# The VLT-FLAMES survey of massive stars: observations centered on the Magellanic Cloud clusters NGC 330, NGC 346, NGC 2004, and the N11 region ${ }^{\star, \star \star}$ 

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#### Abstract

We present new observations of 470 stars using the Fibre Large Array Multi-Element Spectrograph (FLAMES) instrument in fields centered on the clusters NGC 330 and NGC 346 in the Small Magellanic Cloud (SMC), and NGC 2004 and the N11 region in the Large Magellanic Cloud (LMC). A further 14 stars were observed in the N11 and NGC 330 fields using the Ultraviolet and Visual Echelle Spectrograph (UVES) for a separate programme. Spectral classifications and stellar radial velocities are given for each target, with careful attention to checks for binarity. In particular, we have investigated previously unexplored regions around the central LH9/LH10 complex of N11, finding ~25 new O-type stars from our spectroscopy. We have observed a relatively large number of Be-type stars that display permitted $\mathrm{Fe}_{\text {II }}$ emission lines. These are primarily not in the cluster cores and appear to be associated with classical Be-type stars, rather than pre main-sequence objects. The presence of the Fe II emission, as compared to the equivalent width of $\mathrm{H} \alpha$, is not obviously dependent on metallicity. We have also explored the relative fraction of Be - to normal B-type stars in the fieldregions near to NGC 330 and NGC 2004, finding no strong evidence of a trend with metallicity when compared to Galactic results. A consequence of service observations is that we have reasonable time-sampling in three of our FLAMES fields. We find lower limits to the binary fraction of O- and early B-type stars of 23 to $36 \%$. One of our targets (NGC 346-013) is especially interesting with a massive, apparently hotter, less luminous secondary component.


Key words. stars: early-type - stars: fundamental parameters - stars: emission-line, Be - binaries: spectroscopic galaxies: Magellanic Clouds

## 1. Introduction

As part of a European Southern Observatory (ESO) Large Programme we have completed a new spectroscopic survey of massive stars in fields centered on open clusters in the Large and Small Magellanic Clouds (LMC and SMC respectively) and the Galaxy. The survey has employed the Fibre Large Array MultiElement Spectrograph (FLAMES) instrument at the Very Large Telescope (VLT), that provides high-resolution ( $R \sim 20000$ ) multi-object spectroscopy over a $25^{\prime}$ diameter field-of-view. The scientific motivations for the survey, and the observational information for the three Galactic clusters (NGC 3293, NGC 4755, and NGC 6611), were presented by Evans et al. (2005, hereafter Paper I).

In this paper we present the FLAMES observations in the Magellanic Clouds. The material presented is largely a discussion of the spectral classifications and radial velocities of each star, and provides a consistent and thorough overview of what is a particularly large dataset. In parallel to this catalogue, subsets of the sample are now being analysed by different groups. The sources of photometry and astrometry used for target selection

[^0]are given in Sect. 2, followed by details of the observations in Sect. 3, and then a discussion of the observed sample.

Two FLAMES pointings were observed in each of the Clouds, centered on NGC 346 and NGC 330 in the SMC, and on NGC 2004 and the N11 region (Henize 1956) in the LMC. NGC 346 is a young cluster with an age in the range of 1 to $3 \times 10^{6}$ yrs (Kudritzki et al. 1989; Walborn et al. 2000; Bouret et al. 2003; Massey et al. 2005), that has clearly undergone prodigious star formation. It is also the largest H II region in the SMC. The best source of spectroscopic information in NGC 346 is the study by Massey et al. (1989, hereafter MPG), who found as many O-type stars in the cluster as were known in the rest of the SMC at that time. High-resolution optical spectra of five of the O-type stars from MPG were presented by Walborn et al. (2000, together with AzV 220 that is also within the FLAMES field-of-view). These were analysed by Bouret et al. (2003), in conjunction with ultraviolet data, to derive physical parameters.

N11 is also a relatively young region and includes the OB associations LH9, LH10 and LH13 (Lucke \& Hodge 1970), that are of interest in the context of sequential star-formation, see Walborn \& Parker (1992), Parker et al. (1992, hereafter P92), and Barbá et al. (2003). P92 illustrated how rich the region is in terms of massive stars, presenting observations of 43 O-type stars in LH9 and LH10, with three O3-type stars found in LH10. These O3 stars were considered by Walborn et al. (2002) in their
extension of the MK classification scheme to include the new O2 subtype, with one of the stars from P92 reclassified as O2-type. The FLAMES observations in N11 presented an opportunity to obtain good-quality spectroscopy of a large number of known O-type stars, whilst also exploring the spectral content of this highly-structured and dynamic region.

NGC 330 and NGC 2004 are older, more centrally condensed clusters. NGC 330 in particular has been the focus of much attention in recent years. Feast (1972) presented $\mathrm{H} \alpha$ spectroscopy of 18 stars in the cluster, and noted: "It is also an object of considerable importance in discussion of possible differences between stars of the same age in the SMC and in the Galaxy". The community has clearly taken his words to heart - in the past 15 years there have been numerous studies in the cluster, most of which were concerned with the large population of Be-type stars therein, namely Grebel et al. (1992), Lennon et al. (1993), Grebel et al. (1996), Mazzali et al. (1996), Keller \& Bessell (1998), Keller et al. (1999), Maeder et al. (1999), and Lennon et al. (2003). The paper from these with the widest implications is that from Maeder et al. (1999), who compared the fraction of Be stars (relative to all B-type stars) in a total of 21 clusters in the SMC, LMC and the Galaxy. The fraction of Be stars appears to increase with decreasing metallicity, although their study was limited to only one cluster (NGC 330) in the SMC. This trend led Maeder et al. to advance the possibility of faster rotation rates at lower metallicities - one of the key scientific motivations that prompted this FLAMES survey.

In contrast to NGC 330, with the exception of abundance analyses of a few B-type stars by Korn et al. (2002, 2005), relatively little was known about the spectroscopic content of NGC 2004 until recently. A new survey by Martayan et al. (2006), also with FLAMES, has observed part of the field population near NGC 2004 using the lower-resolution mode of the Giraffe spectrograph (and with a different field-centre to ours). Martayan et al. concluded that the Be-fraction in their LMC field is not significantly different to that seen in the Galaxy.

The FLAMES observations for the current survey were obtained in service mode and so span a wide range of observational epochs, giving reasonable time-sampling for the detection of binaries. There are surprisingly few multi-epoch, multiobject spectroscopic studies of stellar clusters in the literature in this respect, with one such study in 30 Doradus summarized by Bertrand et al. (1998). Placing a lower limit on the binary fraction in dense star-forming regions such as NGC 346 and N11, combined with stellar rotation rates, will help to provide useful constraints in the context of star formation and the initial mass function.

## 2. Target selection

### 2.1. SMC photometry

The adopted photometry and astrometry for the targets in NGC 346 and NGC 330 is that from the initial ESO Imaging Survey (EIS) pre-FLAMES release by Momany et al. (2001).

### 2.2. N11 photometry

The N11 region was not covered by the EIS pre-FLAMES Survey and so we obtained 60 s $B$ and $V$ images with the Wide Field Imager (WFI) at the 2.2-m Max Planck Gesellschaft (MPG)/ESO telescope, on 2003 April 04. These were processed by Dr. M. Irwin using a modified version of the Isaac Newton Telescope-Wide Field Camera (INT-WFC) data


Fig. 1. Comparison of $V_{\mathrm{J}}-V_{\text {WFI }}$ with published colours in N11 from Parker et al. (1992), and primarily from Robertson (1974) for NGC 2004.


Fig. 2. Comparison of $B_{\mathrm{J}}-B_{\mathrm{WFI}}$ with published colours in N11 from Parker et al. (1992), and primarily from Robertson (1974) for NGC 2004.
reduction pipeline (Irwin \& Lewis 2001), we then calibrated the photometry to the Johnson-Cousins system using results from P92.

As in Paper I, for photometric calibration we prefer to visually match stars using published finding charts. In crowded regions such as those in our FLAMES fields this ensures accurate cross-identification. Cross-referencing the finding charts of P92 with the WFI images yielded matches of 41 stars (for which both $B$ and $V$ WFI photometry were available), with relatively sparse sampling in terms of $(B-V)$. To increase the number of cross-matched stars an astrometric search was performed between the WFI sources and the full P92 catalogue (available online at the Centre de Données astronomiques de Strasbourg). The mean (absolute) offsets found between the WFI and P92 astrometry (for the 41 stars with visual matches), were $\langle | \Delta \delta\left\rangle \sim 0.4^{\prime \prime}\right.$ and $\langle | \Delta \alpha\left\rangle \sim 0.06^{\text {s }}\right.$; these were used to then expand the sample to 60 stars, with $V<17.0$. The $V$ and $B$ colour terms found for the WFI data in N11 are shown in Figs. 1 and 2, and the transformation equations found were:
$V_{\mathrm{J}}=V_{\mathrm{WFI}}-0.07 \times(B-V)_{\mathrm{J}}-0.34$,
$B_{\mathrm{J}}=B_{\mathrm{WFI}}+0.26 \times(B-V)_{\mathrm{J}}-0.12$.

After transformation we find mean (absolute) differences of $\sim 0.05^{\mathrm{m}}$, with $\sigma \sim 0.05^{\mathrm{m}}$ for both $V$ and $(B-V)$. In the centre of LH 10, in which there is significant nebular emission, the INT-WFC pipeline detected some of the sources as "noise-like" and did not yield sensible results; for these 11 stars (marked with $\mathrm{a} *$ in Table 6) the photometry here is that from P92. Their photometry is also included in the table for N11-105 which was in the gap between CCDs in the WFI $V$-band image.

### 2.3. NGC 2004 photometry

NGC 2004 was observed in two of the EIS pre-FLAMES fields, LMC 33 and 34. At the time of the FLAMES observations a full EIS data release was not available for these fields, so the raw images were acquired from the ESO archive and reduced using the INT-WFC pipeline (also by Dr. M. Irwin).

CCD photometry in NGC 2004 has been published by Bencivenni et al. (1991) and Balona \& Jerzykiewicz (1993). The former study is calibrated to the photographic work of Robertson (1974), albeit with consideration of two of the photoelectric standards from McGregor \& Hyland (1984). The study by Balona \& Jerzykiewicz is independent of previously published photometry in the cluster, however the "finding charts" and format of the catalogue (in terms of pixel positions) are less than ideal for successfully recovering matched stars; without access to the raw frames, accurate cross-matching between their photometry and our WFI images cannot be ensured. Instead we employ visual matches of 48 stars from the identification charts of Robertson (1974) to calibrate the WFI data, taking photoelectric results from McGregor \& Hyland (1984, 2 stars) and Walker (1987, 7 stars), with the data for the remaining 39 stars taken from Robertson. The $V$ and $B$ colour terms found for the NGC 2004 WFI data are also shown in Figs. 1 and 2, and the transformation equations found were:
$V_{\mathrm{J}}=V_{\mathrm{WFI}}-0.03 \times(B-V)_{\mathrm{J}}-0.20$,
$B_{\mathrm{J}}=B_{\mathrm{WFI}}+0.29 \times(B-V)_{\mathrm{J}}-0.36$.
Whilst there is a relatively large scatter in ( $V_{\mathrm{J}}-V_{\mathrm{WFI}}$ ), the colour term is very robust; the same result is found if only the photoelectic values are used or, similarly, if only the photographic results are used. After transformation we find mean (absolute) differences of $\sim 0.06^{\mathrm{m}}$, with $\sigma \sim 0.04^{\mathrm{m}}$ for both $V$ and ( $B-V$ ).

### 2.4. Selection effects

Following similar methods to those in Paper I for target selection, the photometric data were used to create input catalogues for the FLAMES Fibre Positioner Observation Support Software (FPOSS) that allocates the Medusa fibres in a given field.

In Paper I we were perhaps too hasty with our description of avoiding known Be-type stars. To recap, the observed samples in the three Galactic clusters from Paper I were relatively complete for blue stars in the FLAMES pointing, down to $\sim V=13$. In terms of the final samples no external selection effects were present with regard to Be-type stars, with only 12 stars classified as Be and one as Ae-type, from a combined total of 319 FLAMES and FEROS targets. It is worth noting that NGC 3293 and NGC 4755 are two of the three clusters included by Maeder et al. (1999) in their "inner Galaxy" sample (with the lowest Be-fraction compared to normal B-type stars), i.e. both NGC 3293 and NGC 4755 have genuinely small numbers of Be-type stars.

As mentioned in Paper I, one of our primary objectives concerns the process of nitrogen enrichment in OB-type stars and its correlation (or not) with rotational velocities. Spectroscopic analysis of Be stars is more involved (i.e. difficult!) than for "normal" B-type stars. Thus in our FPOSS input catalogue, in an attempt to ensure that we didn't observe a preponderance of Be stars in NGC 330, we excluded 15 stars classified as Betype from previous spectroscopy (Lennon et al. 1993; Keller \& Bessell 1998). However, this isn't such a strong selection effect as it may sound - all of the excluded stars are from the Robertson (1974) survey and therefore are in (or near to) the main body of the cluster. Obviously the FLAMES survey cannot be used to comment on the incidence of the Be-phenomenon in the cluster itself, but it could in principle offer constraints on the field population around the cluster. With regard to the non-cluster population, we also excluded 15 stars from Evans et al. (2004) that have emission in their Balmer lines. However, these are not necessarily Be-type stars as the narrow emission in many of the stars from Evans et al. is likely attributable to nebular origins (see discussion in their Sect. 7). Given the high density of potential targets in the field, the exclusion of the stars from Evans et al. is very unlikely to bias the final sample.

In NGC 2004, Keller et al. (1999) reported 42 Be-type stars from their photometric study. However, due to the relative dearth of published spectroscopy in this field at the time of our observations, no potential targets were excluded when using FPOSS for fibre configuration. Lastly, the only weighting in NGC 346 and N11 was to give higher priority of fibre-assignment to known OB-type stars from MPG and P92.

In summary, the only strong external bias in our observed targets was in the main body of NGC 330. A much stronger selection effect in both NGC 330 and NGC 2004 is that the sheer density of the cluster cores prevents Medusa fibres being placed so close together, with many stellar targets blended - in any one FLAMES pointing only a few stars near the centre could be observed with the Medusa fibres. Follow-up of these two clusters with integral field spectroscopy, such as that offered by FLAMES-ARGUS at the centre of the FLAMES field plate, is an obvious project to allow a comprehensive exploration of the cluster populations. However, the field populations of both NGC 330 and NGC 2004 should be a relatively unbiased sample of the true population, subject to cluster membership issues and the faint magnitude cut-off of the FLAMES survey. These issues are discussed further in Sect. 8.4.

## 3. Observations and data reduction

### 3.1. FLAMES-Giraffe spectroscopy

All of the FLAMES observations were obtained in service mode, with the majority acquired over a 6 month period from 2003 July to 2004 January. The same high-resolution settings were used as for the Galactic observations, i.e. HR02 (with a central wavelength of $\lambda 3958 \AA$ ), HR03 ( 14124 ), HR04 ( $\lambda 4297$ ), HR05 ( $\lambda 4471$ ), HR06 ( $\lambda 4656$ ), and HR14 ( $\lambda 6515$ ). The bulk of the observations in NGC 330 were obtained prior to installation of a new grating in 2003 October, so the spectral coverage and resolution of these data are identical to that of our Galactic observations (see Paper I). However, the observations in NGC 346, NGC 2004 and N11 were taken with the new grating in place. The characteristics of the NGC 346 observations are given in Table 1. In comparison to the older grating the effective resolving power is decreased in some setups (in particular in the HR14

Table 1. Summary of the wavelength coverage, mean $F W H M$ of the arc lines and effective resolving power, $R$, at each Giraffe central wavelength setting, $\lambda_{\mathrm{c}}$, for the observations in NGC 346.

| Setting | $\lambda_{\mathrm{c}}$ | Wavelength coverage | $F W H M$ |  | $R$ |
| :--- | :---: | :---: | :---: | :---: | :---: |
|  | $(\AA)$ | $(\AA)$ | $(\AA)$ | (pixels) |  |
| HR02 | 3958 | $3854-4051$ | 0.18 | 3.7 | 22000 |
| HR03 | 4124 | $4032-4203$ | 0.15 | 3.4 | 27500 |
| HR04 | 4297 | $4187-4394$ | 0.19 | 3.5 | 22600 |
| HR05 | 4471 | $4340-4587$ | 0.23 | 3.7 | 19450 |
| HR06 | 4656 | $4537-4760$ | 0.20 | 3.5 | 23300 |
| HR14 | 6515 | $6308-6701$ | 0.39 | 3.9 | 16700 |

setting, yielding a correspondingly wider wavelength coverage), however the new grating is more efficient in terms of throughput.

In addition to observations at 6 central wavelengths, each field was observed at each wavelength for 6 exposures of 2275 s . The repeat observations at each central wavelength were taken in batches of 3 exposures, each triplet forming an observing block for the ESO service programme. The observational constraints on our programme were not particularly demanding (the required seeing was $1.2^{\prime \prime}$ or better), but in some cases these conditions were not fully satisfied. Therefore, at some settings we have more than 6 observations, for instance the HR14 setting was observed 9 times in our NGC 346 field. Although the conditions may not have been ideal for every observing block, all the completed observations were reduced - in general the seeing was not greater than $1.5^{\prime \prime}$ and the data are of reasonable quality. This is of particular relevance in terms of the radial velocity information contained in the spectra. The majority of the observations in NGC 330 were spread over a relatively short time ( $\sim 10$ days). Otherwise we have reasonable time coverage, e.g. the NGC 346 observations spanned almost 3 months so we are in an excellent position to detect both single and double-lined binaries. In Appendix A we list the modified Julian dates (MJD) of each of the observations.

The data were reduced using the Giraffe Base-Line Reduction Software (girBLDRS), full details of which are given by Blecha et al. (2003). For consistency with our performance tests in Paper I, v1.10 of girBLDRS was used. More recent releases include the option to perform sky subtraction within the pipeline, but we prefer to employ the methods discussed in Paper I.

The final signal-to-noise is, of course, slightly variable between the different wavelength regions for a given target depending on the exact conditions when the observations were taken. As a guide, the signal-to-noise of the reduced, coadded spectra is $\sim 200$ for the brightest stars in each field, decreasing to 110 in N11 (with the brightest faint cut-off), 75 in NGC 2004, and 60 in NGC 346. Inspection of the reduced spectra in the NGC 330 field revealed particularly low signal-to-noise in the six HR03 observations. The Si II and Si IV lines that are important for quantitative analysis are included in this region, so the NGC 330 field was reobserved with the HR03 setup on 2005 July 20 and 24. These more recent observations are included in Table A. 2 as HR03\#07-12. The spectra were reduced using the same routines and software as the rest of the survey.

The NGC 330 field features the faintest stars in the entire survey. Besides the problems with the initial HR03 observations, the signal-to-noise ratio of the fainter stars in this field (even in the co-added spectra) decreases to $\sim 35-40$ per unbinned pixel (at $V=16)$ and down to $25-30$ for the very faintest stars. Binning of the data helps to some degree, but it is clear that detailed
analysis of individual stars (such as those presented by Hunter et al., submitted) will not be feasible for some of the faintest targets. Nevertheless, the data presented here serve as a novel investigation of the spectral content of the region.

### 3.2. FLAMES-UVES spectroscopy

In addition to observations with the Giraffe Spectrograph, one can observe up to an additional 6 objects simultaneously with the red-arm of UVES (with a central wavelength setting of 5200 Å). In the SMC and LMC fields the UVES fibres were used to observe a small number of "red" targets. The FLAMES-UVES $\lambda 5200$ set-up gives spectral coverage from approximately $\lambda 4200$ to $\lambda 5150$ and $\lambda 5250$ to $\lambda 6200 \AA$ (with the break in coverage arising from the gap between the two CCDs). These data were reduced by Dr. A. Kaufer using the standard pipeline (Ballester et al. 2004), which runs under MIDAS and performs the extraction, wavelength calibration, background subtraction and subsequently merges the individual orders to form two continuous spectra, i.e., from $\lambda 4200$ to $\lambda 5150$ and $\lambda 5250$ to $\lambda 6200 \AA$.

Note that these data were observed over multiple epochs, and the pipeline does not correct the spectra to the heliocentric frame. For the purposes of approximate classification the very large number of individual UVES spectra were simply co-added, without correction to the heliocentric frame. Therefore we do not quote radial velocities for these stars.

### 3.3. Additional UVES spectroscopy in N11 and NGC 330

Normal UVES spectroscopy of a further 14 stars was obtained in 2001 November 1-3, as part of programme 68.D-0369(A); these data are included here to supplement the FLAMES sample. The spectra cover $\lambda 3750$ to $\lambda 5000, \lambda 5900$ to $\lambda 7700$, and $\lambda 7750$ to $\lambda 9600 \AA$, at a resolving power of $R \sim 20000$. These data were also reduced using the UVES pipeline, contemporaneously to those presented by Trundle et al. (2004).

The 9 targets in N11 complement the FLAMES programme well, providing a number of sharp-lined, luminous early B-type spectra. The spectra of the 5 targets in NGC 330 were only examined after collation of the FLAMES data hence their inclusion (out of sequence) at the end of Table 5. Note that the 14 stars observed with UVES in the traditional (non-fibre) mode are marked in Tables 5 and 6 as simply "UVES target" (cf. "FLAMESUVES target" for those observed in the more limited, fibre-fed mode).

## 4. Spectral classifications and stellar radial velocities

The FLAMES spectra were classified by visual inspection, largely following the precepts detailed in Paper I, with additional consideration of the lower metallicity of stars in the LMC and SMC. The principal reference for O- and early B-type spectra is the digital atlas from Walborn \& Fitzpatrick (1990), with the effects of metallicity explored by Walborn et al. $(1995,2000)$. Later-type stars in the SMC were classified using the critieria outlined by Lennon (1997), Evans \& Howarth (2003), and Evans et al. (2004). In the LMC, A-type supergiants were classified from interpolation between the Galactic and SMC spectra given by Evans \& Howarth, and B-type supergiants were classified with reference to Fitzpatrick (1988, 1991). Intermediate types of B0.2 and B0.7 have been used for some spectra - these are
interpolated types that, in an effort to avoid metallicity effects, are largely guided by the intensity of the weak He II $\lambda 4686$ line.

Assignment of luminosity classes in early B-type stars, with due attention to metallicity effects and stellar rotation rates, can be difficult. Very subtle changes in the observed spectra can yield different classes. Indeed, the reason that we do not regularly employ the class IV notation for stars in the Magellanic Clouds, arises from these issues - in a large dataset such as the FLAMES survey, one should be careful not to over-emphasize groupings as "dwarfs" and "giants", remembering that luminosity and gravity are continuous quantities. Also, as in our previous studies, we are cautious with regard to employing the Be notation - many of our targets have $\mathrm{H} \alpha$ profiles displaying narrow core emission, accompanied by [ N II] emission lines which are clearly nebular in origin. Where possible we give precise classifications for the Be spectra. In those spectra with Fe II emission (discussed further in Sect. 6) contamination of lines such as Si III $\lambda 4552$ makes classification more difficult. However, as for normal B-type stars, other absorption features are also of use as temperature diagnostics, such as O II $\lambda \lambda 4415-17$ and the O II/C III blend at $\lambda 4650 \AA \AA$ (remembering to account for metallicity effects). Of course, our Be classifications do not consider the likely contribution to the continuum by the emission region, and thus may not correlate to the same temperatures as for normal B stars.

In Tables 4-7 we present the observational properties of each of the stars observed in the four FLAMES fields in the Magellanic Clouds. Spectral classifications and stellar radial velocities are given, together with cross-references to existing catalogues and comments regarding the appearance of the $\mathrm{H} \alpha$ profiles and binarity. For NGC 346, NGC 330 and NGC 2004 we also include the radial distance ( $r_{\mathrm{d}}$, in arcmin) of each star from the centre of the cluster core ${ }^{1}$.

