A Massive Star Odyssey, from Main Sequence to Supernova
Proceedings IAU Symposium No. 212, © 2003 IAU
K.A. van der Hucht, A. Herrero & C. Esteban, eds.

Massive stars in galaxies at high redshift: SMM J 14011+0252

Duilia F. de Mello, Tommy Wiklind

Onsala Space Observatory,
Chalmers Centre for Astrophysics and Space Science,
S-43992 Onsala, Sverige

Claus Leitherer

Space Telescope Science Institute,
3700 San Martin Drive, Baltimore, MD 21218, USA

Abstract. We present high resolution VLT spectra of the optical identification of the high-redshift galaxy SMM J 14011+0252. We concentrate on the C IV 1550 Å region of the spectra and compared the data with a spectral synthesis model generated with STARBURST99.

1. Introduction

As shown for the Lyman-break galaxy MS 1512-cB58 ($z = 2.73$), good signal-to-noise UV spectra of high-z galaxies can provide a comprehensive study of star formation at early times (Leitherer *et al.* 2001; de Mello *et al.* 2000; Pettini *et al.* 2000). The stellar photospheric lines are diagnostics of the stellar population of the galaxy, whereas the interstellar lines probe the kinematics of the gas. The stellar wind lines are radiatively driven and can be used to estimate qualitatively the metallicity. Many of these lines are, however, weak and contaminated by interstellar components requiring high signal-to-noise and high-resolution data. In this contribution we present a high-resolution spectrum of SMM J 14011+0252 taken with the Very Large Telescope (VLT-FORS2). This source is one of the only two high-z sources detected with the JCMT Submm Common-User Bolometer Array (SCUBA) with secure optical identification. It is also the only one which shows no sign of AGN activity (Ivison *et al.* 2001 and references therein). Two objects called J1 and J2 near the SCUBA coordinates have been identified. A *HST* (F702W) image of SMM J 14011+0252 shows a complex system around these objects. Based on the offset between the *HST* coordinates and the CO and radio maps, it has been suggested that J1 and J2 are actually part of just one large galaxy obscured by dust. We present the high-resolution spectroscopy used to analyse the stellar content, the metallicity and dynamics of J1 and J2.

2. Analysis and conclusions

We used the upgraded STARBURST99 package to calculate the synthetic UV spectra (Leitherer *et al.* 2001). We refer to `http://www.stsci.edu/science/starburst99`

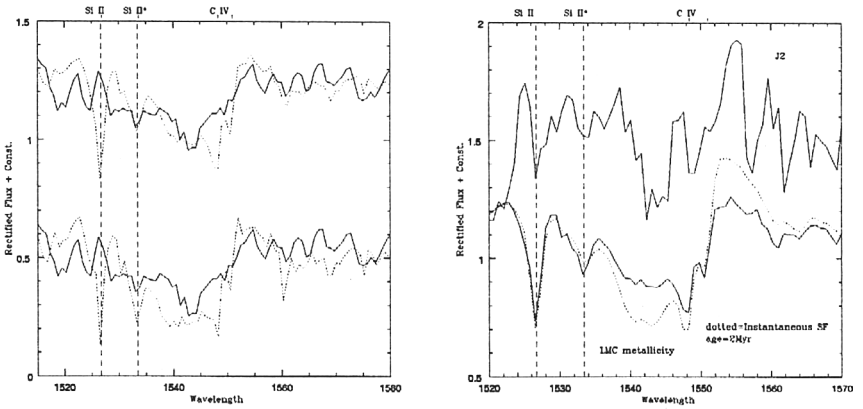

Figure 1. *Left:* Comparison between the observed spectrum of SMM J 14011+0252 J1 in the region of C IV 1550 Å with the STARBURST99 model (dotted line). Salpeter IMF, continuous star formation, 100 Myr old. *Left bottom:* solar metallicity; *Left top:* LMC metallicity. *Right bottom:* Continuous line: Salpeter IMF, LMC metallicity, continuous star formation, and 100 Myr old. Dotted line: Salpeter IMF, LMC metallicity, instantaneous star formation and 2 Myr old; *Right top:* spectrum of SMM J 14011+0252 J2. Si II 1526.70,1533.44 Å lines marked with vertical dashed lines; spectra rectified.

for more details on each individual parameters such as the IMF, and the star formation mode (continuous or instantaneous). The upgraded version includes a library of stars from the LMC. We concentrate on a comparison of the C IV 1550 Å region of spectrum and the set of models compiled with STARBURST99. Figure 1 shows the synthetic models and the spectra of J1 and J2. Our main conclusions are: (*i*) the strength of the Si II 1533.44 Å photospheric line and the shape of C IV 1550 Å absorption component is better reproduced by the LMC model with continuous star formation and age $t = 100$ Myr. However, the shape of the profile is still very different from the model. This difference is probably due to a lower metallicity than in the LMC for J1; (*ii*) the Si II 1533.44 Å photospheric line was used to obtain the redshift of J2 ($z = 2.5643$). J1 is at $z = 2.5650$, which translates into $\Delta v = 200\,\mathrm{km\,s^{-1}}$; (*iii*) the strong P-Cygni profile in J2 suggests the presence of a young population in this region (or a weak AGN) and is better reproduced by a 2 Myr old single burst model; and (*iv*) the resonance line Si II 1526.70 Å, which has a narrow and deep interstellar component, is blue-shifted in J1 by $\Delta v \simeq 466\,\mathrm{km\,s^{-1}}$, typical of large scale outflows. These results are in agreement with the suggestion that these two objects are regions of star formation in one single galaxy. However, three separate units (J1, J2 and the dust source) cannot be ruled out at the present stage.

References

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https://doi.org/10.1017/S0074180900213132 Published online by Cambridge University Press