter F435W) and Gemini (kp-band) images of the XMP BCD galaxies Tol 65 and UM 461, in which we show the FoV and the Hα map of the galaxies obtained using VIMOS-IFU.

Preliminary Results:

Emission Line Ratios

The ionization mechanisms in the ISM of the galaxies can be studied by means of various diagnostic diagrams (see e.g., Cairos et al. 2012, Lagos et al. 2012). In this study, we used the following emission line ratios: [OIII]λ5007/Hβ, [OI]λ6300/Hα, [NII]λ6584/Hβ and [SII]λλ6717,6731/Hα. In Figure 2, we show the maps for [OIII]λ5007/Hβ and [SII] λλ6717,6731/Hα. This figure shows that the emission line ratio [OIII]λ5007/Hβ decreases with distance, while the opposite is observed for [SII]λλ6717,6731/Hα. This spatial distribution is similar to the one observed in other HII/BCD galaxies found in the literature (in Lagos and Papaderos 2013 we list all HII/BCD galaxies studied so far using IFU spectroscopy). The emission line ratios found in this work suggest that photoionization from stellar sources is the dominant excitation mechanism in the ISM of our sample galaxies.

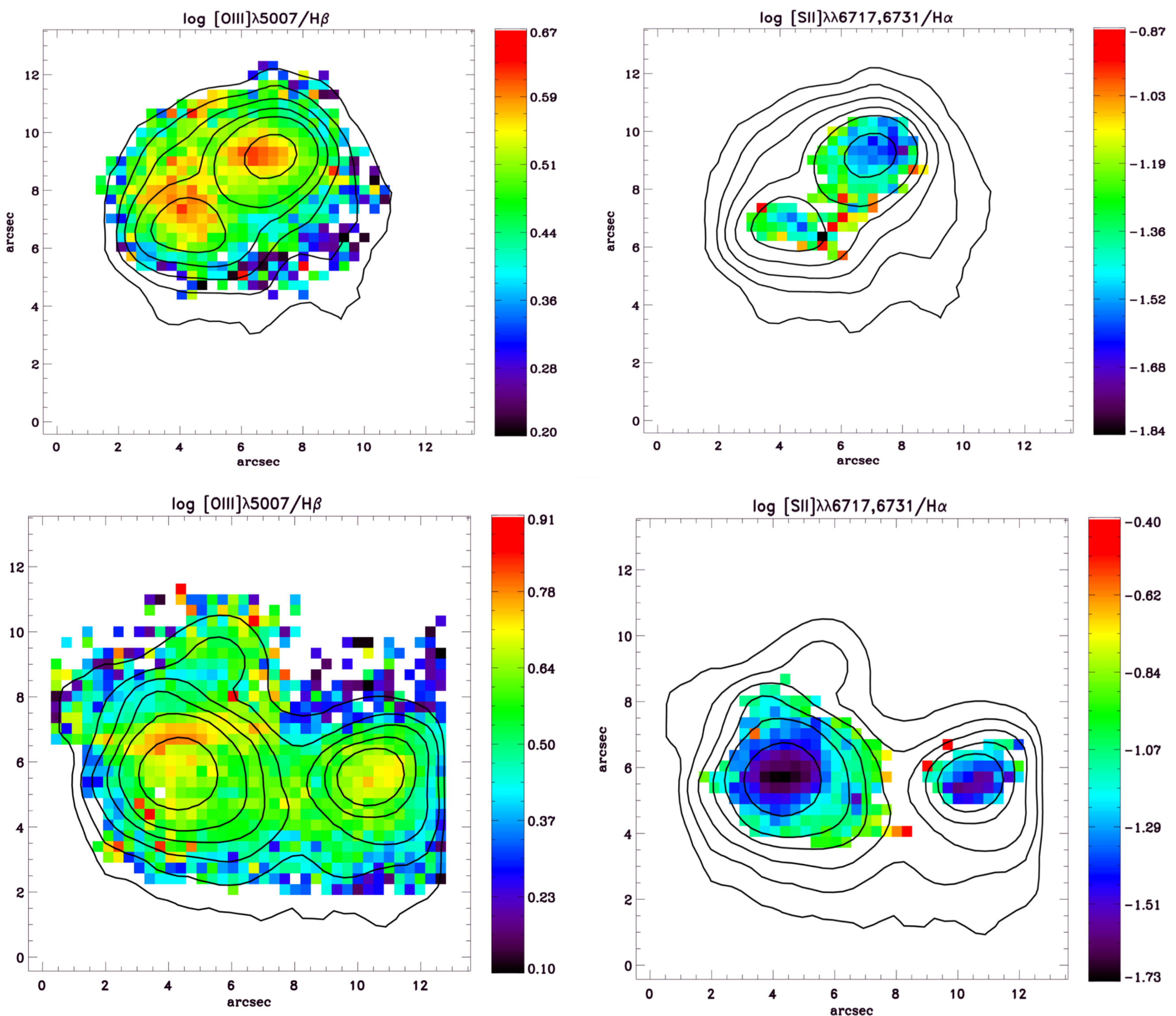

Figure 2. Emission-line ratios: log [OIII]λ5007/Hβ, log [SII]λλ6717,6731/Hα for both galaxies in our sample (Tol 65: upper panels; UM 461: lower panels).