Finding charts are included for each of the fields in Figs. 13-16. The finding charts employ images from the Digitized Sky Survey (DSS) with our targets overlaid. The WFI pre-imaging used for target selection is significantly superior to the DSS images, however our intent here is solely to give a clear overview of the locations of each of the stars in our sample. The DSS images provide such clarity, in particular they are free of the chip-gaps arising from the WFI CCD array. One clear point evident from the finding charts is that NGC 330 and NGC 2004 are very compact clusters and that, whilst the FLAMES observations sample some peripheral cluster members, the majority of the targets sample the local field population. Furthermore, the radius of the ionized region in NGC 346 is given by Relaño et al. (2002) as $\sim 3.5 \mathrm{arcmin}$; many of the FLAMES targets are beyond this radius highlighting that, even in this pointing, the observations sample both the cluster and field population.

The N11 region is more complex, with both LH10 (the denser region above the centre in Fig. 15) and LH9 (the relatively "open" cluster just below centre). The $V$-band WFI image is shown in Fig. 17, in false-colour to better highlight the nebulosity. The full complexity of the region is revealed in the original photographic plate from Henize (1956). Star N11-004 is the principal object in N11G, N11-063 and N11-099 are both in N11C, and some of our targets south of LH9 are in N11F. Further insight into the structure of this region is given by the $\mathrm{H} \alpha+[\mathrm{N}$ II] photograph from Malcolm G. Smith published by

[^1]Walborn \& Parker (1992), and from a near-IR image from Dr. R. Barbá (private communication), both of which show a wide variety of arcs and filaments of nebular gas.

Radial velocities ( $v_{\mathrm{r}}$ in $\mathrm{km} \mathrm{s}^{-1}$ ) are given for each star, excepting those that appear to be multiple systems. The measurements here are the means of manual estimates of a number of line centres, as indicated in parentheses in the tables. The primary lines used are generally those of $\mathrm{He} \mathrm{I} ,\mathrm{He} \mathrm{II} \mathrm{and} \mathrm{Si} \mathrm{III} ,\mathrm{with} \mathrm{a} \mathrm{typ-}$ ical standard deviation of the individual measurements around $5-10 \mathrm{~km} \mathrm{~s}^{-1}$. We prefer manual measurements such as these because of the highly variable nebular contamination in a region such as NGC 346 (which may led to spurious results if more automated methods are employed). In a small number of stars with apparently large rotational velocities (or lower signal-tonoise), precise determination of the line centres is more difficult thereby yielding a less certain value, as indicated here using the usual ":" identifier in the tabulated results. The precision of manual measurements may also be biased by the infilling of helium lines, either by nebular contamination in morphologically normal spectra, or by infilling of the lines in Be-type stars; where these effects are obvious we have avoided the relevant lines but naturally there may be cases in which the effects are not so prominent yet affect the (apparent) line centre.

In Tables 4-7 we present stellar radial velocities for each of our targets. In the process of measuring the velocities we find a relatively large number of spectra displaying evidence of binarity. These are shown in the tables as "Binary", with SB1 and SB2 added to indicate single-lined and double-lined binaries where it was possible to identify the nature of the system. Finally, in the comments column of each table we note a small number of stars as "variable $v_{\mathrm{r}}$ ?". In these one or two lines have anomalous velocities, with it unclear whether they arise from binarity.

### 4.1. Cross-references with $X$-ray observations

We have cross-referenced our FLAMES targets in the N11 and NGC 346 fields with the X-ray sources from Nazé et al. (2003, 2004a,b). We find that NGC 346-067 is $\sim 1.9^{\prime \prime}$ from source \#6 in the Nazé et al. (2003) study. In fact, it is the same counterpart suggested by them, i.e. MA93\#1038 (Meyssonnier \& Azzopardi 1993). The tabulated separation between optical and X-ray positions is $0.5^{\prime \prime}$, suggesting a small offset between their astrometric solution and that from the EIS data. Widening our search radius from $3^{\prime \prime}$ to $5^{\prime \prime}$ we find one further potential cross-match: NGC 346-078 (an early B-type binary) is $3.8^{\prime \prime}$ from their source \#17; although in the opposite sense to NGC 346-067 and \#6 and it seems unlikely that this is a valid match.

Similar searches with the XMM-Newton sources reported by Nazé et al. (2004a) in N11, and additional sources in NGC 346 from Nazé et al. (2004b), revealed no further cross-matches with our FLAMES sample, suggesting that none of our observed stars (excepting NGC 346-067) are particularly strong X-ray sources.

## 5. Comments on individual stars

There is a tremendous amount of new spectroscopic information available in our LMC and SMC fields. In nearly all cases the FLAMES spectra offer significantly better-quality data than previously. Also of note is that many stars, particularly in the NGC 330 and NGC 2004 fields, have not been observed before spectroscopically.

In the following sections we discuss spectra with interesting or peculiar morpholgies. In general we do not address the


Fig. 3. Variations in the He iI $\lambda 4686$ line seen in NGC 346-001. The left panel shows exposure HR06/\#02, with the right panel showing HR06/\#08, note that the intensity of the $\mathrm{N}_{\text {II }} \lambda 4634,4640-41$ emission is identical whereas the He it $\lambda 4686$ morphology and intensity differs.
specific details of detected binaries, restricting ourselves to simply indicating their binarity in Tables 4-7. In many cases the FLAMES spectra are sufficient to determine orbital periods and, for some systems, offer an insight into the physical nature of the individual components. A comprehensive treatment of the binary spectra will be presented elsewhere. Emission-line (i.e. Oe and Be) stars are discussed separately in Sect. 6.

### 5.1. NGC 346-001

NGC 346-001 is the well-studied star Sk 80 (Sanduleak 1968), also identified as AzV 232 (Azzopardi \& Vigneau 1975, 1982) and MPG 789. It was classified as O7 Iaf+ by Walborn (1977), with the $\mathrm{f}+$ suffix employed to denote the strong Si IV $\lambda 4116$, N III $\lambda 4634-40-42$, and He II $\lambda 4686$ emission features; indeed, Sk 80 serves as the principal O7 supergiant in the Walborn \& Fitzpatrick (1990) spectral atlas. A detailed atmospheric analysis of a VLT-UVES spectrum of this star was given by Crowther et al. (2002).

Close inspection of the individual FLAMES-Giraffe spectra reveals several features that suggest this object to be a binary. Perhaps the most distinctive of these is shown in Fig. 3. In the first five exposures there is a weak absorption feature in the blueward wing of the He II $\lambda 4686$ emission line (left-hand panel of figure). Compare this to the HR06/\#06, \#07 and \#08 frames in which it is absent, with slightly weaker $\lambda 4686$ emission (right-hand panel). From the same observations, a small shift $\left(\sim 10 \mathrm{~km} \mathrm{~s}^{-1}\right)$ is seen in the He I 24713 line. A similar, though less significant effect to that seen in the $\lambda 4686$ line, is also seen in the blueward wing of the $\mathrm{H} \alpha$ profile (we do not consider the core intensity given the problems of nebular subtraction). Inspection of the spectra from the HR05 observations (which also include He II 14542 ) reveals a shift of $\sim 10 \mathrm{~km} \mathrm{~s}^{-1}$ between the two epochs, which is also mirrored in the He I $\lambda 4471$ line. That these shifts are seen in the mainly photospheric He I features suggests there is a companion and that we are not seeing evidence of wind variability.

Compared to the VLT-UVES data from Crowther et al., the resolving power from the high-resolution mode of FLAMESGiraffe is roughly a factor of two lower, but the signal-to-noise of the new spectrum is $\sim 400$. Aside from consideration of binarity, we note the presence of two weak emission lines that we


Fig. 4. The HR06 observations of NGC 346-013. The spectra from the two epochs have been co-added, and then 11-pixel median filtered to aid clarity. Identified lines are Si III $\lambda \lambda 4552-68-75 ; \mathrm{N}$ III $\lambda \lambda 4634,4640-42$; С III $\lambda 4650$; Не II $\lambda 4686$; He I $\lambda 4713$. The vertical dotted lines highlight the wavelengths of the He I and II lines in the second batch of observations; these are seen to move in an opposite sense between epochs.
attribute to N III, with rest wavelengths of $\lambda 3938.5$ and $\lambda 4379.0$ (Dr. F. Najarro, private communication). Upon reinspection of the UVES spectrum from Crowther et al. these features can also be seen, but are less obvious due to the inherent problems associated with blaze removal etc. The $\lambda 4379.0$ line can also be seen in the high-resolution spectrum presented by Walborn et al. (1995), although there are some comparable artifacts nearby; the line is also seen in emission in AzV 83 (Walborn et al. 2000).

### 5.2. NGC 346-007

High-resolution optical spectra of NGC 346-007 (MPG 324) have been published by Walborn et al. (1995, NGC346\#6) and Walborn et al. (2000). In the FLAMES spectrum the Si IV $\lambda 4116$ feature is very weakly in emission (such that it was within the noise level of previous spectra) and therefore the Walborn et al. classification of $\mathrm{O} 4 \mathrm{~V}(\mathrm{f})$ ) is revised slightly to $\mathrm{O} 4 \mathrm{~V}((\mathrm{f}+\mathrm{)})$ to reflect this. Small radial velocity shifts are seen in some lines in the spectra of NGC $346-007$ (of order $20-30 \mathrm{~km} \mathrm{~s}^{-1}$ ) suggesting it as a single-lined binary.

### 5.3. NGC 346-013

This object is one of the most intriguing in the FLAMES survey. At first glance the spectrum is that of an early B-type star with a spectral type of B1 or B1.5, but there is also anomalous absorption from He II $\lambda 4686$. Inspection of the individual spectra reveals significant velocity shifts in the He I and Si III absorption lines, with a maximum amplitude over the time coverage of the FLAMES observations of approximately $400 \mathrm{~km} \mathrm{~s}^{-1}$. Other lines such as the C III and N III blends move in the same sense. Interestingly, the He II $\lambda 4686$ moves in the opposite sense to the other features and with a smaller amplitude, suggesting that it is the more massive object in the system (and presumably hotter by virtue of the 4686 line). These features are illustrated in Fig. 4.

We lack other diagnostics of the companion associated with the He II $\lambda 4686$ feature in the current data. The He I $\lambda 4471 \mathrm{ab}-$ sorption appears to be marginally double-lined in the first three HR05 observations, but it is within the noise level preventing accurate characterization. No strong absorption is seen from He II


Fig. 5. Two early O-type stars: N11-026 and NGC 2004-049. The lines identified in N11-026 are, from left to right, N IV $\lambda 4058$; Si iv 4089-4116; $\mathrm{N} v \lambda \lambda 4604-4620 ; \mathrm{N}$ III $\lambda \lambda 4634-4640-4642$. For clarity the spectra have been smoothed by a $1.5 \AA$ FWHM filter.
$\lambda 4542$ in the HR04 data suggesting a narrow temperature range for the companion. We note that NGC 346-013 does not appear in the X-ray catalogue of Nazé et al. (2003). A more detailed treatment of its orbital properties will be presented elsewhere. Further spectroscopic monitoring of this object is clearly a high priority.

### 5.4. NGC 346-026, \& NGC 346-028

High-resolution echelle spectra of NGC 346-026 (MPG 012) and NGC 346-028 (MPG 113) were presented by Walborn et al. (2000), with a detailed discussion of their morphologies. For NGC 346-028 we adopt the Walborn et al. classification of OC6 Vz. In the case of NGC 346-026 we prefer the unique classification of $\mathrm{B} 0(\mathrm{~N}$ str), over the $\mathrm{O} 9.5-\mathrm{B} 0(\mathrm{~N}$ str) from Walborn et al. The line that is least consistent with a B0-type is He II 14200, which is marginally stronger in NGC 346-026 than in $v$ Ori, the B0 V standard (Walborn \& Fitzpatrick 1990) - given the " N str" remark, perhaps part of the explanation for this lies with a stronger $\lambda 4200 \mathrm{~N}$ III line. Interestingly, the Si IV lines in the spectrum are in reasonable agreement with those in $v$ Ori, which is surprising given the lower metallicity of the SMC. This point strengthens the suggestion by Walborn et al. that luminosity class IV might be more befitting of the star, a priori of the luminosity and gravity results found by Bouret et al. (2003). Thus, we classify the star as B0 IV (N str).

### 5.5. N11-020

The spectrum of N11-020 displays broad, asymmetric $\mathrm{H} \alpha$ emission, combined with strong N III $\lambda 4634-41$ and He II $\lambda 4686$ emission. Such morphology is similar to that seen in $\zeta$ Pup (Walborn \& Fitzpatrick 1990). The FLAMES spectrum appears slightly cooler than $\zeta$ Pup, resulting in the classification of $\mathrm{O} 5 \mathrm{I}(\mathrm{n}) \mathrm{f}^{+}$. There are clear variations in both the $\mathrm{H} \alpha$ and He II $\lambda 4686$ lines, which could be indicative of wind variability. However, close inspection of other lines such as He II $\lambda 4542$ and $\mathrm{H} \delta$ reveal subtle morphological changes indicative of a companion, suggesting that N11-020 is a further binary.

### 5.6. N11-026, N11-014 \& N11-091

The spectrum of N11-026 is shown in Fig. 5 and is between the O2 and O3-type standards published by Walborn et al. (2002, 2004). Thus we employ an intermediate type of O2.5 III(f*). N11-026 is $\sim 4.5^{\prime}$ to the north of LH10 (see Fig. 15) and the photograph of N11 from Walborn \& Parker (1992) shows a likely ionization front just to the east of the star. In fact, the FLAMES targets adjacent to \#026 offer a good illustration of the rich starformation history of the region. Cross-matching our targets again with the image from Walborn \& Parker (1992), N11-014 (to the west of \#026) is a B2 supergiant in a more rarefied region, and N11-091 is an O9-type spectroscopic binary (with what appears to be a B-type secondary) lying in a dense knot of gas.

N11-026 has the third largest velocity in the N11 targets, with $v_{r}=330 \mathrm{~km} \mathrm{~s}^{-1}$ (with standard deviation, $\sigma=5$ ). The median result for the N11 stars with measured radial velocities is $295 \mathrm{~km} \mathrm{~s}^{-1}$ suggesting N11-026 as a run-away object, cf. the usual critierion of $\Delta v_{r} \sim 40 \mathrm{~km} \mathrm{~s}^{-1}$ (Blaauw 1961). N11-026 is $\sim 1^{\prime}$ away from N11-091, which at the distance of the LMC corresponds to $\sim 14 \mathrm{pc}$. An ejected young star could conceivably cover this distance in its short lifetime (such arguments are discussed in their definition of a field star by Massey et al. 1995). Indeed, in 2 Myr the star may have even travelled the $\sim 70 \mathrm{pc}$ from the northern edge of LH10.

### 5.7. N11-028

N11-028 is the primary star of N11A, a well-studied nebular knot to the north-east of LH10 (N11B). Heydari-Malayeri \& Testor (1985) suggested that the principal source of ionization was a star with $T_{\text {eff }} \sim 44000 \mathrm{~K}$, i.e. an O-type star. This was confirmed by P92, who found an embedded primary (their star 3264) with two faint companions. P92 show the spectrum of 3264 in their Fig. 5, classifying it as O3-6 V. The uncertainty in the classification arises from the strong nebular emission in the spectrum, as one would expect from the near-IR study by Israel \& Koornneef (1991) who concluded that N11A was dominated by such emission.

More recently, impressive images of N11A from the Wide Field Planetary Camera 2 (WFPC2) on the Hubble Space Telescope were published by Heydari-Malayeri et al. (2001). Their imaging (see their Fig. 2) revealed at least five objects in


Fig. 6. The FLAMES spectrum of the principal star in N11A. The He II lines identified are, from left to right, $\lambda \lambda 4200$, 4542, 4686; the two strongest He I lines at $\lambda \lambda 4026,4471$ are also labelled. Although the nebular spectrum somewhat dominates, there is strong absorption seen in both He lines, necessitating a later spectral type than that adopted by Parker et al. (1992). For clarity the spectrum has been smoothed using a 7-pixel median filter.
the core of N 11 A , which they labelled as numbers 5 to 9 . Their star \#7 was the brightest with Strömgren $v=14.59$, with three of the others ( 5,6 , and 9 ) fainter than 18th magnitude.

In the WFI imaging used to select our FLAMES targets, N11A appears as an unresolved, dense blob, with the fibre placed on the bright core. Our photometric methods here are relatively simple and were primarily concerned with target selection. The multiplicity in N11A, combined with the effects of the nebulosity, highlight that a more tailored photometric analysis is warranted for a star such as this, beyond the scope of our programme (and imaging). As such, the quoted magnitude in Table 6 is brighter than that given by P92 and Heydari-Malayeri et al. (2001).

The MEDUSA fibres used with FLAMES have an onsky aperture of $1.2^{\prime \prime}$. From comparisons with the figure from Heydari-Malayeri et al., it is likely that the MEDUSA fibre was not centered perfectly on the principal star (owing to the resolution of the WFI image). It is also possible that the FLAMES spectrum may include some contribution from their star \#8, which is two magnitudes fainter than the primary.

The FLAMES spectrum of N11-028/Parker 3264 is shown in Figure 6, and is classified here as 06-8 V, cf. O3-6 V from P92. We see no obvious evidence of binarity, or of other features from a possible companion. The absorption at He I $\lambda 4026$ is larger than that seen in He II $\lambda 4200$, thereby requiring a spectral type of O6 or later. The uncertainty in the current classification arises because of the He I $\lambda 4471$ line, in which the degree of infilling is unclear. Obviously such a revision of spectral type will have a significant effect on the perceived ionizing flux in the nebula. Indeed, Heydari-Malayeri et al. (2001) concluded that an O7.5 or O8 main-sequence star could account for the observed ionization, commensurate with our classification. One interesting feature is the weak Mg II $\lambda 4481$ absorption sometimes seen in mid O-type spectra (e.g. Morrell et al. 1991), attributed by Mihalas (1972) to deviations from the assumptions of local thermodynamic equilibrium, i.e. non-LTE effects.

### 5.8. N11-038

There is a striking similarity between the spectrum of this star and that of AzV 75 in the SMC (Walborn et al. 2000), with
the spectrum here classified as $\mathrm{O} 5 \mathrm{III}(\mathrm{f}+$ ). Interestingly this star was observed by P92 (their star 3100) and classified as "O6.5 $\mathrm{V}((\mathrm{f})): "$. The FLAMES data shows strong He II absorption at $\lambda 4200$, cf. the P92 spectrum in which it is relatively weak. The relative ratio of He I $\lambda 4471$ to He II $\lambda 4542$ also appears different in the P92 spectrum in comparison to the FLAMES data; although we see no evidence for binarity in our spectra, variability of this object cannot be ruled out.

N11-038 and AzV 75 are shown together in Fig. 7. Note the very weak N IV emission feature in N11-038, also consistent with an early O-type classification. The stronger N III emission and weaker He II $\lambda 4686$ absorption in AzV 75 suggest a more luminous star than N11-038, and these are bourne out by the brighter $V$ magnitude (taking into account the different distances and reddening). However we argue that both stars fall into the same morphological bin, cf. the standards in Walborn \& Fitzpatrick (1990).

### 5.9. N11-040

Classification of this spectrum was relatively difficult, resulting in a final type of B0: IIIn. There is apparent emission at the edge of both wings in the $\mathrm{H} \alpha$ profile. There are also indications of binarity, with the He II lines appearing to have a slightly larger radial velocity than the other features, although the broadened lines make precise measurements very difficult.

### 5.10. N11-045

Classified here as O9-9.5 III, the hydrogen and helium spectrum of N11-045 is very similar to that of $\iota$ Ori (O9 III) from Walborn \& Fitzpatrick (1990). However, we do not rule out a later O9.5 type; very weak Si III absorption is seen and the Si IV lines are slightly stronger than one would expect at O9, especially when one considers the reduced metallicity of the LMC.

### 5.11. NGC 2004-049

The spectrum of NGC 2004-049 is shown in Fig. 5 and is classified here as O2-3 $\mathrm{III}\left(\mathrm{f}^{*}\right)+\mathrm{OB}$; the spectrum is very similar to that of LH10-3209 (Parker et al. 1992; Walborn et al. 2002). The


Fig. 7. The FLAMES spectrum of N11-038 compared with that of AzV 75 in the SMC, taken from Walborn et al. (2000). The lines identified are the same as in Figs. 5 and 6. For clarity the spectra have been smoothed by a $1.5 \AA$ FWHM filter.

N IV emission has a greater intensity than the N III lines, necessitating an early type of O2-3 for the primary. The secondary component in NGC 2004-049 appears cooler than in LH10-3209, with the He I $\lambda 4471$ absorption greater than that from He II $\lambda 4542$. Given the relatively weak He II $\lambda 4686$ in the composite spectrum, one can speculate there the secondary does not contribute significantly to this line and that the companion is of early B-type.

### 5.12. NGC 2004-057

Some 5' east of the cluster, NGC 2004-057 (Brey 45; Breysacher 1981) is a Wolf-Rayet star classified as WN4b by Smith et al. (1996), in which the "b" denotes broad emission at He II $\lambda 4686$. Given the broad nature of the emission features, and the relatively short spectral range of each Giraffe wavelength-setting, it is not possible to rectify the data for NGC 2004-057 reliably. However, we retain the star in Table 7 as it highlights interesting objects found in the field. The FLAMES data appear to reveal small changes in the structure of emission lines such as He $\lambda 4542$, perhaps indicative of wind variability.

## 6. Emission-line stars

### 6.1. Be-type stars

The $\mathrm{H} \alpha$ profile of NGC 346-023 has asymmetric, double-peaked emission, with infilling in the other Balmer lines. The absorption spectrum suggests a fairly hot star and is classified as B0.2. Of particular note are numerous Fe II emission lines, together with emission from other metallic species, e.g. Mg II ( $\lambda 4481$ ) and Si II $(\lambda \lambda 6347,6371)$. The $\lambda 4300$ to $\lambda 4700 \AA$ region of its spectrum is shown in Fig. 8. Permitted emission lines from Fe II are a well-known phenomenon in some Be-type stars (e.g. Wellmann 1952; Slettebak 1982), with more than a dozen found in the Magellanic Clouds by Massey et al. (1995). The most striking example of these stars in the FLAMES survey is NGC 346023. Also shown in Fig. 8 is another example, NGC 346-060, in which twin-peaked emission lines are seen, likely indicating a different viewing angle. Spectra with Fe II in emission are identified in Tables 4-7 as "Be-Fe". The interesting Oe-type star, N11-055 (see Sect. 6.3) is also shown in Fig. 8.

Prompted by the recent study in NGC 2004 by Martayan et al. (2006) we measured the equivalent widths of $\mathrm{H} \alpha$ emission, $E W(\mathrm{H} \alpha)$, for each of the Be-type FLAMES spectra. These values were then compared with the presence or absence of Fe II emission. Given the problems of nebular subtraction with multifibre data (which introduces a variable uncertainty, proscribing precise measurements in Be-type stars), we do not tabulate the $E W(\mathrm{H} \alpha)$ values, and limit ourselves to a general discussion of the results. Hanuschik (1987) reported $E W(\mathrm{H} \alpha)=7 \AA$ as the minimum for Fe II to be seen in Galactic Be stars. With the lower metallicity in the Clouds one might expect to find that the $E W(\mathrm{H} \alpha)$ threshold for Fe II emission increases. Martayan et al. (2006) find that Fe II emission is seen in their LMC targets when $E W(\mathrm{H} \alpha)>20 \AA$, with the inference that this higher threshold reflects the metallicity difference.

In our NGC 346 and NGC 330 fields we find the threshold for Fe II emission is $E W(\mathrm{H} \alpha)>15-20 \AA$, above which Fe II emission is seen in all stars (except in NGC 346-045). Below this threshold Fe II emission lines are not seen except in NGC 330$031[E W(\mathrm{H} \alpha)=8.5 \AA( \pm 1)]$ which has very weak Fe II emission at $\lambda \lambda 4549,4556$, and 4584 . Five of the six Be stars in N11 have Fe II emission lines (N11-056 is the exception with very weak, double-peaked $\mathrm{H} \alpha$ emission). Four of these five stars have $E W(\mathrm{H} \alpha)>20 \AA$, with the fifth, N11-078, having $E W(\mathrm{H} \alpha) \sim 4 \AA$ (although as in NGC 330-031, the Fe II features are very weak). Lastly, in NGC 2004 both NGC 2004-023 and NGC 2004-035 have strong (i.e. $E W>20 \AA$ ) $\mathrm{H} \alpha$ emission, accompanied by Fe II. Again we find one star (NGC 2004-025) with $E W(\mathrm{H} \alpha)$ below $20 \AA$ (in this case $\sim 12.5 \AA$ ) with very weak Fe II emission.

In summary, Fe II is seen in emission in most stars for which $E W(\mathrm{H} \alpha)>15 \AA$; a strong $\mathrm{H} \alpha$ emission profile does not guarantee Fe II emission, but it is very probable. Also, the threshold isn't completely exclusive, below it we see weak (but clear) emission in the stronger Fe II lines in three stars. Following this investigation of the LMC and SMC spectra, we revisited the 12 Be-type stars from Paper I to check for Fe II emission. In Paper I we did not pay particular attention to Fe II emission, apart from in the Herbig-type star 6611-022. In fact, there are three stars from Paper I with $E W(\mathrm{H} \alpha)>20 \AA$ (3293-011, 4755-014, and 4755$018)$ and Fe II emission is seen in each of these. There are two further stars with moderate $\mathrm{H} \alpha$ emission, 6611-010 and 6611028 , for which $E W(\mathrm{H} \alpha)=15.5$ and $13.5 \AA( \pm 1)$ respectively.


Fig. 8. Examples of Be/Oe-type spectra with Fe II emission lines. The Fe II lines identified in NGC $346-023$ are $\lambda \lambda 4491,4508,4515$, 4520, 4523, $4549,4556,4584$, and 4629 . For clarity the spectra have been filtered by a 7 -pixel median filter and to ease the comparison between SMC and LMC spectra they are corrected for their tabulated radial velocities to rest wavelengths.

There appears to be very weak Fe II emission in both of these spectra, analogous to the stars with moderate $\mathrm{H} \alpha$ emission in our LMC and SMC sample. The weak emission in 6611-010 (W503, Walker 1961) was also noted by Hillenbrand et al. (1993), leading to their classification of the spectrum as a Herbig-type object.

With the benefit of new instrumentation and detectors we can detect Fe II emission that may have gone un-noticed previously. It seems clear that irrespective of environment, if $E W(\mathrm{H} \alpha)>$ $20 \AA$, it is very probable that Fe II emission will also be observed. The statement from Hanuschik (1987) was that "one should not expect to find notable amounts of Fe II emission for stars with $E W(\mathrm{H} \alpha)<7 \AA$ ". This remains true and, if anything, should be revised upwards slightly, depending on one's definition of "notable". However, we dispute the claim by Martayan et al. (2006) that their observations in NGC 2004 display the expected offset arising from the lower metallicity - although we have not measured the intensity of the Fe II emission, we see no obvious trend with metallicity for the presence of Fe II emission.

Given that both NGC 346 and N11 are relatively young regions it does suggest the question of whether these stars are classical Be-type stars, or are they associated with younger (pre-main-sequence) objects. Indeed, the cores of both regions are younger than the 10 Myr threshold given by Fabregat \& Torrejon (2000) for classical Be-type stars to form.

In NGC 346 the three Be-Fe stars closest to the centre of the cluster are NGC 346-023, 036 and 065, all of which are on the periphery of the central ionized region (see Figure 13). Similarly in N11, the Be-Fe stars are not in the obviously dense star-forming regions. Given that also we find such stars in the NGC 2004 and NGC 330 pointings (that sample the more general field population) it seems most plausible that the Be-Fe stars are associated with classical Be-types, rather than younger objects. However, it should be noted that Mokiem et al. (2006) find evidence for coeval O-type stars beyond the ionized region in NGC 346 - detailed analysis of the $\mathrm{Be}-\mathrm{Fe}$ stars is required to test whether those in the NGC 346 field are actually coeval with the young O-stars, or whether they are older.

### 6.2. Shell stars

In Fig. 9 we show the spectrum of NGC 346-048, which permits an elegant comparison with NGC 346-023. The H $\alpha$ profile of NGC 346-048 is double-peaked, leading to moderate "shell" effects in the $\mathrm{H} \gamma$ line shown in Fig. 9. Such a spectrum is thought to originate from absorption by a cooler disk in front of the star (e.g. Hanuschik 1995; Hummel \& Vrancken 2000) and also leads to the Fe II absorption seen in the figure, uncharacteristic of a star classified as B3-type and more comparable to those seen in the sharp-lined, A0 II spectrum of NGC 346-014. Note the weak emission in the wings of the $\lambda 4584$ Fe II line in NGC 346-048. Similar absorption from Fe II is also seen in NGC 330-093, although the signal-to-noise of the data is lower given the fainter magnitude of the star.

### 6.3. Oe-type stars

### 6.3.1. N11-055: An "Oe-Fe" star

This star has a very complex spectrum, a section of which is shown in Fig. 8. Emission is seen in all of the observed Balmer lines, and most of the He I lines are infilled by a twin-peaked profile (e.g. 14026 ), with the $\lambda 4713$ line seen solely in (twinpeaked) emission. A large number of Fe II emission lines are also seen. We find no strong evidence for binarity, with all the features apparently consistent with one radial velocity; the mean radial velocity from the 3 He II lines is $293 \mathrm{~km} \mathrm{~s}^{-1}$. We classify the star here as 07-9 IIIne, with the uncertainty in spectral type arising due to the significant infilling in the He I lines. Assuming that there is no significant companion, the intensity of the $\lambda 4200$ and $\lambda 4542 \mathrm{He}$ II lines suggests that the later-type is most likely the best description of the spectrum. Also, the He II $\lambda 4686$ line appears too weak for the star to be classified as a dwarf, hence the adoption of class III.

In a sense, this star appears as a much less extreme version of iron stars such as HD 87643 (Walborn \& Fitzpatrick 2000). However, the iron stars tend to show strong P Cygni features in


Fig. 9. A comparison of Be-type stars with Fe II emission and absorption lines. The Fe II lines identified are the same as in Fig. 8, and the spectra have also been filtered by a 7-pixel median filter. The spectrum of NGC 346-014 is included to highlight that the Fe iI lines are indicative of a much cooler temperature, comparable to that seen in early A-type stars.
some of their lines, which are not seen here. The $\mathrm{H} \alpha$ emission in N11-055 is strong and symmetric, suggesting this star might be more closely related to Be-type stars, with HD 155806 a likely Galactic counterpart (Walborn 1980).

### 6.3.2. NGC 346-018

NGC 346-018 (MPG 217) is classified as O9.5 IIIe. The spectrum displays very strong and broad $\mathrm{H} \alpha$ emission, with the higher-order lines of the Balmer series somewhat in-filled. The He I 16678 line is strongly in emission and there is evidence of significant infilling in He I $\lambda 4471$ (and perhaps other He I lines in the blue region); we have taken this into account when classifying the spectrum, as discussed by Negueruela et al. (2004).

### 6.3.3. NGC 330-023

The spectrum of NGC 330-023 has strong, broad $\mathrm{H} \alpha$ emission, with an equivalent width of $28 \pm 3 \AA$ (with the uncertainty arising from the rectification in the wings of the emission). It's conceivable that part of this emission may be nebular in origin, but the absence of [ N II] emission suggests that the majority is intrinsic to the star. The blue-region spectrum is particularly interesting, with He II absorption lines consistent with a late O-type star. It is difficult to assign a precise classification due to significant infilling of the He I lines; however from intensity of the He II lines we classify the star as approximately O9-type. Of note (see Fig. 10) is the twin-peaked emission seen in both He I $\lambda 4471$ and 14713. The luminosity class is harder to ascertain, with a final classification of O9 V-IIIe adopted.

Prior to the new HR03 spectra obtained in 2005, radial velocity measurements were limited to the three He II lines, with a mean value of $159 \mathrm{~km} \mathrm{~s}^{-1}$ (with standard deviation, $\sigma=10$ ), and with two of the lines included in the same wavelength setting. Inspection of the spectra acquired in 2005 reveal significant variations in the asymmetric $\mathrm{H} \delta$ emission feature, as shown in Fig. 11. With no obvious radial velocity shifts seen in other lines,
such differences resemble the $\mathrm{V} / \mathrm{R}$ (violet/red) variability seen in Be-type stars, suggested by Hanuschik et al. (1995) as arising from oscillations in the disk. Hummel et al. (2001) studied Betype stars in NGC 330 to see if this phenomenon was metallicity dependent as theory would suggest, but found that the fraction of stars undergoing disk oscillations was comparable to that in Galactic targets. We note that NGC 330-023 is the photometric variable \#95V reported by Sebo \& Wood (1994), with the variability presumably arising from changes such as those reported here.

## 7. Compilation of previous spectroscopy

For completeness, in Table 8 the FLAMES classifications presented here are compared with previous types. Published classifications are included from: W77 (Walborn 1977); FB80 (Feast \& Black 1980); CJF85 (Carney et al. 1985); NMC (Niemela et al. 1986); G87 (Garmany et al. 1987); MPG (Massey et al. 1989); F91 (Fitzpatrick 1991); P92 (Parker et al. 1992); L93 (Lennon et al. 1993); M95 (Massey et al. 1995); G96 (Grebel et al. 1996); HM00 (Heydari-Malayeri et al. 2000); W00 (Walborn et al. 2000); L03 (Lennon et al. 2003); EH04 (Evans et al. 2004). Note that we do not include published types from objectiveprism spectroscopy, preferring to limit our comparisons to long-slit/multi-object observations.

With the benefit of the high-quality FLAMES spectra, many of the classifications from Evans et al. (2004) are now refined. There are few significant differences between the FLAMES classifications and those extant in the literature. Two stars (N11-028 and N11-038) have already been discussed in Sect. 5 - one further target worthy of comment is N11-080 which appears to be comprised of two late-type O stars from the FLAMES data, compared to the O4-6 V classification from P92. This is not surprising given that P 92 had noted the spectrum as a possible composite object.


Fig. 10. A section of the blue-region spectrum of NGC 330-023, highlighting the double-peaked emission in the He I lines at $\lambda 4471$ and $\lambda 4713$. The lower spectrum is at full-resolution, but has been filtered to remove cosmic rays using a 7 -pixel median filter. The upper spectrum has been smoothed with a $1.5 \AA$ FWHM filter. The lines marked in the lower spectrum are He I $\lambda 4388$, and He II $\lambda \lambda 4542,4686$.


Fig. 11. Co-added spectra of NGC 330 - 023 from the two epochs of HR03 observations. Both spectra have been 7 -pixel median filtered for clarity. Note the change in structure of the emission at $\mathrm{H} \delta$, and the apparent wavelength invariance of the (albeit broadened or infilled) He I $\lambda 4143$ line.

## 8. Discussion

In Table 2 we give an overview of the entire sample in the FLAMES survey, incorporating the LMC and SMC observations reported here, with the Galactic data from Paper I. Analysis of many of these data is now well advanced by different groups. Here, with the benefit of a broad view of the whole sample, we discuss some of the more general features of the survey.

### 8.1. H-R diagrams for each of the fields

In Fig. 12 we show Hertzsprung-Russell (H-R diagrams) for each of our LMC and SMC fields. These have been compiled by employing various published calibrations - clearly the detailed studies of different subsets of the survey will yield precise
determinations of temperatures and luminosities, but we take the opportunity now to show the full extent of the LMC/SMC stars in the H-R diagram. Objects listed as likely foreground objects are plotted as open circles, likely binaries as " + ", and emissionline objects as triangles. For illustrative purposes the evolutionary tracks shown are from Schaerer et al. (1993) for the LMC targets and from Charbonnel et al. (1993) for the SMC.

Temperatures were adopted on the basis of spectral type, luminosity and metallicity from Massey et al. (2005, O-type stars), Crowther et al. (2006, B-type supergiants), Evans \& Howarth (2003, A-type superigants), and Schmidt-Kaler (1982, for other types). Objects that have luminosity classes of III or V were assigned temperatures from calibrations for dwarfs; more luminous stars (i.e. II, Ib, Iab and Ia) adopted temperatures from calibrations of supergiants. With no metallicity-dependent

Table 2. Overview of the distribution of spectral types of the FLAMES survey, including the Galactic clusters from Paper I.

| Field | O | Early-B <br> (B0-3) | Late-B <br> (B5-9) | AFG | Total |
| :--- | :--- | :--- | :--- | :--- | :--- |
| MW: NGC 3293 | - | 48 | 51 | 27 | 126 |
| MW: NGC 4755 | - | 54 | 44 | 10 | 108 |
| MW: NGC 6611 | 13 | 28 | 12 | 32 | 85 |
| SMC: NGC 330 | 6 | 98 | 11 | 10 | 125 |
| SMC: NGC 346 | 19 | 84 | 2 | 11 | 116 |
| LMC: NGC 2004 | $4(+1$ WR) | 101 | 6 | 7 | 119 |
| LMC: N11 | 44 | 76 | - | 4 | 124 |
| Total | 87 | 489 | 126 | 101 | 803 |



Fig. 12. H-R diagrams for the four FLAMES fields in the Magellanic Clouds. Open circles denote foreground stars, open triangles are emissionline objects, and likely binaries are indicated with crosses. The evolutionary tracks are taken from Schaerer et al. (1993) for N11 and NGC 2004, and from Charbonnel et al. (1993) for NGC 330 and NGC 346.
temperature scale in the literature for early B-type supergiants, temperatures were taken from the Galactic results (Crowther et al. 2006), which were found to be in good agreement with those from analysis of individual stars in the SMC (Trundle et al. 2004; Trundle \& Lennon 2005).

Luminosities were calculated using intrinsic colours from Fitzgerald (1970), extrapolating or interpolating where required; bolometric corrections were calculated using the relations from Vacca et al. (1996) for the earliest types, and from Balona (1994) for the cooler stars; the ratio of total to selective extinction $(R)$ in
the LMC was taken as 3.1 (e.g. Howarth 1983) and as 2.7 in the SMC (Bouchet et al. 1985); distance moduli were taken as 18.5 to the LMC (e.g. Gibson 2000) and 18.9 to the SMC (Harries et al. 2003).

Figure 12 highlights the predominantly less-massive populations observed in the two older clusters (i.e. NGC 2004 and NGC 330), particularly when compared to N11. The N11 observations also sample a more luminous, more massive population than those in NGC 346. This is, in part, influenced by the fact that some of the O-type stars observed by Walborn et al. (2000)
were explicitly avoided in the FLAMES survey as state-of-theart analyses have already been presented in the literature (e.g. Bouret et al. 2003).

### 8.2. Exploring new regions of N11

As mentioned earlier, part of our intention in the FLAMES observations was to explore some of the less dense, apparently star-forming regions in N11. In addition to the discovery of the O2.5-type star to the north of LH10, the survey has revealed a large number of O-type stars in the regions surrounding LH9 and LH10. In Fig. 17 we show the $V$-band WFI image used for target selection in N11, with the O- and B-type stars marked in different colours; LH9, LH10 and LH13 are also identified in the image. Note the O-type stars to the south of LH9, newly discovered by this survey. These include N11-020 [classified as O5 $\mathrm{I}(\mathrm{n}) \mathrm{f}+\mathrm{]}$ on the northern edge of the N11F region (cf. Fig. 15).

Furthermore, N11-004 [O9.7 Ib] is the bright star in N11G, and $\mathrm{N} 11-058[\mathrm{O} 5.5 \mathrm{~V}((\mathrm{f}))]$ is one of two visually bright stars in N11I, the other being N11-102 [B0.2 V]. Both N11G and N11I appear as small "bubbles" in near-IR images, presumably driven by the ionization and/or the stellar winds from these stars. We have also observed N11-029 [OC9.7 Ib] in N11H, which appears radially smaller than N11G and N11I.

The densest regions in N11, i.e. N11B (LH10) and N11C (LH13) have been demonstrated by other authors (Parker et al. 1992; Walborn \& Parker 1992; Heydari-Malayeri et al. 2000; Barbá et al. 2003) to have rich, young populations of early-type stars. The general consensus is that this region is a two-stage starburst, with the evolution of LH9 triggering star-formation around it. For the first time the FLAMES survey has observed the regions to the south and west of LH9 - whilst much smaller in size and stellar content, we find newly discovered O-type stars as the likely source of ionization and dynamic energy for the observed nebulae.

To place this region in context, the "bigger picture" is dramatically illustrated by the cover image of Edition \#80 of the National Optical Astronomy Observatory/National Solar Observatory (NOAO/NSO) Newsletter. This features an image of N11 from the Magellanic Clouds Emission Line Survey (credited to Drs. S. Points, C. Smith, and M. Hanna). In addition to N12, N13, and N14, the image includes the significantly extended shell of gas that constitutes N10 from Henize (1956).

## 8.3. "Blue stragglers" in NGC 330

Blue stragglers were reported in NGC 330 by Lennon et al. (1993), with Grebel et al. (1996) arguing that they might be a product of binary evolution. Blue stragglers are thought to arise from either mass-exchange or stellar mergers (e.g. Pols \& Marinus 1994), with recent studies of globular clusters suggesting that both channels play a role (Davies et al. 2004). Six of our targets in the NGC 330 observations are late O-type stars, three of which are less than $5^{\prime}$ from the centre of the cluster: NGC 330023 (see Sect. 6.3.3), NGC 330-049, and NGC 330-123.

In particular, NGC 330-123 (R74-B18) is classified here as O9.5 V, cf. B0 Ve from Lennon et al. (1993) and O9 III/Ve from Grebel et al. (1996, who were quoting unpublished types from Lennon). Narrow (and weak) emission is seen in the core of the $\mathrm{H} \alpha$ Balmer line in the UVES spectrum of NGC 330-123, but is accompanied by [ N II] emission so the origins are likely nebular. Indeed, Keller \& Bessell (1998) note that there is an elliptical region of diffuse nebular emission centred on this star,
it would appear that NGC 330-123 is the ionization source of this nebulosity. Interestingly, the radial velocity of NGC 330123 is $177 \mathrm{~km} \mathrm{~s}^{-1}$ (with standard deviation, $\sigma=5$ ), i.e. different from the systemic velocity of the cluster which is $\sim 155 \mathrm{~km} \mathrm{~s}^{-1}$ (e.g. Lennon et al. 2003). Binarity is a possible explanation of this difference, but additional spectra at other epochs (October 1992 and October 1995), though of lower resolution, are in good agreement with the FLAMES data. If this star is coeval with the cluster then its current radial velocity might indicate a previous, though relatively recent ejection event. Its radial velocity however is similar to the three more distant O-type stars in the NGC 330 field: NGC 330-013, NGC 330-046 and NGC 330-052, which have $v_{\mathrm{r}}=176,177$ and $166 \mathrm{~km} \mathrm{~s}^{-1}$ respectively. Two of these, NGC 330-013 and NGC 330-052, are found to be helium rich (Mokiem et al. 2006), whilst NGC 330-123 has also been reported as helium rich by Lennon et al. (1993, note that this paper erroneously refers to R74-A01 as helium rich, when it should actually refer to R74-B18, i.e. NGC 330-123). All four stars could perhaps be considered as members of the general field population which, from the H-R diagram (Fig. 12), can be seen to extend well beyond the notional cluster turn-off - as represented by the $\sim 20$ stars with spectral types earlier than B1. We note that the majority of these stars have radial velocities rather different from the cluster radial velocity, suggesting that the probable number of true blue stragglers in this field belonging to NGC 330 is small.

Both NGC 330-023 and NGC 330-049 are late O-type stars with velocities consistent with the cluster (cf. Lennon et al. 2003), although the pecularities of NGC 330-023 have already been discussed in Sect. 6.3.3. At respective radial distances of $2.3^{\prime}$ and $4.5^{\prime}$ they are not immediately proximate to the cluster core, but are perhaps outer members of the cluster and therefore could be true blue stragglers.

The situation for NGC 2004 is qualitatively similar to that of NGC 330. The Wolf-Rayet and O2-3 stars stand out as potential blue stragglers but are more likely field stars, though the presence of an O2-3 star in the field is unusual in itself. One further candidate blue straggler is NGC 2004-019, which is close to the core, with $r_{\mathrm{d}}=1.5^{\prime}$.

### 8.4. Incidence of Be-stars

The numbers of Be-type stars in each FLAMES pointing are summarised in Table 3. The observed field-population of B- and Be-type stars in our NGC 330 and NGC 2004 pointings should be relatively unaffected by specific selection effects (Sect. 2.4), aside from the slightly different $\left(\sim 0.5^{\mathrm{m}}\right)$ faint cut-off of the observations.

The Be stars in Table 3 include some in the outer regions of the clusters themselves. As an experiment, we considered the B-type stars with $r_{\mathrm{d}}>2^{\prime}$ in NGC 330 and NGC 2004 to sample the field population away from the main clusters. All stars in the range B0-3 were counted and then the relative percentage of those that are seen to be Be-type stars was found. In NGC 2004 this ratio for the field population (i.e. $\mathrm{Be} /[\mathrm{Be}+\mathrm{B}]$ ) was $16 \%$ (13/81), compared to $23 \%$ (18/77) in NGC 330. It is difficult to quantify the uncertainties in these results. Is there any effect in terms of absolute magnitude? As a further experiment (and still with the $r_{\mathrm{d}}>2^{\prime}$ condition) we considered the early B-type stars in our NGC 330 data with $V \leq 16.03$. Taking the difference of the distance moduli of the Clouds as $0.4^{\mathrm{m}}$, and allowing for the fact that the "typical" extinction toward the LMC is $\sim 0.1^{\mathrm{m}}$ greater than the SMC (Massey et al. 1995), this notionally imposes a similar cut-off as that in the NGC 2004 data.

Table 3. Overview of the number of Be-type stars and binaries in the LMC and SMC sample.

| Field | $\mathrm{O}(+\mathrm{Oe})$ | Early-B <br> (B0-3) | Be | Total <br> (O+Early- | Binary <br> Fraction |
| :--- | :--- | :--- | :--- | :--- | :--- |
| SMC: NGC 330 | 6 | 76 | 22 | 104 |  |
| Binary | - | 3 | 1 | 4 | $4 \%$ |
| SMC: NGC 346 <br> Binary | 19 | 59 | 25 | 103 |  |
| LMC: NGC 2004 | 4 | 19 | 4 | 27 | $26 \%$ |
| Binary | 1 | 83 | 18 | 105 |  |
| LMC: N11 | 44 | 68 | 8 | 120 |  |
| Binary | 19 | 21 | 3 | 43 | $36 \%$ |

The Be-fraction for the NGC 330 field population remains robust at $24 \%(11 \mathrm{Be} / 45 \mathrm{Be}+\mathrm{B})$.

Our results are in reasonable agreement with those from Keller et al. (1999) and, for NGC 2004, match those of Martayan et al. (2006). Both Keller et al. and Martayan et al. advanced their results as a lack of evidence for a strong dependence of the Befraction with metallicity when compared to the general result for the Milky Way of $\sim 17-20 \%$ (Zorec \& Briot 1997). This is in contrast to the results for clusters from Maeder et al. (1999). The statistics in our NGC 346 and N11 data do not provide a meaningful test of the relative numbers of Be stars at different metallicities. Aside from a likely mix of field and cluster populations in the NGC 346 pointing, the N11 region is even less suited given its complex star-formation history.

### 8.5. Binaries and the binary fraction

With the time-sampling provided by the service-mode observations we are reasonably sensitive to detection of binarity in our SMC and LMC targets. In Appendix A we give full details of the observational epochs of the FLAMES spectra. The observations in both N11 and NGC 2004 spanned a total of 57 days, and those in NGC 346 covered 84 days. The time-coverage of the majority of the NGC 330 data is not as extensive as for the other fields, covering 10 days. The new HR03 ( $\lambda 4124$ ) data offer some extra information in this regard (e.g. Sect. 6.3.3). However, given the relatively poor signal-to-noise in the 2003 data it is difficult to compare measured velocities meaningfully - from these comparisons a number of stars are flagged as having potentially variable velocities.