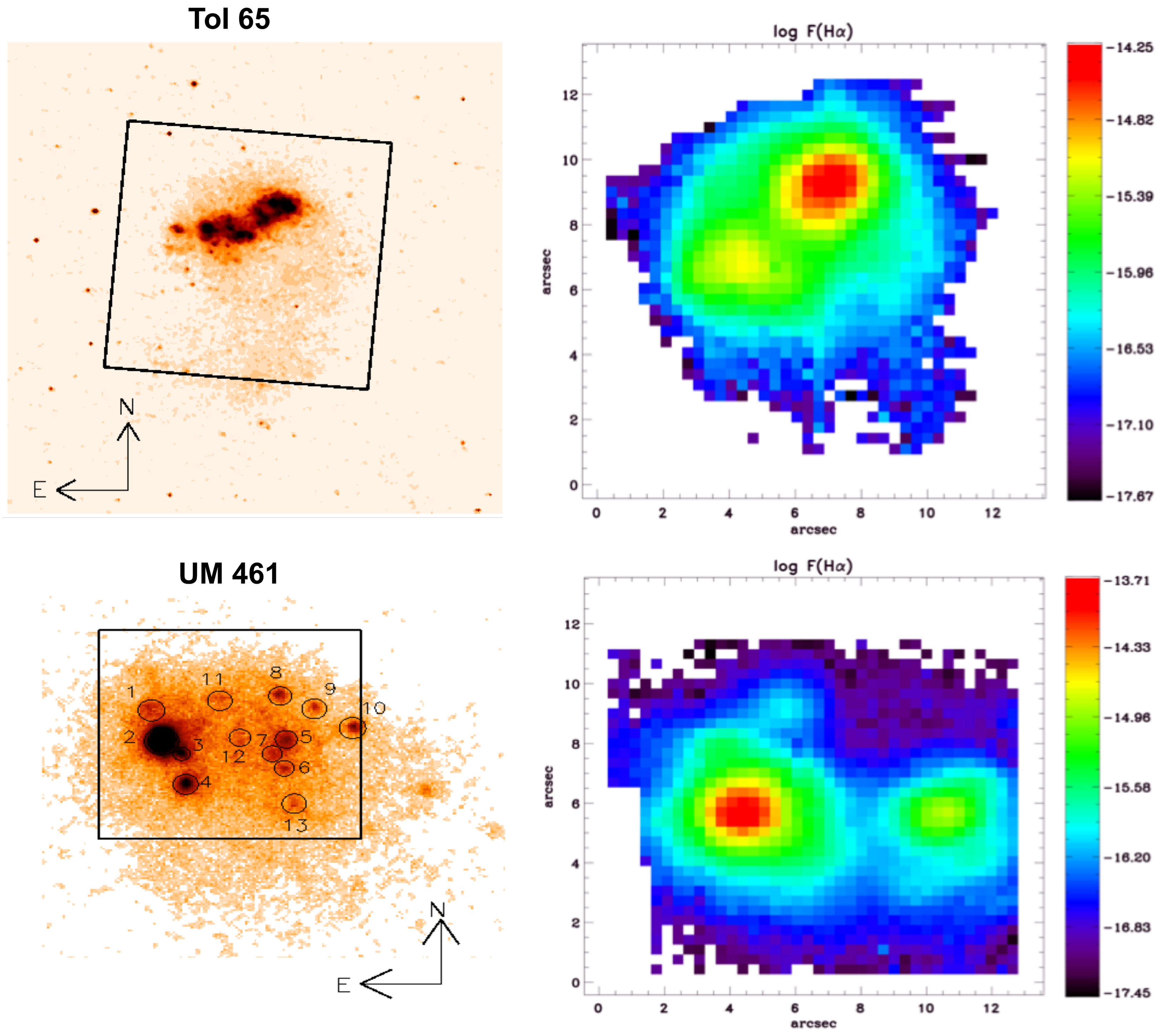

Figure 1. Left panels: HST (filter F435W) and Gemini-NIRI Kp-band (Lagos et al. 2011) images of the galaxies Tol 65 and UM 461. Right panels: Ha emission line maps of the galaxies. Fluxes in units of erg cm^{-2} s^{-1}. The Hα maps show an extended morphology which reveal a clear nebular contribution in the outer part (underlying component) of the galaxies.