The FLAMES data are sufficient to derive periods for some of the newly discovered systems, the most interesting of which will receive a detailed treatment in a future study. The incidence of binaries in summarised in Table 3. We stress that stars considered as multiple in this discussion are those listed in Tables 4-7 as "Binary" (be they SB1, SB2 or not specified). Stars suggested to perhaps demonstrate $v_{r}$ variations are not considered further, pending follow-up. As such, the percentages in Table 2 serve as strong, lower limits on the binary fraction in our fields.

In young, dense clusters multiplicity seems a common, almost ubiquitous feature. García \& Mermilliod (2001) found a significant binary fraction (79\%) in the very young Galactic cluster NGC 6231, and Weigelt et al. (1999) and Preibisch et al. (1999) highlighted the high degree of multiplicity found in the massive members of the Orion Nebula, suggesting a different
mode of star formation to that at lower masses (in which the binary fraction is lower).

The formation mechanism of massive stars is still a point of significant debate. In their discussion of the competing scenarios of massive-star formation from accretion versus stellar mergers, Bally \& Zinnecker (2005) suggest that the multiple star fraction will be larger if merging dominates. Bally \& Zinnecker also suggest that mergers may be the dominant process in ultradense regions such as 30 Doradus; perhaps the high binary fraction of O- and early B-type stars in N11 is indicative of this mode of star-formation, remembering that $36 \%$ is a solid, lower limit obtained from a programme that was not optimised for detection of binaries.

By comparison, the low binary fraction in the NGC 330 targets is somewhat puzzling. Although fewer binaries are generally found in the field population (e.g. Mason et al. 1998), the NGC 330 fraction is significantly lower than that for NGC 2004, which similarly samples the field (see Figs. 14 and 16). We speculate that, whilst the new HR03 data added an additional epoch to the time-sampling for the NGC 330 targets, it is still not as thorough as for the other fields.

## 9. Summary

Quantitative analyses of different subsets of the FLAMES survey are now underway by various groups, e.g. Dufton et al. (submitted); Hunter et al. (submitted); Mokiem et al. (2006). Here we have presented a significant dataset of high-resolution observations of early-type stars in the Magellanic Clouds, giving stellar classifications and radial velocities, and noting evidence of binarity from the multi-epoch observations. Spectral peculiarities were discussed, in particular with regard to emission-line spectra. We have found a relatively large number of Be-type stars that display permitted Fe II emission lines. We find that in nearly all the spectra with $E W(\mathrm{H} \alpha)>20 \AA, \mathrm{Fe}$ II is seen in emission. We do not find evidence for a metallicity-dependent scaling of the required $\mathrm{H} \alpha$ equivalent width for Fe II emission to be present, contrary to the suggestion by Martayan et al. (2006). We have tentatively explored the relative fraction of Be - to normal B-type stars in the field-regions of NGC 330 and NGC 2004, finding no compelling evidence of a strong trend with metallicity for field stars.

We have investigated previously unexplored regions around the central LH9/LH10 complex of N11, finding ~25 new O-type stars from our spectroscopy. Furthermore, to the north of LH10 we have discovered a very hot, potential runaway star (N11-026) that we classify as $\mathrm{O} 2.5 \mathrm{III}\left(\mathrm{f}^{*}\right)$.

For three of our fields we find lower limits to the binary fraction of O- and early B-type stars of 23 to $36 \%$. Following identification of a relatively large number of binaries, more sophisticated methods will be used in a subsequent paper to characterise as many of these systems as possible. NGC 346-013 is particularly interesting with an apparently hotter, more massive, but less luminous secondary component.

The overall distribution of the targets observed in the VLTFLAMES survey of massive stars is summarised in Table 2. The large number of O-type stars observed will provide allow for better sampling of this domain, building on the significant studies by Massey et al. $(2004,2005)$. In the early B-type domain the FLAMES survey is truly unique, allowing precise abundance determinations of a hitherto impossible number of stars (Hunter et al., submitted), enabling us to really address some of the unsolved questions regarding the dependence of stellar evolution on metallicity.

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C. J. Evans et al.: FLAMES survey of massive stars: LMC and SMC clusters, Online Material p 1

## Online Material

## C. J. Evans et al.: FLAMES survey of massive stars: LMC and SMC clusters, Online Material p 2

Table 4. NGC 346: observational parameters of target stars. Cross-references to identifications by Sanduleak (1968, Sk), Azzopardi \& Vigneau (1975, 1982, AzV), Niemela et al. (1986, NMC), Massey et al. (1989, MPG), Meyssonnier \& Azzopardi (1993, MA93), Keller et al. (1999, KWB), and Evans et al. (2004, 2dFS) are given in the final column. The radial velocities ( $v_{\mathrm{r}}$, in $\mathrm{km} \mathrm{s}^{-1}$ ) and radial distances to the centre of the cluster ( $r_{\mathrm{d}}$, in arcmin) are given for each star. The number of lines measured in determination of the radial velocities is given in parentheses.

| ID | EIS\# | $\alpha(2000)$ | $\delta(2000)$ | $r_{\text {d }}$ | V | $B-V$ | Sp. type | $v_{\mathrm{r}}$ | Comments |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| NGC 346-001 $\dagger$ | SMC5_083194 | 005931.94 | -72 1046.05 | 1.07 | 12.31 | -0.19 | O7 Iaf+ | Binary | Sk 80, AzV 232, MPG 789, H $\alpha=$ broad em. |
| NGC 346-002 | SMC5_082844 | 005806.39 | -72 0705.47 | 6.62 | 13.22 | -0.04 | A2: Iab | - | FLAMES-UVES target |
| NGC 346-003 | SMC5_082834 | 005847.62 | -72 1331.01 | 3.58 | 13.56 | 0.62 | G0: | - | FLAMES-UVES target; foreground |
| NGC 346-004 | SMC5_082667 | 005737.22 | -72 1309.12 | 8.06 | 13.69 | -0.16 | Be (B1:) | 106: (8) | MA93\#1021, AzV 191; $\mathrm{H} \alpha=$ twin em. |
| NGC 346-005 | SMC5_072019 | 005721.47 | -72 1333.70 | 9.33 | 13.88 | -0.02 | A0 II | 162 (5) |  |
| NGC 346-006 | SMC5_000969 | 005951.39 | -72 1449.23 | 4.76 | 14.02 | 0.15 | F2: | - | FLAMES-UVES target |
| NGC 346-007 | SMC5_079542 | 005857.40 | -72 1033.53 | 1.59 | 14.07 | -0.28 | O4 V((f+)) | Binary (SB1) | MPG 324, NMC 32 |
| NGC 346-008 | SMC5_081043 | 005915.99 | -72 0444.46 | 6.06 | 14.20 | -0.20 | B1e | 158 (6) | AzV 224; $\mathrm{H} \alpha=$ twin em. |
| NGC 346-009 | SMC5_028909 | 005951.32 | -72 1128.57 | 2.64 | 14.36 | -0.25 | B0e | 154 (7) | MPG 845, MA93\#1167, $\mathrm{H} \alpha=$ broad em. |
| NGC 346-010 | SMC5_000836 | 005920.70 | -72 1710.52 | 6.38 | 14.37 | -0.22 | O7 IIIn((f)) | 208: (8) | AzV 226 |
| NGC 346-011 $\dagger$ | SMC5_075100 | 005729.49 | -72 1600.40 | 9.80 | 14.39 | -0.12 | B9 II | 160 (10) |  |
| NGC 346-012 | SMC5_001361 | 005814.46 | -72 0729.51 | 5.88 | 14.39 | -0.23 | B1 Ib | 181 (13) | AzV 202 |
| NGC 346-013 | SMC5_072124 | 005930.36 | -72 0909.59 | 1.89 | 14.46 | 0.06 | B1: | Binary (SB2) | MPG 782 |
| NGC 346-014 | SMC5_026814 | 005950.36 | -72 1357.16 | 4.01 | 14.58 | 0.01 | A0 II | 164 (5) | 2dFS\#1425 |
| NGC 346-015 | SMC5_022635 | 005901.95 | -72 1852.91 | 8.17 | 14.62 | -0.30 | B1 V | Binary (SB2) | AzV 217, 2dFS\#1357 |
| NGC 346-016 | SMC5_089653 | 005936.19 | -72 1556.74 | 5.33 | 14.65 | -0.23 | B0.5 Vn | Binary (SB2) | 2dFS\#5100 |
| NGC 346-017 | SMC5_007202 | 005811.94 | -72 0402.06 | 8.44 | 14.67 | -0.22 | Be (B1) | Binary | $\mathrm{H} \alpha=$ twin em. |
| NGC 346-018 | SMC5_038701 | 005847.10 | -72 1301.57 | 3.25 | 14.78 | -0.12 | O9.5 IIIe | 164 (3) | MPG $217, \mathrm{H} \alpha=\mathrm{em}$. |
| NGC 346-019 | SMC5_031737 | 005905.56 | -720802.38 | 2.92 | 14.82 | -0.03 | A0 II | 162 (3) |  |
| NGC 346-020 | SMC5_005500 | 005746.46 | -72 1245.01 | 7.27 | 14.89 | -0.22 | B1 V+early-B | Binary (SB2) | 2dFS\#1259 |
| NGC 346-021 | SMC5_000965 | 005919.58 | -72 1450.47 | 4.04 | 14.90 | -0.18 | B1 III | 166 (11) | 2dFS\#5099 |
| NGC 346-022 | SMC5_005834 | 005918.59 | -72 1109.89 | 0.37 | 14.91 | -0.26 | 09 V | 156 (6) | MPG 682, NMC 40 |
| NGC 346-023 | SMC5_029130 | 005841.86 | -72 1117.55 | 2.81 | 14.92 | -0.07 | B0.2: ( $\mathrm{Be}-\mathrm{Fe}$ ) | 161 (6) | MPG 178, MA93\#1089, NMC 45, 2dFS\#5097 |
| NGC 346-024 $\dagger$ | SMC5_078074 | 005906.38 | -72 0744.97 | 3.18 | 14.92 | -0.17 | B2: shell ( $\mathrm{Be}-\mathrm{Fe}$ ) | 151 (5) | MA93\#1118, KWB346\#205, $\mathrm{H} \alpha=$ twin |
| NGC 346-025 | SMC5_056190 | 005952.93 | -72 1049.07 | 2.67 | 14.95 | -0.27 | O9 V | Binary (SB1) | MPG 848 |
| NGC 346-026 $\dagger$ | SMC5_056277 | 005814.10 | -72 1044.18 | 4.89 | 14.98 | -0.14 | B0 IV (Nstr) | 222 (17) | MPG 12, 2dFS\#1299 |
| NGC 346-027 | SMC5_032353 | 005900.92 | -72 0718.16 | 3.73 | 15.00 | -0.24 | B0.5 V | 166: (6) |  |
| NGC 346-028 | SMC5_069506 | 005831.77 | -72 1057.92 | 3.54 | 15.01 | -0.26 | OC6 Vz | 178 (8) | MPG 113 |
| NGC 346-029 | SMC5_055586 | 005914.53 | -72 1159.77 | 1.23 | 15.02 | -0.19 | B0 V | Binary (SB1) | MPG 637, NMC 50 |
| NGC 346-030 | SMC5_000991 | 005855.97 | -72 1437.59 | 4.18 | 15.02 | -0.21 | B0 V | Binary | 2dFS\#5098 |
| NGC 346-031 | SMC5_034478 | 005954.04 | -72 0431.28 | 6.86 | 15.02 | -0.26 | O8 Vz | 159 (11) |  |
| NGC 346-032 | SMC5_034263 | 005924.81 | -72 0447.68 | 6.03 | 15.06 | -0.26 | B0.5 V | 174 (11) |  |
| NGC 346-033 $\dagger$ | SMC5_089286 | 005911.62 | -72 0957.52 | 0.97 | 15.07 | -0.25 | O8 V | 189: (3) | MPG 593 |
| NGC 346-034 | SMC5_029400 | 005905.90 | -72 1050.28 | 0.93 | 15.08 | -0.26 | O8.5 V | Binary (SB1) | MPG 467, NMC 18 |
| NGC 346-035 | SMC5_001453 | 005946.61 | -72 0532.45 | 5.70 | 15.09 | -0.23 | B1 V | Binary (SB2) | 2dFS\#1418 |
| NGC 346-036 $\dagger$ | SMC5_233890 | 005923.33 | -72 1200.62 | 1.28 | 15.11 | -0.07 | B0.5 V (Be-Fe) | Binary? | MPG 729, MA93\#1144 |
| NGC 346-037 | SMC5_032995 | 005918.84 | -72 0629.27 | 4.31 | 15.18 | -0.21 | B3 III | 153 (13) |  |
| NGC 346-038 | SMC5_079698 | 005851.33 | -72 0510.25 | 5.99 | 15.18 | -0.24 | B1 V | 180 (7) | variable $v_{r}$ ? |
| NGC 346-039 | SMC5_075002 | 005747.42 | -72 1640.44 | 9.08 | 15.19 | -0.20 | B0.7 V | 156 (13) | 2dFS\#1262 |
| NGC 346-040 | SMC5_005698 | 005823.59 | -72 1153.20 | 4.30 | 15.23 | -0.16 | B0. 2 V | Binary (SB1) | MPG 61 |
| NGC 346-041 | SMC5_024945 | 005744.32 | -72 1610.72 | 8.96 | 15.24 | 0.01 | B2 ( $\mathrm{Be}-\mathrm{Fe}$ ) | 176 (9) | MA93\#1030, $\mathrm{H} \alpha=$ broad em. |
| NGC 346-042 | SMC5_067681 | 005936.26 | -72 1826.32 | 7.77 | 15.28 | 0.09 | A7 II | 122 (5) |  |
| NGC 346-043 | SMC5_075935 | 005813.95 | -72 0919.04 | 5.12 | 15.36 | -0.23 | B0 V | 172 (16) | MPG 11 |
| NGC 346-044 | SMC5_081656 | 005926.46 | -72 1311.78 | 2.48 | 15.38 | -0.22 | B1 II | 146 (11) | MPG 753 |
| NGC 346-045 | SMC5_069093 | 005824.19 | -72 1246.82 | 4.57 | 15.43 | -0.20 | B0.5 Vne | 155 (5) | MPG 64, MA93\#1070, $\mathrm{H} \alpha=$ broad em. |
| NGC 346-046 | SMC5_027160 | 005931.84 | -72 1335.24 | 2.98 | 15.44 | -0.28 | O7 Vn | 250: (8) |  |
| NGC 346-047 | SMC5_006207 | 005703.23 | -72 0915.03 | 10.43 | 15.45 | -0.19 | B2.5 III | 137 (13) | 2dFS\#1189 |
| NGC 346-048 | SMC5_028019 | 005847.50 | -72 1236.57 | 2.95 | 15.47 | -0.21 | Be (B3 shell) | 165 (7) | MPG 222, KWB346\#377, $\dagger, \mathrm{H} \alpha=$ twin |
| NGC 346-049 | SMC5_026567 | 005737.55 | -72 1417.54 | 8.44 | 15.50 | -0.05 | B8 II | 144 (11) |  |
| NGC 346-050 | SMC5_075959 | 005855.22 | -72 0906.57 | 2.43 | 15.50 | -0.30 | O8 Vn | 160 (5) | MPG 299 |
| NGC 346-051 | SMC5_038979 | 005908.68 | -72 1014.08 | 0.91 | 15.51 | -0.26 | O7 Vz | 169 (9) | MPG 523, NMC 38 |
| NGC 346-052 | SMC5_000921 | 005807.49 | -72 1547.98 | 7.36 | 15.52 | -0.23 | B1.5 V | Binary (SB1) |  |
| NGC 346-053 | SMC5_004887 | 005757.68 | -72 1602.24 | 8.07 | 15.52 | -0.25 | B0.5 V | Binary (SB1) |  |
| NGC 346-054 | SMC5_038674 | 005856.51 | -72 1313.43 | 2.93 | 15.59 | -0.15 | B1 V | 164 (8) | MPG 309 |
| NGC 346-055 | SMC5_001131 | 005827.59 | -72 1154.55 | 4.01 | 15.59 | -0.15 | B0.5 V | 176 (6) | MPG 84, MA93\#1072 |
| NGC 346-056 | SMC5_079574 | 005856.12 | -72 0933.84 | 2.08 | 15.59 | -0.26 | B0 V | 178 (11) | MPG 310, NMC 48 |
| NGC 346-057 | SMC5_032947 | 005952.69 | -72 0629.50 | 5.06 | 15.62 | -0.23 | B2.5 III | 143 (9) | MA93\#1169, KWB346\#526, $\dagger$,str. nebular lines |
| NGC 346-058 | SMC5_001067 | 005931.53 | -72 1306.46 | 2.53 | 15.63 | -0.22 | B0.5 V | Binary (SB1) | MPG 787 |
| NGC 346-059 | SMC5_076160 | 005804.83 | -72 0717.70 | 6.60 | 15.64 | 0.09 | A5 II | 188 (5) |  |
| NGC 346-060 | SMC5_033513 | 005919.28 | -72 0547.80 | 5.00 | 15.68 | -0.13 | B0.5e (shell) | 142 (5) | MA93\#1140, KWB346\#236, $\mathrm{H} \alpha=$ twin |
| NGC 346-061 | SMC5_082792 | 005757.82 | -72 0755.43 | 6.78 | 15.70 | -0.21 | B1-2 (Be-Fe) | 152: (4) | KWB346\#122,2dFS\#1277, $\dagger, \mathrm{H} \alpha=$ broad em. |
| NGC 346-062 | SMC5_039483 | 005956.61 | -720508.50 | 6.38 | 15.70 | -0.24 | B0.2 V | 136 (15) |  |

Table 4. Continued.

| ID | EIS\# | $\alpha(2000)$ | $\delta(2000)$ | $r_{\text {d }}$ | V | $B-V$ | Sp. type | $v_{\mathrm{r}}$ | Comments |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| NGC 346-066 | SMC5_001152 | 005845.98 | -72 1136.78 | 2.58 | 15.75 | -0.25 | 09.5 V | 163 (5) | MPG 213; variable $v_{r}$ ? |
| NGC 346-067 | SMC5_001335 | 005750.38 | -72 0756.04 | 7.29 | 15.76 | -0.04 | B1-2 (Be-Fe) | 172: (8) | MA93\#1038, $\mathrm{H} \alpha=$ twin |
| NGC 346-068 | SMC5_076404 | 005904.14 | -72 0448.72 | 6.08 | 15.77 | -0.17 | $\mathrm{B} 0 \mathrm{~V}(\mathrm{Be}-\mathrm{Fe})$ | Binary | $\mathrm{H} \alpha=$ broad em. |
| NGC 346-069 | SMC5_005388 | 005707.29 | -72 1319.31 | 10.31 | 15.80 | -0.10 | B1-2 (Be-Fe) | 138: (6) | MA93\#981, $\mathrm{H} \alpha=$ broad em. |
| NGC 346-070 | SMC5_026922 | 005915.49 | -72 1352.21 | 3.08 | 15.82 | -0.22 | B0.5 V | 165: (13) |  |
| NGC 346-071 | SMC5_052484 | 010004.21 | -72 1647.56 | 6.96 | 15.84 | -0.07 | A0 II | 178 (2) |  |
| NGC 346-072† | SMC5_055979 | 005822.65 | -72 1117.86 | 4.26 | 15.84 | -0.10 | B1-2 (Be-Fe) | 153 (6) | MPG 54,MWB143,H $\alpha=$ broad em. |
| NGC 346-073 | SMC5_025100 | 010005.24 | -72 1555.54 | 6.27 | 15.84 | -0.17 | B1-2 (Be-Fe) | 143 (5) | MA93\#1183, $\mathrm{H} \alpha=$ broad em. |
| NGC 346-074 | SMC5_000748 | 005855.81 | -72 1841.29 | 8.07 | 15.85 | -0.22 | B3 III | 142 (12) |  |
| NGC 346-075 | SMC5_006828 | 005925.96 | -72 0601.45 | 4.81 | 15.85 | -0.26 | B1 V | Binary (SB1) | 2dFS\#1389 |
| NGC 346-076 | SMC5_055468 | 005912.12 | -72 1211.69 | 1.47 | 15.87 | 0.05 | B2 ( $\mathrm{Be}-\mathrm{Fe}$ ) | 172: (4) | MPG 596,,KWB346\#445, $\dagger, \mathrm{H} \alpha=$ broad em. |
| NGC 346-077 | SMC5_030292 | 005848.97 | -72 0951.92 | 2.41 | 15.88 | -0.18 | O9 V | 165 (6) | MPG 238, NMC 39 |
| NGC 346-078 | SMC5_026141 | 005822.07 | -72 1445.69 | 5.83 | 15.88 | -0.21 | B2 III | Binary |  |
| NGC 346-079 | SMC5_029544 | 005903.05 | -72 1044.07 | 1.15 | 15.88 | -0.23 | B0.5 Vn | 168 (4) | MPG 400 |
| NGC 346-080 | SMC5_029906 | 005849.61 | -72 1019.52 | 2.22 | 15.89 | -0.11 | B1 V | 160: (6) | MPG 243, NMC 47, $\mathrm{H} \alpha=$ broad em.,neb? |
| NGC 346-081 | SMC5_027589 | 005800.38 | -72 1307.86 | 6.38 | 15.91 | -0.20 | B2 IIIn | 148 (10) |  |
| NGC 346-082 | SMC5_026587 | 005808.32 | -72 1416.49 | 6.36 | 15.91 | -0.21 | B2 III | Binary (SB1) |  |
| NGC 346-083 | SMC5_005921 | 005928.07 | -72 1042.23 | 0.78 | 15.91 | -0.24 | B1 V | 172: (5) | MPG 767 |
| NGC 346-084 | SMC5_001425 | 005813.04 | -72 0602.88 | 6.88 | 15.92 | -0.23 | B1 V | 147 (8) | 2dFS\#1296 |
| NGC 346-085 | SMC5_030007 | 005737.95 | -72 1013.78 | 7.68 | 15.93 | -0.22 | B2 III | Binary (SB1) |  |
| NGC 346-086 | SMC5_056528 | 005901.92 | -72 1021.33 | 1.31 | 15.94 | -0.25 | B0.2 V | Binary (SB1) | MPG 371 |
| NGC 346-087 | SMC5_052697 | 005921.91 | -72 1627.37 | 5.66 | 15.95 | 0.00 | A0 II | 115 (6) |  |
| NGC 346-088 | SMC5_024131 | 005907.82 | -72 1706.01 | 6.35 | 15.95 | -0.22 | B1 V | 174 (11) |  |
| NGC 346-089 | SMC5_023010 | 005910.87 | -72 1827.92 | 7.68 | 15.96 | -0.17 | B1-2 (Be-Fe) | 185 (6) | MA93\#1123, $\mathrm{H} \alpha=$ twin em. |
| NGC 346-090 | SMC5_026342 | 005825.73 | -72 1433.19 | 5.48 | 15.96 | -0.18 | O9.5 V | 172 (7) |  |
| NGC 346-091 | SMC5_022851 | 005829.64 | -72 1840.58 | 8.70 | 15.98 | -0.18 | B1e | Binary (SB1) | MA93\#1075, $\mathrm{H} \alpha=$ broad em. |
| NGC 346-092 | SMC5_032179 | 005942.36 | -72 0727.12 | 3.83 | 16.00 | -0.27 | B1 Vn | 157: (6) |  |
| NGC 346-093 | SMC5_069704 | 005855.60 | -72 1007.19 | 1.84 | 16.01 | -0.19 | B0 V | 157 (6) | MPG 304 |
| NGC 346-094 | SMC5_006635 | 005957.22 | -720700.28 | 4.84 | 16.01 | -0.31 | B0.7 V | 138 (13) |  |
| NGC 346-095 | SMC5_004916 | 005740.34 | -72 1551.42 | 9.02 | 16.04 | -0.05 | B1-2 (Be-Fe) | 162: (6) | MA93\#1027, $\mathrm{H} \alpha=$ broad em. |
| NGC 346-096 | SMC5_033169 | 005728.87 | -72 0619.25 | 9.47 | 16.04 | -0.08 | B1-2 (Be-Fe) | 185: (6) | MA93\#1009, $\mathrm{H} \alpha=$ broad em. |
| NGC 346-097 | SMC5_005824 | 005908.53 | -72 1112.56 | 0.83 | 16.06 | -0.07 | 09 V | 159 (8) | MPG 519, NMC 6 |
| NGC 346-098 | SMC5_005427 | 005911.01 | -72 1304.04 | 2.33 | 16.09 | -0.22 | B1.5 V | 158 (9) | MPG 568 |
| NGC 346-099 | SMC5_060385 | 005802.32 | -72 0312.37 | 9.55 | 16.10 | -0.18 | B3 III | 157 (10) |  |
| NGC 346-100 | SMC5_007269 | 005920.66 | -72 0338.00 | 7.17 | 16.10 | -0.24 | B1.5 V | 152 (6) |  |
| NGC 346-101 | SMC5_056629 | 005759.80 | -72 1011.61 | 6.01 | 16.15 | -0.23 | B1 V | 184 (13) |  |
| NGC 346-102 | SMC5_058504 | 005812.30 | -72 0652.07 | 6.38 | 16.16 | -0.17 | B3 III | 144 (11) |  |
| NGC 346-103 | SMC5_007370 | 005920.82 | -72 0258.58 | 7.83 | 16.16 | -0.30 | B0.5 V | 137 (16) |  |
| NGC 346-104† | SMC5_089334 | 005913.76 | -72 0927.36 | 1.38 | 16.16 | -0.34 | B0 V | Binary (SB1) | MPG 628,MA93\#1129, $\mathrm{H} \alpha=$ str. em. |
| NGC 346-105 | SMC5_069135 | 005828.48 | -72 1234.27 | 4.18 | 16.19 | -0.11 | B2 III | Binary | MPG 88 |
| NGC 346-106 | SMC5_004992 | 005752.24 | -72 1528.18 | 8.05 | 16.19 | -0.17 | B1 V | Binary |  |
| NGC 346-107 | SMC5_001206 | 005910.37 | -72 1028.45 | 0.67 | 16.20 | -0.27 | O9.5 V | 156 (7) | MPG 559, NMC 22 |
| NGC 346-108 | SMC5_006368 | 005958.11 | -72 0821.80 | 3.92 | 16.21 | -0.28 | B1.5 V | 160 (6) |  |
| NGC 346-109 | SMC5_089444 | 005919.39 | -72 0429.11 | 6.32 | 16.21 | -0.29 | B1.5 V | 169: (6) |  |
| NGC 346-110 | SMC5_005120 | 005811.49 | -72 1442.70 | 6.42 | 16.22 | -0.15 | B1-2 (Be-Fe) | Binary | KWB346\#313, $\mathrm{H} \alpha=$ twin em. |
| NGC 346-111 | SMC5_082079 | 005900.16 | -72 1046.66 | 1.37 | 16.24 | -0.24 | B0.5 V | 163 (5) | MPG 344 |
| NGC 346-112 | SMC5_005637 | 005858.54 | -72 1206.72 | 1.98 | 16.24 | -0.24 | O9.5 V | 162 (5) | MPG 327 |
| NGC 346-113 | SMC5_006076 | 005811.22 | -72 0959.08 | 5.17 | 16.27 | -0.27 | B0.5 V | 177: (13) | variable $v_{r}$ ? |
| NGC 346-114 | SMC5_031881 | 010002.66 | -72 0748.68 | 4.54 | 16.28 | -0.30 | B1 Vn | 174: (6) |  |
| NGC 346-115 $\dagger$ | SMC5_075795 | 005904.63 | -72 1031.16 | 1.06 | 16.30 | -0.28 | B0.2 V | 182 (7) | MPG 443 |
| NGC 346-116 | SMC5_076289 | 010003.23 | -720603.65 | 5.87 | 16.30 | -0.30 | B1 V | 154 (13) |  |

$\dagger$ : Further notes on individual stars:
NGC 346-001: saturated in images, photometry is from MPG
NGC 346-011: member of Lindsay 56/LHA 115-S26
NGC 346-024: is also KWB346\#72, blended with SMC5_078073
NGC 346-026: faint companions in WFI images
NGC 346-033: blended in images with SMC5_080234
NGC 346-036: bad column in $V$ image, photometry is from MPG
NGC 346-048: is also MA93\#1101
NGC 346-057: blended in images with SMC5_032946
NGC 346-061: is also MA93\#1048
NGC 346-065: is also MA93\#1100
NGC 346-072: correlated with MA93\#1067, which is resolved into two bright components in WFI image
NGC 346-076: is also MA93\#1126
NGC 346-104: part blended with SMC5_082742/MPG 635
NGC 346-115: part blended with SMC5_246984/MPG 426

Table 5. NGC 330: observational parameters of target stars. Cross-references to identifications given by Sanduleak (1968, Sk), Arp (1959), Robertson (1974, R74), Azzopardi \& Vigneau (1975, 1982, AzV), Meyssonnier \& Azzopardi (1993, MA93), Keller et al. (1999, KWB) and Evans et al. (2004, 2dFS) are given in the final column. The radial velocities ( $v_{\mathrm{r}}$, in $\mathrm{km} \mathrm{s}^{-1}$ ) and radial distances to the centre of the cluster $\left(r_{\mathrm{d}}\right.$, in arcmin) are given for each star.

| ID | EIS\# | $\alpha(2000)$ | $\delta(2000)$ | $r_{\text {d }}$ | V | $B-V$ | Sp. type | $v_{\mathrm{r}}$ | Comments |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| NGC 330-001 | SMC5_078698 | 005548.34 | -72 3052.90 | 3.85 | 12.99 | 0.03 | B9-A0 Iab | - | FLAMES-UVES target |
| NGC 330-002 | SMC5_082820 | 005624.85 | -72 2741.79 | 0.46 | 13.03 | -0.04 | B3 Ib | 154 (20) | R74-A02 |
| NGC 330-003 | SMC5_081785 | 005655.29 | -72 2420.55 | 4.41 | 13.17 | 0.00 | B2 Ib | 147 (17) | Sk 65, AzV 180, 2dFS\#1183; H $\alpha=$ infilled abs. |
| NGC 330-004 | SMC5_082763 | 005620.80 | -72 2833.98 | 0.79 | 13.33 | -0.07 | B2.5 Ib | 157 (16) | R74-B37, 2dFS\#5090; H $\alpha=$ infilled abs. |
| NGC 330-005 | SMC5_082862 | 005504.93 | -72 2922.87 | 5.79 | 13.35 | -0.06 | B5 Ib | 150 (15) |  |
| NGC 330-006 | SMC5_082471 | 005638.18 | -72 1837.72 | 9.27 | 13.41 | 0.02 | A3: II | - | FLAMES-UVES target |
| NGC 330-007 | SMC5_082854 | 005658.26 | -72 3117.34 | 4.59 | 13.48 | 0.23 | A7-F0 II | - | FLAMES-UVES target |
| NGC 330-008 | SMC5_082532 | 005609.63 | -72 3228.56 | 4.74 | 13.71 | 0.23 | A7-F0 II | - | FLAMES-UVES target |
| NGC 330-009 | SMC5_082706 | 005353.75 | -72 2649.99 | 10.97 | 13.72 | -0.06 | B5 Ib | 139 (11) |  |
| NGC 330-010 | SMC5_082798 | 005455.21 | -72 3326.49 | 8.46 | 13.89 | -0.03 | B5 Ib | 142 (10) |  |
| NGC 330-011 | SMC5_051901 | 005656.75 | -72 1744.71 | 10.44 | 13.91 | -0.02 | B9 Ib | 156 (6) | AzV 181 |
| NGC 330-012 | SMC5_015870 | 005607.95 | -72 2603.74 | 1.91 | 13.92 | -0.01 | A0 Ib | 128 (6) | Arp 211 |
| NGC 330-013 | SMC5_001959 | 005726.97 | -72 3313.30 | 7.48 | 14.00 | -0.13 | O8.5 III-II ((f)) | 176 (11) | AzV 186, 2dFS\#1230 |
| NGC 330-014 | SMC5_081774 | 005638.79 | -72 2513.75 | 2.97 | 14.07 | -0.12 | B1.5 Ib | 159 (15) | AzV 176 |
| NGC 330-015 | SMC5_003863 | 005521.62 | -72 2150.23 | 7.35 | 14.27 | 0.15 | A7-F0 II | - | AzV 167; FLAMES-UVES target |
| NGC 330-016 | SMC5_073986 | 005521.48 | -72 2338.01 | 5.99 | 14.28 | -0.14 | B5: II | 130 (12) | contaminated by arcs |
| NGC 330-017 | SMC5_064339 | 005647.98 | -72 2846.86 | 2.41 | 14.35 | -0.11 | B2 II | 157 (15) | AzV 178, 2dFS\#1171 |
| NGC 330-018 | SMC5_078858 | 005609.41 | -72 2758.71 | 0.73 | 14.37 | -0.13 | B3 II | 153 (11) | R74-B30 |
| NGC 330-019 | SMC5_037327 | 005552.85 | -72 2631.42 | 2.33 | 14.38 | -0.03 | B9 Ib | 127 (8) |  |
| NGC 330-020 | SMC5_002300 | 005728.08 | -72 3103.34 | 6.16 | 14.43 | -0.03 | B3 II | 158 (14) | 2dFS\#1232 |
| NGC 330-021 | SMC5_003855 | 005737.34 | -72 2153.94 | 8.35 | 14.45 | -0.25 | B0.2 III | 173 (10) | AzV 192, 2dFS\#1242 |
| NGC 330-022 | SMC5_002377 | 005515.68 | -72 3033.73 | 5.51 | 14.56 | -0.13 | B3 II | 147 (16) | 2dFS\#1062 |
| NGC 330-023 | SMC5_190576 | 005644.31 | -72 2906.33 | 2.33 | 14.56 | -0.12 | O9 V-IIIe | 159: (3) | KWB330\#111, $\mathrm{H} \alpha=$ strong em. |
| NGC 330-024 | SMC5_065615 | 005458.57 | -72 2509.71 | 6.59 | 14.72 | -0.06 | B5 Ib | 161 (11) | 2dFS\#1034 |
| NGC 330-025 | SMC5_037578 | 005723.98 | -72 2356.49 | 6.24 | 14.81 | -0.11 | B1.5e | 110: (7) | 2dFS\#1224, $\mathrm{H} \alpha=$ twin |
| NGC 330-026 | SMC5_019099 | 005723.40 | -72 2245.68 | 7.00 | 14.82 | -0.15 | B2.5 II | 152 (11) |  |
| NGC 330-027 | SMC5_003910 | 005618.27 | -72 2133.39 | 6.23 | 14.86 | -0.16 | B1 V | 170 (11) |  |
| NGC 330-028 | SMC5_002054 | 005706.05 | -72 3239.25 | 6.03 | 14.94 | -0.11 | B1 V | 172 (9) | 2dFS\#1195 |
| NGC 330-029 | SMC5_000205 | 005700.18 | -72 3009.78 | 3.92 | 14.97 | -0.09 | B0.2 V ( $\mathrm{Be}-\mathrm{Fe}$ ) | Binary | MA93\#973, KWB330\#104, $\dagger, \mathrm{H} \alpha=\mathrm{em}$. |
| NGC 330-030 | SMC5_020391 | 005623.58 | -72 2123.64 | 6.40 | 14.99 | -0.26 | B0.5 V | Binary |  |
| NGC 330-031 | SMC5_002476 | 005613.84 | -72 3000.77 | 2.26 | 15.00 | -0.04 | B0.5 V ( $\mathrm{Be}-\mathrm{Fe}$ ) | 146 (4) | 2dFS\#5088, $\mathrm{H} \alpha=\mathrm{em}$. |
| NGC 330-032 | SMC5_076906 | 005738.56 | -72 3038.67 | 6.65 | 15.07 | -0.10 | B0.5 V | 162 (19) |  |
| NGC 330-033 | SMC5_079846 | 005710.52 | -72 3004.17 | 4.52 | 15.08 | -0.11 | B1.5 V | 177: (9) | 2dFS\#5094, variable $v_{r}$ ?, contaminated by arcs |
| NGC 330-034 | SMC5_000183 | 005440.74 | -72 3028.56 | 7.86 | 15.09 | -0.09 | B1-2e | 121: (5) | MA93\#794 |
| NGC 330-035 | SMC5_009426 | 005723.92 | -72 3237.52 | 6.89 | 15.09 | -0.07 | B3 II | 143 (12) |  |
| NGC 330-036 | SMC5_044567 | 005610.66 | -72 2810.25 | 0.72 | 15.10 | -0.16 | B2 II | 156 (16) | R74-B32 |
| NGC 330-037 | SMC5_004102 | 005509.80 | -72 2024.65 | 9.02 | 15.12 | -0.02 | A2 II | 145 (5) | 2dFS\#1058 |
| NGC 330-038 | SMC5_014400 | 005715.31 | -72 2733.94 | 4.26 | 15.21 | -0.19 | B1 V | 133: (9) | 2dFS\#1206 |
| NGC 330-039 | SMC5_003405 | 005555.67 | -72 2432.80 | 3.68 | 15.26 | -0.22 | B0 V | 173: (9) | 2dFS\#1109 |
| NGC 330-040 | SMC5_007692 | 005503.41 | -72 3412.96 | 8.58 | 15.29 | -0.05 | B2 III | 152 (7) | 2dFS\#1041 |
| NGC 330-041 | SMC5_077354 | 005737.17 | -72 2355.97 | 7.05 | 15.38 | -0.24 | B0 V | 184 (10) | 2dFS\#1241 |
| NGC 330-042 | SMC5_016204 | 005627.09 | -72 2542.59 | 2.17 | 15.41 | -0.16 | B2 II | 130 (12) |  |
| NGC 330-043 | SMC5_046989 | 005627.11 | -72 2504.74 | 2.78 | 15.47 | -0.19 | B0 V | 161: (6) |  |
| NGC 330-044 | SMC5_037013 | 005513.61 | -72 2913.69 | 5.12 | 15.50 | -0.02 | B1-2 (Be-Fe) | 158: (5) | MA93\#824 |
| NGC 330-045 | SMC5_003118 | 005605.59 | -72 2621.48 | 1.74 | 15.54 | -0.15 | B3 III | 159 (3) | 2dFS\#5087 |
| NGC 330-046 | SMC5_088493 | 005812.39 | -72 2612.09 | 8.70 | 15.56 | -0.14 | O9.5 V | 177 (6) | 2dFS\#1293 |
| NGC 330-047 | SMC5_021183 | 005703.45 | -72 2035.41 | 7.94 | 15.61 | -0.28 | B1 V | 176 (13) | 2dFS\#1190, variable $v_{r}$ ? |
| NGC 330-048 | SMC5_042483 | 005535.03 | -72 3051.53 | 4.51 | 15.62 | -0.19 | B0.5 V | 181 (6) |  |
| NGC 330-049 | SMC5_086635 | 005559.58 | -72 2331.30 | 4.50 | 15.63 | -0.27 | O9 V | 158 (8) |  |
| NGC 330-050 | SMC5_004159 | 005656.44 | -72 2007.40 | 8.17 | 15.66 | -0.18 | B3e | 113 (7) | MA93\#969, $\mathrm{H} \alpha=$ twin |
| NGC 330-051 | SMC5_082766 | 005757.69 | -72 2710.54 | 7.47 | 15.66 | -0.16 | B1.5 V | 174 (5) | 2dFS\#1276 |
| NGC 330-052 | SMC5_000744 | 005631.00 | -72 1852.99 | 8.95 | 15.69 | -0.26 | O8.5 Vn | 166: (7) | 2dFS\#1152 |
| NGC 330-053† | SMC5_013120 | 005758.81 | -72 2850.68 | 7.61 | 15.69 | -0.12 | B0.5 V | 167 (10) | variable $v_{r}$ ? |
| NGC 330-054 | SMC5_037029 | 005528.20 | -72 2906.50 | 4.03 | 15.70 | -0.08 | B 2 ( $\mathrm{Be}-\mathrm{Fe}$ ) | 127: (6) | MA93\#851, $\mathrm{H} \alpha=\mathrm{em}$. |
| NGC 330-055 | SMC5_012510 | 005649.24 | -72 2928.96 | 2.85 | 15.72 | -0.11 | B0.5 V | 174: (7) | variable $v_{r}$ ? |
| NGC 330-056 | SMC5_002447 | 005523.37 | -72 3009.56 | 4.80 | 15.76 | -0.19 | B2 III | 122: (9) |  |
| NGC 330-057 | SMC5_009833 | 005454.63 | -72 3209.58 | 7.70 | 15.82 | -0.17 | B0.5 V | 124: (4) |  |
| NGC 330-058 | SMC5_036895 | 005458.54 | -72 3022.38 | 6.58 | 15.84 | -0.11 | B3: | 112: (2) |  |
| NGC 330-059 | SMC5_002498 | 005752.13 | -72 2951.87 | 7.33 | 15.85 | -0.08 | B3 III | 151: (11) |  |
| NGC 330-060 | SMC5_011393 | 005559.43 | -72 3034.33 | 3.14 | 15.86 | -0.06 | B2.5 (Be-Fe) | 156: (7) | MA93\#890, $\mathrm{H} \alpha=\mathrm{em}$. |
| NGC 330-061 | SMC5_004133 | 005600.52 | -72 2015.94 | 7.65 | 15.88 | -0.10 | A0 II | 131 (3) | 2dFS\#1118 |
| NGC 330-062 | SMC5_045835 | 005618.05 | -72 2635.82 | 1.19 | 15.90 | -0.10 | B3e | 156: (6) | $\mathrm{H} \alpha=\mathrm{twin}$ |
| NGC 330-063 | SMC5_080598 | 005606.81 | -72 3028.62 | 2.84 | 15.90 | -0.06 | B1-3 | 121: (9) |  |
| NGC 330-064 | SMC5_061057 | 005545.87 | -72 3313.06 | 5.97 | 15.96 | -0.09 | B3: | 135 (4) |  |
| NGC 330-065 | SMC5_002751 | 005614.27 | -7228 30.13 | 0.79 | 15.99 | -0.04 | B1-3 (Be-Fe) | 158: (8) | R74-B34, KWB330\#239, $\dagger, \mathrm{H} \alpha=\mathrm{em}$. |

Table 5. Continued.

| ID | EIS\# | $\alpha(2000)$ | $\delta(2000)$ | $r_{\text {d }}$ | V | $B-V$ | Sp. type | $v_{\mathrm{r}}$ | Comments |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| NGC 330-066 | SMC5_010645 | 005555.96 | -72 3119.82 | 3.94 | 15.99 | -0.10 | B3 III | 152 (8) |  |
| NGC 330-067 | SMC5_079924 | 005534.83 | -72 2718.75 | 3.35 | 16.00 | -0.17 | B2.5 III | 141 (8) |  |
| NGC 330-068 | SMC5_009989 | 005535.52 | -72 3200.30 | 5.33 | 16.02 | -0.06 | B1.5 (Be-Fe) | 133 (9) | MA93\#860, $\mathrm{H} \alpha=$ twin |
| NGC 330-069 | SMC5_043375 | 005648.62 | -72 2940.11 | 2.93 | 16.02 | -0.05 | B3 III | 160: (7) |  |
| NGC 330-070 | SMC5_077231 | 005702.19 | -72 2555.33 | 3.76 | 16.02 | -0.05 | B0.5e | 128 (4) | $\mathrm{H} \alpha=\mathrm{twin}$ |
| NGC 330-071 | SMC5_014767 | 005659.92 | -72 2704.66 | 3.18 | 16.03 | -0.09 | B3 III | 134 (10) |  |
| NGC 330-072 | SMC5_017978 | 005609.16 | -72 2355.23 | 3.93 | 16.03 | -0.20 | B0.5 V | 136: (6) |  |
| NGC 330-073 | SMC5_047763 | 005542.62 | -72 2358.22 | 4.69 | 16.04 | -0.08 | B8 Ib | 58 (6) | KWB330\#522, $\dagger, \mathrm{H} \alpha=\mathrm{em}$. , variable $v_{r}$ ? |
| NGC 330-074 | SMC5_002782 | 005441.61 | -72 2815.74 | 7.34 | 16.09 | -0.24 | B0 V | 156 (6) |  |
| NGC 330-075 | SMC5_004413 | 005552.41 | -72 1845.05 | 9.25 | 16.10 | -0.17 | B8 II | 131: (3) |  |
| NGC 330-076 | SMC5_014864 | 005633.11 | -72 2704.99 | 1.29 | 16.12 | -0.05 | B3 ( $\mathrm{Be}-\mathrm{Fe}$ ) | 126: (10) | R74-B09, KWB330\#419, $\dagger, \mathrm{H} \alpha=\mathrm{em}$. |
| NGC 330-077 | SMC5_000166 | 005543.22 | -72 3049.00 | 4.05 | 16.13 | -0.01 | B0-3 ( $\mathrm{Be}-\mathrm{Fe}$ ) |  | $\dagger$, low S/N, strongly contaminated by arcs |
| NGC 330-078 | SMC5_003498 | 005511.95 | -72 2354.90 | 6.35 | 16.15 | -0.03 | A0: III | 112 (2) |  |
| NGC 330-079 | SMC5_037369 | 005552.41 | -72 2611.32 | 2.55 | 16.16 | -0.13 | B3 III | 155 (5) | variable $v_{r}$ ? |
| NGC 330-080 | SMC5_037034 | 005735.30 | -72 2904.90 | 5.91 | 16.17 | -0.07 | B1-3 | 141: (5) | MA93\#1019 |
| NGC 330-081 | SMC5_044096 | 005602.28 | -72 2844.96 | 1.57 | 16.17 | -0.16 | B1-3 | 130: (8) |  |
| NGC 330-082 | SMC5_044447 | 005724.60 | -72 2817.06 | 4.98 | 16.18 | -0.07 | B1-3 | 141: (8) | contaminated by arcs |
| NGC 330-083 | SMC5_087520 | 005704.56 | -72 2253.62 | 5.99 | 16.19 | -0.13 | B3 III | 140 (9) |  |
| NGC 330-084 | SMC5_044140 | 005536.33 | -72 2840.84 | 3.32 | 16.20 | -0.08 | B3 V-III | Binary (SB1) |  |
| NGC 330-085 | SMC5_073581 | 005626.60 | -72 2623.02 | 1.52 | 16.22 | -0.12 | B3: | 110: (3) | $\mathrm{H} \alpha=$ twin |
| NGC 330-086 | SMC5_012975 | 005633.74 | -72 2901.55 | 1.67 | 16.25 | -0.15 | B2.5 III | 128: (9) | R74-B01 |
| NGC 330-087 | SMC5_000135 | 005543.50 | -72 3132.61 | 4.60 | 16.26 | -0.12 | Be-Fe | - | MA93\#869, $\mathrm{H} \alpha=\mathrm{em}$. |
| NGC 330-088 | SMC5_009618 | 005556.53 | -72 3225.98 | 4.94 | 16.30 | -0.14 | B1-3 | - |  |
| NGC 330-089 | SMC5_002393 | 005537.99 | -72 3027.19 | 4.07 | 16.32 | -0.17 | B1-5 | 154: (4) | contaminated by arcs |
| NGC 330-090 | SMC5_073266 | 005544.03 | -72 2810.44 | 2.65 | 16.34 | -0.15 | B3 III | 117: (5) |  |
| NGC 330-091 | SMC5_080521 | 005705.74 | -72 3341.81 | 6.89 | 16.34 | -0.13 | B0e | 162 (7) | $\mathrm{H} \alpha=$ twin + abs. |
| NGC 330-092 | SMC5_002411 | 005748.75 | -72 3019.28 | 7.23 | 16.35 | -0.03 | B3: | - |  |
| NGC 330-093 | SMC5_036967 | 005540.11 | -72 2944.78 | 3.51 | 16.36 | -0.14 | $\mathrm{Be}-\mathrm{Fe}$ | - | MA93\#863, KWB330\#528, $\mathrm{H} \alpha=$ twin |
| NGC 330-094 | SMC5_082714 | 005533.33 | -72 2357.34 | 5.14 | 16.36 | -0.21 | B1-5 | 179: (2) | contaminated by arcs |
| NGC 330-095 | SMC5_014467 | 005615.39 | -72 2729.32 | 0.39 | 16.38 | -0.15 | B3 III | 155 (10) |  |
| NGC 330-096 | SMC5_014644 | 005439.14 | -72 2716.74 | 7.52 | 16.38 | -0.08 | B1-3 (Be-Fe) | - | MA93\#782, $\mathrm{H} \alpha=\mathrm{em}$. |
| NGC 330-097 | SMC5_002965 | 005617.13 | -72 2717.95 | 0.50 | 16.40 | -0.19 | B1 V | 148: (7) |  |
| NGC 330-098 | SMC5_065934 | 005607.74 | -72 2418.13 | 3.58 | 16.40 | -0.24 | B0.2: V | 175: (2) | contaminated by arcs |
| NGC 330-099 | SMC5_044674 | 005501.81 | -72 2801.35 | 5.80 | 16.41 | -0.18 | B2-3 | - |  |
| NGC 330-100 | SMC5_002442 | 005654.25 | -72 3012.22 | 3.60 | 16.43 | 0.00 | Be (B0-3) | - | $\mathrm{H} \alpha=$ twin |
| NGC 330-101 | SMC5_002817 | 005635.34 | -72 2806.57 | 1.29 | 16.44 | -0.14 | B2.5 III | 154 (8) |  |
| NGC 330-102 | SMC5_014776 | 005712.14 | -72 2710.37 | 4.06 | 16.46 | -0.16 | B2-3 III | 162: (5) |  |
| NGC 330-103 | SMC5_002256 | 005652.31 | -72 3118.50 | 4.33 | 16.47 | -0.07 | B1-3 | - | contaminated by arcs |
| NGC 330-104 | SMC5_048561 | 005501.81 | -72 2249.67 | 7.63 | 16.50 | -0.30 | B0: V | 129: (4) | 2dFS\#1037 |
| NGC 330-105 | SMC5_020588 | 005705.64 | -72 2111.89 | 7.47 | 16.53 | -0.17 | B1-3 | - |  |
| NGC 330-106 | SMC5_011915 | 005635.13 | -72 2958.90 | 2.52 | 16.54 | -0.15 | B1-2 | 135 (12) |  |
| NGC 330-107 | SMC5_014046 | 005557.78 | -72 2751.05 | 1.58 | 16.56 | -0.12 | B3: V-III | 138 (5) |  |
| NGC 330-108 | SMC5_015203 | 005514.50 | -72 2643.73 | 4.96 | 16.56 | -0.13 | B5 III | 126: (2) |  |
| NGC 330-109 | SMC5_065064 | 005624.94 | -72 2648.43 | 1.08 | 16.56 | -0.17 | B3 III | 144: (4) |  |
| NGC 330-110 | SMC5_037341 | 005620.67 | -72 2625.49 | 1.37 | 16.57 | -0.19 | B2 III | 160: (6) |  |
| NGC 330-111 | SMC5_013331 | 005617.70 | -72 2837.71 | 0.85 | 16.58 | -0.17 | B1-3 |  |  |
| NGC 330-112 | SMC5_048045 | 005556.33 | -72 2333.34 | 4.56 | 16.59 | -0.11 | B1-3 (Be-Fe) | - | MA93\#886, KWB330\#509, $\mathrm{H} \alpha=\mathrm{em}$. |
| NGC 330-113 | SMC5_015068 | 005548.73 | -72 2651.42 | 2.45 | 16.61 | -0.14 | B1-3 | - |  |
| NGC 330-114 | SMC5_078349 | 005657.01 | -72 2531.71 | 3.66 | 16.62 | -0.14 | B2 III | 157 (11) |  |
| NGC 330-115 | SMC5_061511 | 005515.38 | -72 2423.49 | 5.86 | 16.65 | -0.26 | B1-3 | Binary |  |
| NGC 330-116 | SMC5_045013 | 005526.53 | -72 2733.66 | 3.94 | 16.66 | -0.19 | B3 III | 133 (6) |  |
| NGC 330-117 | SMC5_049053 | 005639.75 | -72 2206.43 | 5.89 | 16.67 | -0.21 | B1-3 | 120: (6) |  |
| NGC 330-118 | SMC5_037899 | 005447.70 | -72 2051.51 | 9.75 | 16.69 | -0.26 | B1-2 | 170 (4) | 2dFS\#1013 |
| NGC 330-119 | SMC5_191730 | 005645.39 | -72 2755.47 | 2.01 | 16.71 | -0.22 | B1-3 | - |  |
| NGC 330-120 | SMC5_191173 | 005642.59 | -72 2727.78 | 1.82 | 16.89 | -0.42 | B3: V-III | 147: (5) |  |
| NGC 330-121 | SMC5_081980 | 005622.57 | -72 2835.68 | 0.86 | 12.62 | 0.20 | A5 II | 154 (5) | R74-B38; UVES target |
| NGC 330-122 | SMC5_015195 | 005618.56 | -72 2645.21 | 1.03 | 14.00 | 0.04 | A2 II | 138 (5) | R74-B16; UVES target |
| NGC 330-123 | SMC5_037226 | 005603.92 | -72 2713.01 | 1.26 | 15.79 | -0.22 | O9.5 V | 177 (11) | R74-B18; UVES target |
| NGC 330-124 | SMC5_013293 | 005606.81 | -72 2835.08 | 1.21 | 15.83 | -0.20 | B0.2 V | 155 (12) | R74-B28; UVES target |
| NGC 330-125 | SMC5_003014 | 005620.18 | -72 2702.02 | 0.76 | 15.89 | -0.17 | B2 III | 151 (8) | R74-B13; UVES target |