Oxygen abundance

As far as the spatial distribution of oxygen abundances is concerned, we did not detect a statistically significant variation of metallicity along the galaxies. On the contrary, the oxygen and nitrogen appear to be well mixed across the ISM of these BCD galaxies, suggesting a global and efficient transport and mixing by expanding starburst-driven super-shells (e.g., Tenorio-Tagle 1996, Lagos et al 2009, Lagos et al. 2012) and/or gas infall from the halo. For the sake of illustration, in Figure 3 we show the spatial distribution of 12+log(O/H) in the galaxy Tol 65. Further details will be presented in a forthcoming paper.

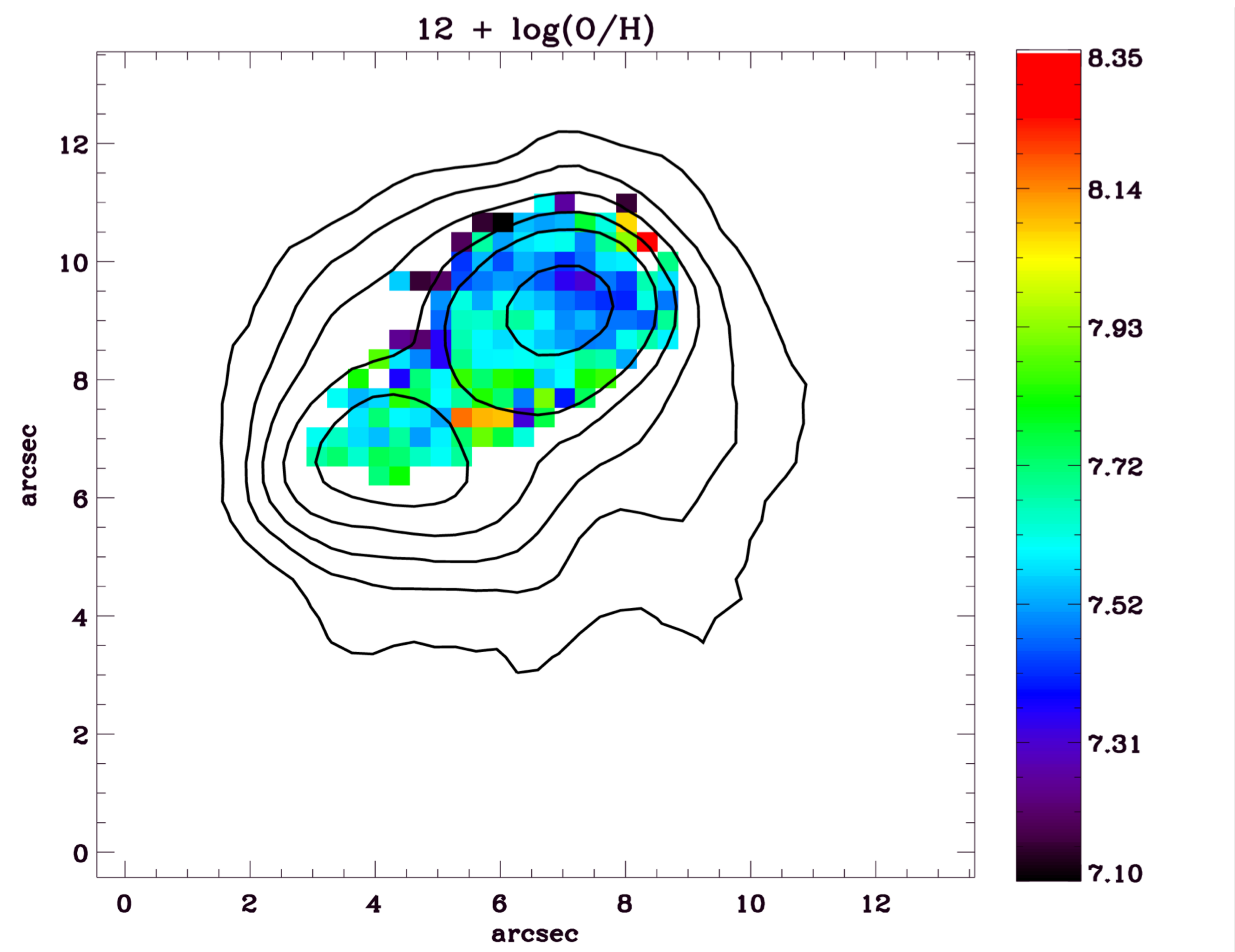

Figure 3. 12+log(O/H) abundance map of Tol 65. Overlaid are the Hα flux contours. We considered spaxels with signal-to-noise ratio (S/N) > 3 in the [OIII] λ4363 line.

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