$\dagger$ : Further notes on individual stars:
NGC 330-029: is also 2dFS\#5093
NGC 330-053: 2dFS\#1279 is likely a blend of 330-053 \& SMC5_064320
NGC 330-065: is also MA93\#920
NGC 330-073: is also 2dFS\#1087
NGC 330-076: is also MA93\#948
NGC 330-077: is also MA93\#868

## C. J. Evans et al.: FLAMES survey of massive stars: LMC and SMC clusters, Online Material p 6

Table 6. N11: observational parameters of target stars. The cross-references in the final column are to Sanduleak (1969, Sk) and Parker et al. (1992, P) The photometry for stars flagged with an asterisk was taken from Parker et al. (1992). Classifications for N11-031 and N11-060 were taken from Walborn et al. (2002) and Walborn et al. (2004) respectively.

| ID | $\alpha(2000)$ | $\delta(2000)$ | $V$ | $B-V$ | Sp. type | $v_{\mathrm{r}}$ | Comments |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| N11-001 | 045708.85 | -66 2325.1 | 11.63 | 0.64 | B2 Ia | 299 (12) | Sk-66036, P3252; UVES spectrum, $\mathrm{H} \alpha=\mathrm{P}$ Cyg em. |
| N11-002 | 045623.51 | -66 2951.7 | 11.83 | 0.60 | B3 Ia | 295 (12) | Sk-66²7, P1062; UVES spectrum, $\mathrm{H} \alpha=\mathrm{P}$ Cyg em. |
| N11-003 | 045650.59 | -66 2434.9 | 12.47* | -0.02 | B1 Ia | 287 (12) | P3157; UVES spectrum, $\mathrm{H} \alpha=$ broad em. |
| N11-004 | 045529.42 | -66 2312.0 | 12.56 | -0.06 | O9.7 Ib | 304 (15) | Sk-66 ${ }^{\circ} 16$ |
| N11-005 | 045704.10 | -66 2910.1 | 12.62 | 0.03 | B1 Ia | Binary | $\mathrm{Sk}-66^{\circ} 34, \mathrm{H} \alpha=\mathrm{em}$. |
| N11-006 | 045651.45 | -66 2806.4 | 12.66 | 0.51 | F8: | - | FLAMES-UVES target, foreground |
| N11-007 | 045617.29 | -66 3103.6 | 12.74 | -0.03 | O8 Ib (f) | 302 (14) | $\mathrm{Sk}-66^{\circ} 25$, variable $v_{r}$ or wind var.? |
| N11-008 | 045522.35 | -66 2818.9 | 12.77 | -0.01 | B0.5 Ia | 288 (14) | Sk-66 ${ }^{\circ} 15$ |
| N11-009 | 045717.68 | -66 2631.5 | 12.80 | 0.06 | B3 Iab | 288 (15) |  |
| N11-010 | 045640.94 | -66 2740.1 | 12.89 | -0.14 | O9.5 III + B1-2: | Binary (SB2) | P1310 |
| N11-011 | 045555.50 | -662820.3 | 12.89 | -0.08 | OC9.5 II | Binary (SB1) | Sk-66 ${ }^{\circ} 17$ |
| N11-012 | 045651.15 | -66 3148.3 | 12.90 | 0.02 | B1 Ia | 295 (11) | variable $v_{r}$ ? |
| N11-013 | 045700.86 | -662424.8 | 12.93 | -0.07 | O8 V | Binary (SB2) | P3223 |
| N11-014 | 045648.02 | -66 2009.8 | 12.98 | -0.02 | B2 Iab | 298 (13) | Sk-66 30 |
| N11-015 | 045722.08 | -662427.5 | 13.00 | -0.10 | B0.7 Ib | 307 (12) | Sk-66 ${ }^{\circ} 37$, P3271; UVES spectrum |
| N11-016 | 045620.59 | -66 2714.0 | 13.05 | -0.12 | B1 Ib | 294 (12) | Sk-66 ${ }^{\circ} 26$, P1036; UVES spectrum |
| N11-017 | 045617.57 | -66 1818.5 | 13.11 | 0.02 | B2.5 Iab | 291 (14) | Sk-66 ${ }^{\circ} 3$ |
| N11-018 | 045641.04 | -66 2440.3 | 13.13* | -0.09 | $\mathrm{O} 6 \mathrm{II}\left(\mathrm{f}^{+}\right)$ | 301 (6) | P3053, variable $v_{r}$ or wind var.? |
| N11-019 | 045611.72 | -66 3159.1 | 13.14 | -0.17 | O8-9 V-III(f)) | Binary (SB2) | Sk-66 ${ }^{\circ} 2$ |
| N11-020 | 045650.32 | -663103.6 | 13.18 | -0.22 | O5 I(n)f+ | Binary | $\mathrm{H} \alpha=$ broad em. |
| N11-021 | 045630.58 | -66 1808.6 | 13.24 | 0.12 | A7 II | 298 (4) |  |
| N11-022 | 045600.90 | -66 2616.4 | 13.33 | -0.15 | O6.5 II(f) var | 289 (8) | Sk-66 ${ }^{\circ} 2$ |
| N11-023 $\dagger$ | 045615.44 | -66 2734.9 | 13.40 | -0.14 | B0.7 Ib | 286 (12) | P1014; UVES spectrum |
| N11-024 | 045532.93 | -66 2527.7 | 13.45 | -0.10 | B1 Ib | 292 (12) |  |
| N11-025 | 045634.84 | -66 2823.1 | 13.45 | 0.35 | O8.5 V | - | FLAMES-UVES target |
| N11-026 | 045652.54 | -66 1955.8 | 13.51 | -0.17 | O2.5 $\mathrm{III}\left(\mathrm{f}^{*}\right)$ | 330 (8) |  |
| N11-027 | 045653.19 | -66 1901.9 | 13.56 | 0.68 | G2 | - | FLAMES-UVES target, foreground |
| N11-028 | 045716.24 | -66 2320.8 | 13.63 | 0.10 | O6-8 V | 304 (3) | P3264; strong nebular contamination |
| N11-029 | 045556.34 | -66 2903.9 | 13.63 | -0.12 | OC9.7 Ib | 297 (15) |  |
| N11-030 | 045548.38 | -66 2941.4 | 13.66 | -0.10 | Ble | Binary | $\mathrm{H} \alpha=$ broad em. |
| N11-031 | 045642.49 | -66 2518.0 | 13.68* | -0.01 | ON2 III (f*) | 322 (6) | P3061 |
| N11-032 | 045654.46 | -6624 15.6 | 13.68* | -0.11 | O7 II(f) | 305 (9) | P3168; no observations in HR02/ג3958 region |
| N11-033 | 045611.04 | -66 2823.9 | 13.68 | -0.16 | B0 IIIn | 296: (9) | P1005 |
| N11-034 | 045642.66 | -66 2945.1 | 13.68 | -0.15 | B0.5 III | 289: (10) | P1332; variable $v_{r}$ ? |
| N11-035 | 045728.70 | -66 3102.4 | 13.69 | 0.03 | O9 II(f) | Binary (SB1) |  |
| N11-036 | 045741.00 | -66 2956.4 | 13.72 | -0.15 | B0.5 Ib | 292 (16) |  |
| N11-037 | 045622.33 | -66 2804.6 | 13.77 | -0.10 | B0 III | Binary (SB1) | P1052 |
| N11-038 | 045645.21 | -66 2510.6 | 13.81* | 0.00 | O5 III(f+) | 318 (4) | P3100 |
| N11-039 | 045617.33 | -66 1748.0 | 13.83 | -0.18 | B2 III | 286 (9) |  |
| N11-040 | 045716.72 | -66 2822.7 | 13.84 | -0.10 | B0: IIIn | Binary? | $\mathrm{H} \alpha=$ abs + twin em. |
| N11-041 | 045652.32 | -66 3252.5 | 13.87 | -0.19 | O6.5 Iaf | Binary | $\mathrm{H} \alpha=$ complex abs + broad em. |
| N11-042 | 045615.57 | -66 2721.2 | 13.93 | -0.23 | B0 III | 288 (15) | P1017 |
| N11-043 | 045701.06 | -66 2829.8 | 13.93 | -0.21 | O7 III + B0: | Binary (SB2) |  |
| N11-044 | 045715.74 | -66 3354.0 | 13.96 | -0.14 | O6-8 V-III(f)) | Binary (SB2) | early B-type secondary |
| N11-045 | 045658.32 | -663132.9 | 13.97 | -0.15 | O9-9.5 III | 290 (13) |  |
| N11-046 | 045644.62 | -66 3420.5 | 13.98 | -0.24 | O9.5 V | Binary |  |
| N11-047 | 045625.48 | -66 2633.2 | 14.01 | -0.23 | B0 III | Binary (SB1) |  |
| N11-048 $\dagger$ | 045658.79 | -66 2440.7 | 14.02* | -0.17 | O6.5 V(f)) | 299 (3) | P3204 |
| N11-049 | 045629.59 | -66 2820.5 | 14.02 | -0.24 | 07.5 V | Binary (SB1) | P1110 |
| N11-050 | 045700.88 | -66 2357.1 | 14.03 | 0.10 | O4-5 + O7: | Binary (SB2) | P3224 |
| N11-051 | 045629.72 | -662138.5 | 14.03 | -0.26 | O5 Vn(f)) | 296: (5) |  |
| N11-052 | 045740.12 | -66 2602.8 | 14.06 | -0.18 | O9.5 V | Binary (SB2) |  |
| N11-053 | 045654.48 | -66 2732.0 | 14.09 | -0.16 | B1: ( $\mathrm{Be}-\mathrm{Fe}$ ) | Binary |  |
| N11-054 | 045718.33 | -66 2559.6 | 14.10 | -0.06 | B1 Ib | 294 (12) |  |
| N11-055 | 045710.57 | -66 1806.8 | 14.11 | 0.18 | O8-9 IIIne | 293 (3) | $\mathrm{H} \alpha=$ broad em. |
| N11-056 | 045749.05 | -6624 17.4 | 14.13 | -0.10 | Ble | 304 (8) | $\mathrm{H} \alpha=$ weak twin em. |
| N11-057† | 045615.48 | -6627 41.5 | 14.13 | 0.03 | A0 II | 284 (4) | P1015 |
| N11-058 | 045552.35 | -66 3413.4 | 14.16 | -0.23 | O5.5 V((f)) | 301 (3) |  |
| N11-059 | 045631.02 | -66 2840.8 | 14.23 | -0.25 | O9 V | Binary (SB1) | P1125 |
| N11-060 | 045642.16 | -66 2454.4 | 14.24* | -0.06 | $\mathrm{O} 3 \mathrm{~V}\left(\mathrm{f}^{*}\right)$ ) | 314 (3) | P3058 |
| N11-061 | 045725.73 | -662105.4 | 14.24 | -0.06 | O9 V | 305 (10) |  |
| N11-062 | 045655.35 | -66 3301.8 | 14.32 | -0.23 | B0.2 V | Binary (SB1) |  |
| N11-063 | 045740.53 | -662725.1 | 14.35 | -0.18 | O9: Vn | Binary (SB2) |  |
| N11-064 | 045711.47 | -66 2218.8 | 14.40 | -0.14 | B0.2: Vn | Binary |  |
| N11-065 | 045619.35 | -662701.8 | 14.40 | -0.24 | O6.5 V((f)) | 303 (7) | P1027 |
| N11-066 | 045657.51 | -66 3521.3 | 14.40 | -0.24 | O7 V(ff)) | 282 (7) |  |
| N11-067 | 045703.33 | -66 3008.1 | 14.50 | -0.24 | B0.5: Vn | Binary |  |
| N11-068 | 045604.61 | -66 2357.8 | 14.55 | -0.23 | O7 V(ff)) | 291 (10) |  |
| N11-069 | 045620.80 | -66 2703.3 | 14.56 | -0.19 | B1 III | 279 (12) | P1037; UVES spectrum |
| N11-070 | 045704.61 | -66 2422.3 | 14.59 | -0.13 | B3 III | 274 (8) | P3239 |
| N11-071 | 045724.19 | -662600.0 | 14.61 | -0.19 | O8: V | Binary (SB2) |  |

Table 6. Continued.

| ID | $\alpha(2000)$ | $\delta(2000)$ | V | $B-V$ | Sp. type | $v_{\mathrm{r}}$ | Comments |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| N11-072 | 045551.63 | -662157.5 | 14.61 | -0.27 | B0.2 V | 296 (13) |  |
| N11-073 | 045711.26 | -662653.8 | 14.63 | -0.06 | B0.5 ( $\mathrm{Be}-\mathrm{Fe}$ ) | 288: (6) | $\mathrm{H} \alpha=$ broad em. |
| N11-074 | 045619.49 | -6627 37.9 | 14.63 | -0.01 | B 0.5 ( $\mathrm{Be}-\mathrm{Fe}$ ) | 288: (5) | P1028; $\mathrm{H} \alpha=$ broad em. |
| N11-075 | 045722.05 | -66 1920.7 | 14.67 | -0.18 | B2 III | Binary? | Gaps in spectra due to bad pixels |
| N11-076 | 045633.58 | -6623 28.0 | 14.67 | 0.33 | B0.2 Ia | 331 (9) | $\mathrm{H} \alpha=\mathrm{P}$ Cyg., variable $v_{r}$ ? |
| N11-077 | 045601.36 | -66 2051.2 | 14.68 | -0.14 | B2 III | Binary (SB1) |  |
| N11-078 | 045604.94 | -663124.8 | 14.69 | -0.19 | B2 ( $\mathrm{Be}-\mathrm{Fe}$ ) | Binary (SB1) | $\mathrm{H} \alpha=$ broad em. |
| N11-079 | 045647.22 | -6624 42.1 | 14.71* | -0.12 | B0.2 V | 305 (8) | P3128 |
| N11-080 | 045654.71 | -6624 54.3 | 14.71* | -0.15 | O7: V + O9: | Binary (SB2) | P3173 |
| N11-081 | 045517.87 | -663149.7 | 14.72 | 0.09 | B0: n ( $\mathrm{Be}-\mathrm{Fe}$ ) | - | $\mathrm{H} \gamma=$ twin em. + str. nebular; HeII 14686: $v_{r}=286$ |
| N11-082 | 045732.49 | -66 2949.1 | 14.72 | -0.16 | B1-2 +early-B | Binary (SB2) |  |
| N11-083 | 045700.24 | -66 3216.3 | 14.73 | -0.20 | B0.5 V | 287 (12) | variable $v_{r}$ ? |
| N11-084 | 045609.20 | -6627 08.5 | 14.75 | -0.21 | B0.5 V | 306: (8) |  |
| N11-085 | 045639.34 | -662859.0 | 14.75 | -0.16 | B0.5 V | 293: (10) | variable $v_{r}$ ? |
| N11-086 | 045643.69 | -6628 36.0 | 14.75 | -0.21 | B1 V | 284 (7) |  |
| N11-087 | 045639.18 | -6624 50.0 | 14.76* | -0.10 | 09.5 Vn | 309 (2) | P3042 |
| N11-088 | 045632.93 | -662852.1 | 14.78 | -0.21 | B1 III | 281: (6) | P1160 |
| N11-089 | 045528.33 | -66 2941.6 | 14.81 | -0.03 | B2 III | Binary (SB1) |  |
| N11-090 | 045732.51 | -6625 56.8 | 14.83 | -0.08 | B2e | 292: (5) | $\mathrm{H} \alpha=$ broad em. |
| N11-091 | 045701.32 | -66 2013.0 | 14.85 | -0.10 | O9 V | Binary |  |
| N11-092 $\dagger$ | 045554.19 | -6625 01.5 | 14.87 | 0.11 | O7 V | Binary |  |
| N11-093 | 045529.95 | -6630 37.5 | 14.87 | -0.14 | B2.5 III | 293 (10) |  |
| N11-094 | 045717.08 | -66 3022.5 | 14.87 | -0.18 | B1 III | Binary (SB1) |  |
| N11-095 | 045737.92 | -6624 59.7 | 14.89 | -0.18 | B1 Vn | 295: (5) |  |
| N11-096 | 045654.08 | -662156.3 | 14.89 | -0.19 | B1.5 III | Binary (SB2) |  |
| N11-097 | 045517.66 | -6627 35.8 | 14.90 | 0.05 | B3 II | 294 (12) |  |
| N11-098 | 045658.97 | -66 3446.3 | 14.93 | -0.18 | B2 III | Binary (SB1) |  |
| N11-099 | 045746.69 | -6628 27.8 | 14.93 | -0.11 | B0.2 V | Binary (SB1) | strong nebular contamination |
| N11-100 | 045721.21 | -6625 01.2 | 14.94 | -0.20 | B0.5 V | 345 (12) | P3270; UVES spectrum |
| N11-101 | 045638.12 | -6623 54.2 | 14.95* | -0.14 | B0.2 V | 302 (10) | P3033; UVES spectrum |
| N11-102 | 045553.84 | -66 3429.4 | 14.95 | -0.16 | B0.2 V | 296: (5) |  |
| N11-103 | 045643.96 | -662814.5 | 14.95 | -0.14 | B1-2 +early-B | Binary |  |
| N11-104 | 045555.23 | -662157.2 | 14.96 | -0.19 | B1.5 V | 263: (9) |  |
| N11-105 | 045646.37 | -66 2716.7 | 14.97* | -0.25 | B1 V | 295 (8) | P1378; variable $v_{r}$ ? |
| N11-106 | 045642.08 | -663119.0 | 14.99 | -0.26 | B0 V | 290 (13) |  |
| N11-107 | 045532.90 | -6632 31.3 | 15.00 | -0.14 | B1-2 +early-B | Binary (SB2) |  |
| N11-108 | 045709.31 | -6622 11.8 | 15.04 | -0.18 | O9.5 V | 306 (15) |  |
| N11-109 | 045549.10 | -6627 39.1 | 15.07 | 0.10 | B0.5 Ib | 300 (15) |  |
| N11-110 | 045737.11 | -66 2344.7 | 15.08 | -0.05 | B1 III | 298 (14) |  |
| N11-111 | 045605.86 | -662154.8 | 15.11 | -0.24 | B1.5 III | 285 (10) |  |
| N11-112 | 045658.50 | -66 3243.6 | 15.12 | -0.11 | B1 Vn | Binary |  |
| N11-113 | 045646.72 | -6629 11.4 | 15.13 | -0.26 | B0.5 III | Binary (SB2) | Early B-type companion |
| N11-114 | 045737.69 | -6624 48.5 | 15.15 | -0.21 | B0 Vn | 296 (6) | variable $v_{r}$ ? |
| N11-115 | 045743.26 | -6624 38.0 | 15.15 | -0.14 | B1 III | 299 (10) |  |
| N11-116 | 045554.80 | -6627 41.8 | 15.16 | -0.07 | B2 III | 295 (8) |  |
| N11-117 | 045744.46 | -6623 59.2 | 15.21 | -0.19 | B1 Vn | 291: (6) | variable $v_{r}$ ? |
| N11-118 | 045644.30 | -6623 04.8 | 15.21 | -0.17 | B1.5 V | Binary (SB1) |  |
| N11-119 | 045549.45 | -6626 03.5 | 15.22 | -0.21 | B1.5 V | Binary (SB2) |  |
| N11-120 | 045715.22 | -6622 29.5 | 15.24 | -0.12 | B0.2 Vn | Binary |  |
| N11-121 | 045644.52 | -66 3003.3 | 15.24 | -0.19 | B1 Vn | 299: (4) |  |
| N11-122 | 045628.76 | -6628 47.1 | 15.27 | -0.27 | O9.5 V | 289 (10) |  |
| N11-123 | 045650.50 | -6628 23.1 | 15.29 | -0.25 | 09.5 V | 295 (11) |  |
| N11-124 | 045618.63 | -662837.2 | 15.34 | -0.21 | B0.5 V | Binary (SB1) |  |

$\dagger$ : Further notes on individual stars
N11-023 \& N11-057: These two stars are unresolved in the charts of Sanduleak (1969) and together were identified Sk-66 24.
N11-048: Blended with Parker 3209, which together likely comprise Sk-66 33 .
N11-092: Blended with another star in the WFI image, which together comprise $\mathrm{Sk}-66^{\circ} 19$.

Table 7. NGC 2004: observational parameters of target stars. The cross-references in the final column are to Sanduleak (1969, Sk), Robertson (1974, R74), Breysacher (1981, Brey), Walker (1987) and Martayan et al. (2006, MHF). All spectral types are those of the authors, excepting NGC 2004-057 (Brey 45), taken from Smith et al. (1996).

| ID | $\alpha(20346-0800)$ | $\delta(2000)$ | $\mathrm{r}_{\text {d }}$ | V | $B-V$ | Sp. type | $v_{\text {r }}$ | Comments |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| NGC 2004-001 | 053007.07 | -67 1543.3 | 3.54 | 11.60 | -0.07 | A1 Ia | 314 (6) | Sk-67 ${ }^{\circ} 143 ; \mathrm{H} \alpha=>v_{r}$ variable or var. em. |
| NGC 2004-002 | 053112.82 | -67 1508.0 | 3.79 | 11.62 | 0.44 | A3: Iab | 295 (2) | Sk-67 155 ; FLAMES-UVES target |
| NGC 2004-003 | 053040.40 | -67 1609.0 | 1.09 | 11.94 | 0.20 | B5 Ia | 309 (12) | R74-C01; binary? |
| NGC 2004-004 | 053127.90 | -6724 43.9 | 8.79 | 11.94 | 0.23 | B9 Ia | 322 (8) | Sk-67 157 |
| NGC 2004-005 | 052942.61 | -6720 47.5 | 6.60 | 11.99 | -0.11 | B8 Ia | 313 (10) | Sk-67 137 |
| NGC 2004-006 | 053001.22 | -67 1436.9 | 4.59 | 11.99 | 0.00 | A2 Iab | 313 (3) | Sk-67 ${ }^{\circ} 141$ |
| NGC 2004-007 | 053200.76 | -6720 22.6 | 8.39 | 12.09 | 0.14 | B8 Ia | 310 (10) | Sk-670 171 |
| NGC 2004-008 | 053040.10 | -67 1637.9 | 0.61 | 12.28 | 0.07 | B9 Ia | 305 (10) | R74-B01 |
| NGC 2004-009 | 053152.98 | -671215.4 | 8.61 | 12.47 | 0.01 | A1 Iab | 308 (4) |  |
| NGC 2004-010 | 052921.72 | -6720 11.0 | 8.13 | 12.60 | -0.15 | B2.5 Iab | 296 (12) | Sk-67 ${ }^{\circ} 133$ |
| NGC 2004-011 | 053103.75 | -6721 20.1 | 4.69 | 12.64 | -0.13 | B1.5 Ia | 309 (12) | Sk-67 154 |
| NGC 2004-012 | 053037.48 | -67 1653.7 | 0.43 | 13.39 | -0.20 | B1.5 Iab | 305 (12) | R74-B09 |
| NGC 2004-013 | 053046.55 | -67 1939.8 | 2.50 | 13.40 | -0.17 | B2 II | 289: (10) | R74-D13; $\mathrm{H} \alpha=>v_{r}$ variable or var. em. |
| NGC 2004-014 | 053044.47 | -672101.5 | 3.81 | 13.43 | -0.12 | B3 Ib | 306 (12) |  |
| NGC 2004-015 | 052911.46 | -67 1524.4 | 8.76 | 13.48 | -0.20 | B1.5 II | Binary (SB1) |  |
| NGC 2004-016 | 053040.11 | -67 1859.1 | 1.75 | 13.54 | -0.05 | B9 Ib | 296 (5) | R74-D18 |
| NGC 2004-017 | 053046.59 | -67 1421.7 | 2.94 | 13.55 | 0.56 | G2 | - | FLAMES-UVES target; foreground |
| NGC 2004-018 | 053102.69 | -6720 49.8 | 4.20 | 13.58 | 0.57 | G8: | - | FLAMES-UVES target; foreground |
| NGC 2004-019 | 053044.62 | -67 1837.9 | 1.46 | 13.60 | -0.20 | O9.5 IIIn | 318: (12) | R74-D16 |
| NGC 2004-020 | 053053.80 | -67 1548.8 | 1.94 | 13.61 | -0.13 | B1.5 II | Binary (SB1) |  |
| NGC 2004-021 | 053042.01 | -672141.4 | 4.46 | 13.67 | -0.14 | B1.5 Ib | 311 (12) |  |
| NGC 2004-022 | 053047.37 | -67 1723.4 | 0.71 | 13.77 | -0.17 | B1.5 Ib | 300 (12) | R74-B30 |
| NGC 2004-023 | 053058.01 | -67 1814.8 | 1.99 | 13.91 | -0.08 | B2 ( $\mathrm{Be}-\mathrm{Fe}$ ) | 311: (6) | $\mathrm{H} \alpha=$ str. em. |
| NGC 2004-024 | 052953.99 | -67 1722.2 | 4.46 | 14.07 | -0.15 | B1.5 IIIn | 356 (7) |  |
| NGC 2004-025 | 053000.73 | -672156.4 | 6.05 | 14.17 | -0.16 | B2 ( $\mathrm{Be}-\mathrm{Fe}$ ) | 305 (8) | $\mathrm{H} \alpha=$ str. em. |
| NGC 2004-026 | 053036.35 | -67 1742.9 | 0.60 | 14.18 | -0.17 | B2 II | Binary (SB1) | R74-B15; $\mathrm{H} \alpha=$ shell star |
| NGC 2004-027 | 052934.53 | -67 1156.1 | 8.26 | 14.18 | -0.11 | B0e | 282 (5) | $\mathrm{H} \alpha$ \& He6678 variable $v_{r}$ or var. em.? |
| NGC 2004-028 | 053132.59 | -67 1640.3 | 5.09 | 14.26 | -0.19 | B2 II | 311: (6) |  |
| NGC 2004-029 | 053100.11 | -67 1459.2 | 2.96 | 14.27 | -0.20 | B1.5e | 322 (10) | $\mathrm{H} \alpha=$ str. em. |
| NGC 2004-030 | 053011.03 | -6722 57.1 | 6.37 | 14.28 | -0.23 | B0.2 Ib | Binary (SB1) |  |
| NGC 2004-031 | 053038.77 | -6720 23.9 | 3.16 | 14.29 | -0.16 | B2 II | Binary (SB1) |  |
| NGC 2004-032 | 053037.30 | -67 1034.0 | 6.68 | 14.30 | -0.14 | B2 II | 305: (7) |  |
| NGC 2004-033 | 052932.69 | -67 1705.0 | 6.52 | 14.31 | -0.18 | B1.5e | 309 (6) | $\mathrm{H} \alpha=$ twin em., var |
| NGC 2004-034 | 053028.11 | -67 1516.7 | 2.28 | 14.40 | -0.11 | B1.5e | 310 (6) | $\mathrm{H} \alpha=$ twin em. |
| NGC 2004-035 | 053037.16 | -67 1544.3 | 1.53 | 14.40 | -0.02 | B1: ( $\mathrm{Be}-\mathrm{Fe}$ ) | 312: (4) | $\mathrm{H} \alpha=$ twin em . |
| NGC 2004-036 | 052920.73 | -67 1754.8 | 7.70 | 14.43 | -0.22 | B1.5 III | 308 (12) |  |
| NGC 2004-037 | 053026.38 | -670900.8 | 8.33 | 14.45 | -0.10 | B2e | 270: (4) | $\mathrm{H} \alpha=$ twim em, variable $v_{r}$ ? |
| NGC 2004-038 | 053122.14 | -67 1739.1 | 4.07 | 14.46 | -0.24 | B0.7 V | 290: (6) |  |
| NGC 2004-039 | 053027.22 | -67 1327.6 | 3.98 | 14.47 | -0.11 | B1.5e | 310: (6) | $\mathrm{H} \alpha=\mathrm{wk}$ twin em |
| NGC 2004-040 | 053007.27 | -671423.3 | 4.27 | 14.49 | 0.07 | A7 II | 292 (3) |  |
| NGC 2004-041 | 053032.64 | -67 1525.9 | 1.95 | 14.52 | -0.14 | B2.5 III | Binary (SB1) | MHF98013 |
| NGC 2004-042 | 053111.98 | -6723 14.3 | 6.74 | 14.53 | -0.18 | B2.5 III | 294 (10) |  |
| NGC 2004-043 | 053038.74 | -67 1513.2 | 2.02 | 14.58 | -0.16 | B1.5 III | 333 (12) |  |
| NGC 2004-044 | 052933.98 | -67 1806.9 | 6.45 | 14.60 | -0.22 | B1.5: | Binary (SB2) | Similar temperature secondary; MHF83937 |
| NGC 2004-045 | 053050.19 | -67 1447.6 | 2.63 | 14.60 | -0.18 | B2 III | Binary (SB1) |  |
| NGC 2004-046 | 053042.96 | -67 1643.5 | 0.58 | 14.64 | -0.19 | B1.5 III | 312 (12) | R74-B50 |
| NGC 2004-047 | 053013.54 | -67 1427.3 | 3.79 | 14.70 | -0.21 | B2 III | Binary (SB1) | MHF103207 |
| NGC 2004-048 | 053147.04 | -67 1754.6 | 6.49 | 14.70 | -0.20 | B2.5e | 307: (7) |  |
| NGC 2004-049 | 053006.19 | -67 1432.9 | 4.24 | 14.71 | -0.24 | O2-3 III( ${\left(f^{*}\right.}^{\text {a }}$ ) +OB | Binary (SB2) |  |
| NGC 2004-050 | 053043.07 | -67 1743.9 | 0.57 | 14.71 | -0.19 | B2.5 III | Binary (SB1) | R74-B24 |
| NGC 2004-051 | 053053.44 | -671710.6 | 1.28 | 14.73 | -0.19 | B2 III | 308 (12) | R74-C16 |
| NGC 2004-052 | 053206.28 | -67 1949.2 | 8.70 | 14.75 | -0.23 | B2 III | 291: (10) |  |
| NGC 2004-053 | 053043.79 | -67 1522.6 | 1.89 | 14.75 | -0.21 | B0.2 Ve | 303 (14) | $\mathrm{H} \alpha=\mathrm{em}$. |
| NGC 2004-054 | 053146.38 | -67 1328.9 | 7.41 | 14.76 | -0.20 | B2 III | Binary (SB1) |  |
| NGC 2004-055 | 053014.55 | -67 1527.2 | 3.05 | 14.76 | -0.17 | B2.5 III | 309: (8) | $\mathrm{H} \alpha=$ complex, in-filled from em. |
| NGC 2004-056 | 053035.92 | -671108.5 | 6.11 | 14.84 | -0.04 | B1.5e | 300 (4) | $\mathrm{H} \alpha=$ twin em. |
| NGC 2004-057 | 053134.37 | -67 1629.4 | 5.28 | 14.85 | -0.51 | WN4b | - | Sk-67 ${ }^{\circ} 160$; Brey 45 |
| NGC 2004-058 | 053005.13 | -67 1845.8 | 3.71 | 14.86 | -0.20 | O9.5 V ( N str ) | 303: (10) |  |
| NGC 2004-059 | 053045.92 | -671824.4 | 1.29 | 14.86 | -0.20 | B2 III | Binary (SB1) | R74-D17 |
| NGC 2004-060 | 053032.94 | -671122.5 | 5.91 | 14.86 | -0.14 | B2 III | 295 (7) |  |
| NGC 2004-061 | 052915.96 | -67 1945.4 | 8.51 | 14.88 | -0.25 | B2 III | 312 (12) |  |
| NGC 2004-062 | 053110.97 | -672251.4 | 6.36 | 14.90 | -0.23 | B0.2 V | 319: (8) |  |
| NGC 2004-063 | 053034.49 | -67 1734.9 | 0.65 | 14.93 | -0.15 | B2 III | 311 (8) | R74-C08 |
| NGC 2004-064 | 053119.11 | -67 1654.7 | 3.77 | 14.96 | -0.22 | B0.7-B1 III | 310 (12) |  |
| NGC 2004-065 | 053013.10 | -672106.5 | 4.67 | 14.96 | -0.19 | B2.5 III | 306: (7) |  |
| NGC 2004-066 | 053027.78 | -67 1722.8 | 1.21 | 14.96 | -0.16 | B1.5 Vn | 308: (6) |  |
| NGC 2004-067 | 053034.64 | -67 1445.6 | 2.54 | 14.96 | -0.08 | B1.5e | 284: (5) | H $\alpha=$ twin; MHF101350 |
| NGC 2004-068 | 053023.00 | -67 0853.6 | 8.51 | 14.97 | -0.08 | B2.5 III | 281 (10) |  |
| NGC 2004-069 | 053012.15 | -67 1019.7 | 7.42 | 14.99 | -0.24 | B0.7 V | 332 (6) |  |
| NGC 2004-070 | 053103.61 | -67 1607.7 | 2.52 | 15.01 | -0.22 | B0.7-B1 III | 310 (12) |  |
| NGC 2004-071 | 053131.31 | -67 1133.3 | 7.53 | 15.05 | -0.23 | B1.5 III | 298 (9) |  |
| NGC 2004-072 | 052950.50 | -671510.4 | 5.22 | 15.08 | -0.22 | B1.5 V | Binary (SB1) |  |

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\text { C. J. Evans et al.: FLAMES survey of massive stars: LMC and SMC clusters, Online Material p } 9
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Table 7. Continued.

| ID | $\alpha(20346-0800)$ | $\delta(2000)$ | $\mathrm{r}_{\mathrm{d}}$ | V | $B-V$ | Sp. type | $v_{\mathrm{r}}$ | Comments |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| NGC 2004-073 | 053055.73 | -671848.6 | 2.17 | 15.08 | -0.20 | B2 III | 304 (12) | R74-D12 |
| NGC 2004-074 | 053029.03 | -6722 52.8 | 5.74 | 15.08 | -0.19 | B0.7-B1 V | Binary (SB1) |  |
| NGC 2004-075 | 053053.42 | -671803.7 | 1.52 | 15.08 | -0.18 | B2 III | 289: (11) | R74-D10 |
| NGC 2004-076 | 053020.65 | -670841.2 | 8.76 | 15.08 | -0.08 | B2.5 III | Binary (SB1) |  |
| NGC 2004-077 | 052916.94 | -6720 33.8 | 8.70 | 15.09 | -0.29 | B0.5 V | 296: (6) |  |
| NGC 2004-078 | 053131.33 | -671505.9 | 5.38 | 15.09 | -0.20 | B2 III | Binary (SB1) |  |
| NGC 2004-079 | 053040.75 | -671143.9 | 5.51 | 15.09 | -0.16 | B2 III | Binary (SB1) |  |
| NGC 2004-080 | 052958.83 | -671617.8 | 4.10 | 15.11 | -0.21 | B2.5 III | 313 (10) |  |
| NGC 2004-081 | 052952.86 | -671814.6 | 4.68 | 15.11 | -0.20 | B1 V | 298 (8) |  |
| NGC 2004-082 | 053020.37 | -67 2055.4 | 4.15 | 15.11 | -0.19 | B1.5 V | 305: (7) |  |
| NGC 2004-083 | 053028.43 | -671700.6 | 1.16 | 15.11 | -0.11 | B1.5: e | Binary (SB1) | R74-D22; $\mathrm{H} \alpha=$ twin |
| NGC 2004-084 | 053108.01 | -67 2000.3 | 3.85 | 15.14 | -0.21 | B1.5 III | 306 (12) |  |
| NGC 2004-085 | 052956.32 | -671755.5 | 4.29 | 15.14 | -0.19 | B2.5 III | 305: (10) |  |
| NGC 2004-086 | 053058.02 | -671404.8 | 3.60 | 15.15 | -0.20 | B2 III | 312 (10) |  |
| NGC 2004-087 | 053101.27 | -672008.7 | 3.55 | 15.15 | -0.20 | B1.5 V | 316 (12) |  |
| NGC 2004-088 | 053057.15 | -671514.3 | 2.58 | 15.15 | -0.18 | B2.5 III | 307: (5) | No 24124 data |
| NGC 2004-089 | 053048.35 | -672158.6 | 4.80 | 15.16 | -0.14 | B2.5e | 304: (9) | $\mathrm{H} \alpha=$ twin |
| NGC 2004-090 | 052922.31 | -671640.1 | 7.54 | 15.17 | -0.28 | O9.5 III | 310 (16) |  |
| NGC 2004-091 | 052934.32 | -671501.9 | 6.73 | 15.17 | -0.22 | B1.5 III | 310 (12) |  |
| NGC 2004-092 | 053024.95 | -671246.8 | 4.70 | 15.18 | -0.11 | B2e | 304: (5) | $\mathrm{H} \alpha=$ twin |
| NGC 2004-093 | 052920.33 | -671904.3 | 7.92 | 15.19 | -0.21 | B3 III | 287: (9) |  |
| NGC 2004-094 | 053109.27 | -67 1522.3 | 3.37 | 15.20 | -0.19 | B2.5 III | Binary |  |
| NGC 2004-095 | 053059.22 | -671531.7 | 2.51 | 15.20 | -0.19 | B1.5 V | 287 (8) |  |
| NGC 2004-096 | 053029.95 | -67 1553.5 | 1.67 | 15.21 | -0.09 | B1.5e | 317: (4) | $\mathrm{H} \alpha=$ twin |
| NGC 2004-097 | 053013.21 | -670840.4 | 8.95 | 15.24 | -0.20 | B2 III | 298 (10) | variable $v_{r}$ ? |
| NGC 2004-098 | 053100.30 | -67 1905.9 | 2.69 | 15.24 | -0.18 | B2 III | 287: (7) |  |
| NGC 2004-099 | 053116.52 | -67 2055.7 | 5.09 | 15.26 | -0.21 | B2 III | 292: (7) |  |
| NGC 2004-100 | 052929.89 | -671822.1 | 6.88 | 15.29 | -0.18 | B1 Vn | 298: (6) |  |
| NGC 2004-101 | 053048.23 | -671713.0 | 0.78 | 15.30 | -0.18 | B2 III | 309: (10) | R74-B28 |
| NGC 2004-102 | 053100.23 | -671604.0 | 2.26 | 15.30 | -0.18 | B2 III | Binary |  |
| NGC 2004-103 | 053020.63 | -6713 40.7 | 4.03 | 15.30 | -0.12 | B2 III | 303 (11) |  |
| NGC 2004-104 | 052938.76 | -67 1207.6 | 7.83 | 15.31 | -0.19 | B1.5 V | 301: (6) |  |
| NGC 2004-105 | 053010.20 | -671842.3 | 3.25 | 15.31 | -0.19 | B1.5 V | 297: (7) |  |
| NGC 2004-106 | 053029.49 | -671646.0 | 1.14 | 15.31 | -0.14 | B2 III | 307 (11) | R74-D23; Walker 4 |
| NGC 2004-107 | 053145.13 | -67 2301.8 | 8.53 | 15.32 | -0.25 | B0.5 V | Binary (SB1) |  |
| NGC 2004-108 | 053018.15 | -67 1258.6 | 4.76 | 15.32 | -0.21 | B2.5 III | 296 (10) |  |
| NGC 2004-109 | 052911.05 | -671859.2 | 8.78 | 15.32 | -0.20 | B2.5 III | 298: (11) | MHF79301 |
| NGC 2004-110 | 053050.48 | -671038.4 | 6.67 | 15.32 | -0.19 | B2 III | 296: (7) |  |
| NGC 2004-111 | 053205.74 | -67 1558.1 | 8.35 | 15.39 | -0.21 | B2.5 III | 310 (10) |  |
| NGC 2004-112 | 053204.73 | -67 1903.7 | 8.36 | 15.39 | -0.19 | B2 III | 307 (8) |  |
| NGC 2004-113 | 053053.86 | -671654.4 | 1.36 | 15.39 | -0.17 | B2.5 IIIn | 293: (7) | R74-D08 |
| NGC 2004-114 | 053047.87 | -6724 45.4 | 7.55 | 15.43 | -0.18 | B2 III | 298 (11) |  |
| NGC 2004-115 | 053104.64 | -671835.1 | 2.72 | 15.44 | -0.19 | B2e | Binary (SB1) | $\mathrm{H} \alpha=$ twin+central abs |
| NGC 2004-116 | 053023.58 | -671041.7 | 6.74 | 15.44 | -0.12 | B2 III | 309 (13) | $\mathrm{H} \alpha=>v_{r}$ variable or var. em. |
| NGC 2004-117 | 053029.14 | -67 0951.2 | 7.46 | 15.47 | -0.14 | B2 III | 305 (10) |  |
| NGC 2004-118 | 053117.28 | -6718 42.5 | 3.87 | 15.52 | -0.21 | B1.5 V | Binary (SB1) |  |
| NGC 2004-119 | 053114.65 | -671159.8 | 6.21 | 15.53 | -0.20 | B2 III | 309 (14) |  |

## C. J. Evans et al.: FLAMES survey of massive stars: LMC and SMC clusters, Online Material p 10

Table 8. Comparison of current classifications with published spectral types. Sources of classifications are W77 (Walborn 1977); FB80 (Feast \& Black 1980); CJF85 (Carney et al. 1985); NMC (Niemela et al. 1986); G87 (Garmany et al. 1987); MPG (Massey et al. 1989 ); F91 (Fitzpatrick 1991); P92 (Parker et al. 1992); L93 (Lennon et al. 1993); M95 (Massey et al. 1995); G96 (Grebel et al. 1996); LG96 (classifications from Lennon, given by Grebel et al. 1996); HM00 (Heydari-Malayeri et al. 2000, who adopt identifications from Woolley 1963); W00 (Walborn et al. 2000); L03 (Lennon et al. 2003); EH04 (Evans et al. 2004).

| ID | Alias | FLAMES | Published |
| :---: | :---: | :---: | :---: |
| NGC 346-001 | AzV 232/Sk 80 | O7 Iaf+ | O7 Iaf+ [W77]; O7 If [MPG 789] |
| NGC 346-004 | AzV 191 | Be (B1:) | B extr [G87] |
| NGC 346-007 | MPG 324 | O4 V((f+)) | O4-5 V [NMC]; O4 V((f)) [MPG]; O4 ((f)) [W00] |
| NGC 346-008 | AzV 224 | B1e | B1 III [G87] |
| NGC 346-009 | MPG 845 | B0e | O9.5 V [MPG] |
| NGC 346-010 | AzV 226 | O7 IIIn((f)) | O7 III [G87] |
| NGC 346-012 | AzV 202 | B1 Ib | B1 III [G87] |
| NGC 346-014 | 2dFS\#1425 | A0 II | A0 (Ib) [EH04] |
| NGC 346-015 | AzV 217 | B1 V + ? | B1 III [M95]; B 1-3 (II) [EH04: 2dFS\#1357] |
| NGC 346-016 | 2dFS\#5100 | $\mathrm{B} 0.5 \mathrm{Vn}+$ ? | B0-3 (III) [EH04] |
| NGC 346-020 | 2dFS\#1259 | B1 V+early-B | B0-3 (III) [EH04] |
| NGC 346-021 | 2dFS\#5099 | B1 III | B1-3 (III) [EH04] |
| NGC 346-022 | MPG 682 | O9 V | O8 V [MPG] |
| NGC 346-023 | MPG 178 | Be (B0.2:) | O8-8.5 V:: [MPG]; B0: (IV) [EH04: 2dFS\#5097] |
| NGC 346-025 | MPG 848 | O9 V | O8.5 V [MPG] |
| NGC 346-026 | MPG 12 | B0 IV (Nstr) | O9.5 V [MPG]; O9.5-B0 V (N str) [W00]; O9.5 III [EH04: 2dFS\#1299] |
| NGC 346-028 | MPG 113 | OC6 Vz | O6 V [MPG]; OC6 Vz [W00, the source of the type adopted here] |
| NGC 346-029 | MPG 637 | $\mathrm{B} 0 \mathrm{~V}+$ ? | B0 V [MPG] |
| NGC 346-030 | 2dFS\#5098 | B0 V +? | B0.5 (V) [EH04] |
| NGC 346-034 | MPG 467 | O8.5 V | O8 V+neb [MPG] |
| NGC 346-035 | 2dFS\#1418 | B1 V + ? | B1-5 (II) [EH04] |
| NGC 346-036 | MPG 729 | B0.5 Ve | B0+neb [MPG] |
| NGC 346-039 | 2dFS\#1262 | B0.7 V | B1-3 (III) [EH04] |
| NGC 346-043 | MPG 11 | B0 V | B0 V [MPG] |
| NGC 346-047 | 2dFS\#1189 | B2.5 III | B1-5 (III) [EH04] |
| NGC 346-050 | MPG 299 | O 8 Vn | O9 V [MPG] |
| NGC 346-051 | MPG 523 | O 7 Vz | O7 V+neb [MPG] |
| NGC 346-056 | MPG 310 | B0 V | O9.5 V [MPG] |
| NGC 346-061 | 2dFS\#1277 | Be (B1-2) | B1-5 (II)e [EH04] |
| NGC 346-063 | 2dFS\#1413 | A0 II | A0 (II) [EH04] |
| NGC 346-075 | 2dFS\#1389 | B1 V +? | B1-3 (IV) [EH04] |
| NGC 346-077 | MPG 238 | O9 V | B0: [MPG] |
| NGC 346-084 | 2dFS\#1296 | B1 V | B0-5 (IV) [EH04] |
| NGC 330-002 | R74-A02 | B3 Ib | B5 I [FB80]; B6 I [CJF85]; B4 Iab/b [L93]; B5 I [G96]; B4 Ib [L03] |
| NGC 330-003 | 2dFS\#1183 | B2 Ib | B2.5 (Ib) [EH04] |
| NGC 330-004 | R74-B37 | B2.5 Ib | B5 I [FB80]; B5 I [CJF85]; B3 Ib [L93]; B2.5 (Ib) [EH04: 2dFS\#5090] |
| NGC 330-012 | Arp 211 | A0 Ib | A0 I [CJF85] |
| NGC 330-013 | AzV 186 | O8 III-II((f)) | O7 III [G87]; O8 III((f)) [EH04: 2dFS\#1230]] |
| NGC 330-017 | 2dFS\#1171 | B2 II | B1-3 (II) [EH04] |
| NGC 330-018 | R74-B30 | B3 II | B6 I [CJF85]; B2 II [L93] |
| NGC 330-020 | 2dFS\#1232 | B3 II | B3 (II) [EH04] |
| NGC 330-021 | 2dFS\#1242 | B0.2 III | B0.5 (IV) [EH04] |
| NGC 330-022 | 2dFS\#1062 | B3 II | B3 (II) [EH04] |
| NGC 330-024 | 2dFS\#1034 | B5 Ib | B5 (II) [EH04] |
| NGC 330-025 | 2dFS\#1224 | B1.5e | B2 (II) [EH04] |
| NGC 330-028 | 2dFS\#1195 | B1 V | B2 (III) [EH04] |
| NGC 330-029 | 2dFS\#5093 | B0.2 Ve | B0-3 (III)e [EH04] |
| NGC 330-031 | 2dFS\#5088 | B0.5 Ve | B0.5 (IV) [EH04] |
| NGC 330-033 | 2dFS\#5094 | B1.5 V | B1-5 (II) [EH04] |
| NGC 330-036 | R74-B32 | B2 II | B2 III [L03] |
| NGC 330-037 | 2dFS\#1058 | A2 II | A0 (II) [EH04] |
| NGC 330-038 | 2dFS\#1206 | B1 V | B1-2 (III) [EH04] |
| NGC 330-039 | 2dFS\#1109 | B0 V | B0.5 (V) [EH04] |
| NGC 330-040 | 2dFS\#1041 | B2 III | B1-2 (III) [EH04] |
| NGC 330-041 | 2dFS\#1241 | B0 V | B0 (V) [EH04] |
| NGC 330-045 | 2dFS\#5087 | B3 III | B1-5 (III) [EH04] |
| NGC 330-046 | 2dFS\#1293 | O9.5 V | B0 (V) [EH04] |
| NGC 330-047 | 2dFS\#1190 | B1 V | B1-3 (III) [EH04] |
| NGC 330-051 | 2dFS\#1276 | B1.5 V | B1-5 (III) [EH04] |
| NGC 330-052 | 2dFS\#1152 | O8.5 Vn | O8 V [EH04] |

Table 8. Continued.

| ID | Alias | FLAMES | Published |
| :---: | :---: | :---: | :---: |
| NGC 330-061 | 2dFS\#1118 | A0 II | A0 (II) [EH04] |
| NGC 330-073 | 2dFS\#1087 | B8 Ib | B8 (II) [EH04] |
| NGC 330-104 | 2dFS\#1037 | B0: V | B0-5 (IV) [EH04] |
| NGC 330-118 | 2dFS\#1013 | B1-2 | B1-2 (V) [EH04] |
| NGC 330-121 | R74-B38 | A5 II | A1 I [FB80] |
| NGC 330-123 | R74-B18 | O9.5 V | B0 Ve [L93]; O9 III/Ve [LG96] |
| NGC 330-124 | R74-B28 | B0.2 V | B0 Ve [L93]; B0.2 IIIe [LG96] |
| NGC 330-125 | R74-B13 | B2 III | B2 III/IVe [L93]; B2 III/IVe [LG96] |
| N11-001 | Sk-66³6/P3252 | B2 Ia | B2 I + neb [F91]; B2 II (Hwk) [P92] |
| N11-002 | Sk-66²7/P1062 | B3 Ia | B2.5-3 Ia [F91]; B4 Ia [P92] |
| N11-003 | P3157 | B1 Ia | BC1 Ia (Nwk) [P92] |
| N11-010 | P1310 | O9.5 III + B1-2: | B0 V [P92] |
| N11-013 | P3223 | O8 V | O8.5 IV [P92] |
| N11-015 | Sk-66 ${ }^{\circ} 37 / \mathrm{P} 3271$ | B0.7 Ib | B1 II (Hwk) [P92] |
| N11-016 | Sk-66²6/P1036 | B1 Ib | B1.5 Ia (Nwk) [P92]; B1 III [M95] |
| N11-018 | P3053 | O6 II(f*) | O5.5 I-III(f) [P92] |
| N11-022 | Sk-66 20 | O6.5 II(f) | O6 III [M95] |
| N11-023 | P1014 | B0.7 Ib | B0.5 II (blend?) [P92] |
| N11-028 | P3264 | O6-8 V | O3-6 V (ZAMS in N11A) [P92] |
| N11-031 | P3061 | ON2 III( $\mathrm{f}^{*}$ ) | O3 III(fi) [P92]; O2 III(fi) [W02]; ON2 III(f*) [W04, adopted here] |
| N11-032 | P3168 | O7 II(f) | O7 II(f) [P92] |
| N11-033 | P1005 | B0 IIIn | B0 III [P92] |
| N11-034 | P1332 | B0.5 III | B0.7 II [P92] |
| N11-037 | P1052 | B0 III | B0.2 III [P92] |
| N11-038 | P3100 | O5 II(f+) | O6.5 V((f)): [P92] |
| N11-042 | P1017 | B0 III | B0 III [P92] |
| N11-048 | P3204 | O6.5 V((f)) | O6-7 V (ZAMS) [P92] |
| N11-049 | P1110 | 07.5 V | O7.5 V [P92] |
| N11-050 | P3224 | O4-5 + 07: | O6 III (blend?) [P92] |
| N11-059 | P1125 | O9 V | O8.5 V [P92] |
| N11-060 | P3058 | O3 V((f*)) | O3 V((f*)) [P92]; O3 V((f*)) [W02, adopted here] |
| N11-063 | Wo597 | O9: Vn | O9 V [HM00] |
| N11-065 | P1027 | O6.5 V((f)) | O6.5 V((f)) [P92] |
| N11-069 | P1037 | B1 III | B1.5 II [P92] |
| N11-070 | P3239 | B3 III | B2 V [P92] |
| N11-074 | P1028 | B0.5e | O8-9: III: [P92] |
| N11-079 | P3128 | B0.2 V | O9.5 IV [P92] |
| N11-080 | P3173 | O7: V + O9: | O4-6 V [P92] |
| N11-087 | P3042 | O9.5 Vn | O9.5: III: [P92] |
| N11-088 | P1160 | B1 III | B1 V [P92] |
| N11-099 | Wo622 | B0.2 V | O9.7 III/B0.2 V [HM00] |
| N11-100 | P3270 | B0.5 V | B1 V [P92] |
| N11-101 | P3033 | B0.2 V | B0.2 IV [P92] |
| N11-105 | P1378 | B1 V | B1 V [P92] |
| NGC 2004-001 | Sk-67 ${ }^{\circ} 143$ | A1 Ia | B7 Ia+ [F91] |



Fig. 13. FLAMES targets in the NGC 346 field. Due to crowding in the core of the cluster 346-007, 034, 079, 086, 111, and 115 are not labelled. Each of these is included in the Massey et al. (1989) study and the reader is referred to their finding charts for these stars.

## C. J. Evans et al.: FLAMES survey of massive stars: LMC and SMC clusters, Online Material p 13



Fig. 14. FLAMES targets in the NGC 330 field. The five additional UVES targets (nos. 121-125) are not included, the reader is directed to the finding charts by Robertson (1974).


Fig. 15. FLAMES targets in the N11 field. The nine additional UVES targets are not included, the reader is directed to the finding charts by Parker et al. (1992).


Fig. 16. FLAMES targets in the NGC 2004 field.


Fig. 17. O-type (open blue circles) and B-type (gold) FLAMES \& UVES targets in the N11 field.

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\text { C. J. Evans et al.: FLAMES survey of massive stars: LMC and SMC clusters, Online Material p } 17
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## Appendix A: Detailed record of observations

Following the detailed discussion of numerous binaries in this paper, for completeness we also include the Modified Julian Dates (MJD) of each of our observations in Tables A.1, A.2, A.3, and A.4.

Table A.1. Modified Julian Dates (MJD) of the NGC 346 FLAMES observations. The Giraffe wavelength settings (e.g. HR02) and central wavelengths ( $\lambda_{\mathrm{c}}$ ) are given. The exposure time for each observation was 2275 s , excepting HR06/\#08, for which it was 2500 s .

| Giraffe <br> setting | $\lambda_{\mathrm{c}}$ | $\#$ | MJD |
| :--- | :---: | :---: | :---: |
| HR02 | 3958 | 01 | 52954.135894 |
| HR02 | 3958 | 02 | 52954.162910 |
| HR02 | 3958 | 03 | 52954.189858 |
| HR02 | 3958 | 04 | 52955.089567 |
| HR02 | 3958 | 05 | 52955.116573 |
| HR02 | 3958 | 06 | 52955.143518 |
|  |  |  |  |
| HR03 | 4124 | 01 | 52981.045452 |
| HR03 | 4124 | 02 | 52981.072478 |
| HR03 | 4124 | 03 | 52981.099430 |
| HR03 | 4124 | 04 | 52981.132751 |
| HR03 | 4124 | 05 | 52981.159698 |
| HR03 | 4124 | 06 | 52981.186653 |
|  |  |  |  |
| HR04 | 4297 | 01 | 52989.130391 |
| HR04 | 4297 | 02 | 52989.157348 |
| HR04 | 4297 | 03 | 52989.184302 |
| HR04 | 4297 | 04 | 53005.048810 |
| HR04 | 4297 | 05 | 53005.075776 |
| HR04 | 4297 | 06 | 53005.102733 |
|  |  |  |  |
| HR05 | 4471 | 01 | 52978.115490 |
| HR05 | 4471 | 02 | 52978.142443 |
| HR05 | 4471 | 03 | 52978.169401 |
| HR05 | 4471 | 04 | 53006.047328 |
| HR05 | 4471 | 05 | 53006.074344 |
| HR05 | 4471 | 06 | 53006.101307 |
|  |  |  |  |
| HR06 | 4656 | 01 | 52926.086233 |
| HR06 | 4656 | 02 | 52926.138196 |
| HR06 | 4656 | 03 | 52926.165224 |
| HR06 | 4656 | 04 | 52926.203441 |
| HR06 | 4656 | 05 | 52926.230394 |
| HR06 | 4656 | 06 | 52988.1111039 |
| HR06 | 4656 | 07 | 52988.15055 |
| HR06 | 4656 | 08 | 52988.183316 |
|  |  |  |  |
| HR14 | 6515 | 01 | 52922.133208 |
| HR14 | 6515 | 02 | 52922.177677 |
| HR14 | 6515 | 03 | 52922.204633 |
| HR14 | 6515 | 04 | 52922.240118 |
| HR14 | 6515 | 05 | 52922.267069 |
| HR14 | 6515 | 06 | 5292.308471 |
| HR14 | 6515 | 07 | 52925.152684 |
| HR14 | 6515 | 08 | 52925.179646 |
| HR14 | 6515 | 09 | 52925.206601 |
|  |  |  |  |

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\text { C. J. Evans et al.: FLAMES survey of massive stars: LMC and SMC clusters, Online Material p } 18
$$

Table A.2. Modified Julian Dates (MJD) of the NGC 330 FLAMES observations. The Giraffe wavelength settings (e.g. HR02) and central wavelengths $\left(\lambda_{\mathrm{c}}\right)$ are given. The exposure time for each observation was 2275 s , excepting HR02/\#06 (1743 s); HR05/\#05 (2221 s); HR04/\#06 (1900 s).

| Giraffe <br> setting | $\lambda_{\mathrm{c}}$ | \# | MJD |
| :--- | :---: | :---: | :---: |
| HR02 | 3958 | 01 | 52831.335190 |
| HR02 | 3958 | 02 | 52831.362917 |
| HR02 | 3958 | 03 | 52831.389880 |
| HR02 | 3958 | 04 | 52833.343405 |
| HR02 | 3958 | 05 | 52833.380020 |
| HR02 | 3958 | 06 | 52833.407722 |
| HR02 | 3958 | 07 | 52834.272660 |
| HR02 | 3958 | 08 | 52834.310219 |
| HR02 | 3958 | 09 | 52834.338165 |
|  |  |  |  |
| HR03 | 4124 | 01 | 52832.306332 |
| HR03 | 4124 | 02 | 52832.334079 |
| HR03 | 4124 | 03 | 52832.361042 |
| HR03 | 4124 | 04 | 52832.389991 |
| HR03 | 4124 | 05 | 52832.417687 |
| HR03 | 4124 | 06 | 52833.431610 |
| HR03 | 4124 | 07 | 53571.338966 |
| HR03 | 4124 | 08 | 53571.365957 |
| HR03 | 4124 | 09 | 53571.392904 |
| HR03 | 4124 | 10 | 53575.350926 |
| HR03 | 4124 | 11 | 53575.377924 |
| HR03 | 4124 | 12 | 53575.404861 |
|  |  |  |  |
| HR04 | 4297 | 01 | 52835.365846 |
| HR04 | 4297 | 02 | 52835.392841 |
| HR04 | 4297 | 03 | 52835.418862 |
| HR04 | 4297 | 04 | 52839.383749 |
| HR04 | 4297 | 05 | 52839.410778 |
| HR04 | 4297 | 06 | 52839.435562 |
| HR05 | 4471 | 01 | 52836.311151 |
| HR05 | 4471 | 02 | 52836.338693 |
| HR05 | 4471 | 03 | 52836.36549 |
| HR05 | 4471 | 04 | 52836.406499 |
| HR05 | 4471 | 05 | 52836.433197 |
| HR05 | 4471 | 06 | 52837.228526 |
| HR05 | 4471 | 07 | 52837.255493 |
| HR05 | 4471 | 08 | 52837.282458 |
| HR05 | 4471 | 09 | 52837.409609 |
| HR05 | 4471 | 10 | 52839.296100 |
| HR05 | 4471 | 11 | 52839.323059 |
| HR05 | 4471 | 12 | 52839.350034 |
| HR06 | 4656 | 01 | 52834.365133 |
| HR06 | 4656 | 02 | 52834.400818 |
| HR06 | 4656 | 03 | 52834.428742 |
| HR06 | 4656 | 04 | 52837.32064 |
| HR06 | 4656 | 05 | 52837.347739 |
| HR06 | 4656 | 06 | 52837.375036 |
|  |  |  |  |
| HR14 | 6515 | 01 | 52829.311413 |
| HR14 | 6515 | 02 | 52829.339117 |
| HR14 | 6515 | 03 | 52829.366074 |
| HR14 | 6515 | 04 | 52830.302236 |
| HR14 | 6515 | 05 | 52830.329997 |
| HR14 | 6515 | 06 | 52830.356985 |
|  |  |  |  |

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\text { C. J. Evans et al.: FLAMES survey of massive stars: LMC and SMC clusters, Online Material p } 19
$$

Table A.3. Modified Julian Dates (MJD) of the N11 FLAMES observations. The Giraffe wavelength settings (e.g. HR02) and central wavelengths $\left(\lambda_{c}\right)$ are given. The exposure time for each observation was 2275 s .

| Giraffe <br> setting | $\lambda_{\mathrm{c}}$ | $\#$ | MJD |
| :--- | :---: | :---: | :---: |
| HR02 | 3958 | 01 | 52928.313905 |
| HR02 | 3958 | 02 | 52928.340935 |
| HR02 | 3958 | 03 | 52928.367887 |
| HR02 | 3958 | 04 | 52978.209107 |
| HR02 | 3958 | 05 | 52978.236069 |
| HR02 | 3958 | 06 | 52978.263031 |
| HR03 | 4124 | 01 | 52978.298954 |
| HR03 | 4124 | 02 | 52978.325913 |
| HR03 | 4124 | 03 | 52978.352876 |
| HR03 | 4124 | 04 | 52979.120168 |
| HR03 | 4124 | 05 | 52979.147117 |
| HR03 | 4124 | 06 | 52979.174080 |
|  |  |  |  |
| HR04 | 4297 | 01 | 52979.209306 |
| HR04 | 4297 | 02 | 52979.236270 |
| HR04 | 4297 | 03 | 52979.263219 |
| HR04 | 4297 | 04 | 52979.297524 |
| HR04 | 4297 | 05 | 52979.324479 |
| HR04 | 4297 | 06 | 52979.351427 |
| HR05 | 4471 | 01 | 52980.104396 |
| HR05 | 4471 | 02 | 52980.131349 |
| HR05 | 4471 | 03 | 52980.158315 |
| HR05 | 4471 | 04 | 52980.193917 |
| HR05 | 4471 | 05 | 52980.220880 |
| HR05 | 4471 | 06 | 52980.247825 |
| HR06 | 4656 | 01 | 52980.282525 |
| HR06 | 4656 | 02 | 52980.309565 |
| HR06 | 4656 | 03 | 52980.336517 |
| HR06 | 4656 | 04 | 52981.222102 |
| HR06 | 4656 | 05 | 52981.249059 |
| HR06 | 4656 | 06 | 52981.276019 |
| HR14 | 6515 | 01 | 52924.309781 |
| HR14 | 6515 | 02 | 52924.336804 |
| HR14 | 6515 | 03 | 52924.363751 |
| HR14 | 6515 | 04 | 52955.178388 |
| HR14 | 6515 | 05 | 52955.205160 |
| HR14 | 6515 | 06 | 52955.232125 |
|  |  |  |  |

Table A.4. Modified Julian Dates (MJD) of the NGC 2004 FLAMES observations. The Giraffe wavelength settings (e.g. HR02) and central wavelengths $\left(\lambda_{c}\right)$ are given. The exposure time for each observation was 2275 s , excepting HR06/\#06 ( 1468 s ).

| Giraffe <br> setting | $\lambda_{\mathrm{c}}$ | $\#$ | MJD |
| :--- | :---: | :---: | :---: |
| HR02 | 3958 | 01 | 52982.201147 |
| HR02 | 3958 | 02 | 52982.228998 |
| HR02 | 3958 | 03 | 52982.255044 |
| HR02 | 3958 | 04 | 52988.219081 |
| HR02 | 3958 | 05 | 52988.250594 |
| HR02 | 3958 | 06 | 52988.277546 |
|  |  |  |  |
| HR03 | 4124 | 01 | 53005.136738 |
| HR03 | 4124 | 02 | 53005.16353 |
| HR03 | 4124 | 03 | 53005.190706 |
| HR03 | 4124 | 04 | 53005.221334 |
| HR03 | 4124 | 05 | 53005.248354 |
| HR03 | 4124 | 06 | 53005.275313 |
|  |  |  |  |
| HR04 | 4297 | 01 | 53006.135301 |
| HR04 | 4297 | 02 | 53006.16257 |
| HR04 | 4297 | 03 | 53006.189220 |
| HR04 | 4297 | 04 | 53008.047982 |
| HR04 | 4297 | 05 | 53008.075016 |
| HR04 | 4297 | 06 | 53008.101980 |
| HR05 | 4471 | 01 | 53008.163059 |
| HR05 | 4471 | 02 | 53008.190005 |
| HR05 | 4471 | 03 | 53008.216952 |
| HR05 | 4471 | 04 | 53009.161824 |
| HR05 | 4471 | 05 | 53009.188777 |
| HR05 | 4471 | 06 | 53009.215739 |
| HR06 | 4656 | 01 | 53012.095573 |
| HR06 | 4656 | 02 | 53012.122595 |
| HR06 | 4656 | 03 | 53012.149545 |
| HR06 | 4656 | 04 | 53012.183447 |
| HR06 | 4656 | 05 | 53012.210458 |
| HR06 | 4656 | 06 | 53012.232744 |
| HR14 | 6515 | 01 | 52955.266266 |
| HR14 | 6515 | 02 | 52955.293277 |
| HR14 | 6515 | 03 | 52955.320221 |
| HR14 | 6515 | 04 | 52989.259276 |
| HR14 | 6515 | 05 | 52989.286232 |
| HR14 | 6515 | 06 | 52989.313190 |
|  |  |  |  |


[^0]:    * Based on observations at the European Southern Observatory Very Large Telescope in programmes 68.D-0369 and 171.D-0237.
    ** Tables 4-8, Figs. 13-17 and Appendix A are only available in electronic form at http://www.edpsciences.org

[^1]:    ${ }^{1}$ For completeness, the coordinates (J2000.0) used in calculating the radial distances were:
    NGC 346: $\alpha=00^{\mathrm{h}} 59^{\mathrm{m}} 18.0^{\mathrm{s}}, \delta=-72^{\circ} 10^{\prime} 48.0^{\prime \prime}$,
    NGC 330: $\alpha=00^{\mathrm{h}} 56^{\mathrm{m}} 18.8^{\mathrm{s}}, \delta=-72^{\circ} 27^{\prime} 47.2^{\prime \prime}$,
    NGC 2004: $\alpha=05^{\mathrm{h}} 30^{\mathrm{m}} 40.2^{\mathrm{s}}, \delta=-67^{\circ} 17^{\prime} 14.3^{\prime \prime}$.

