An Abundance and Kinematic Analysis from High Dispersion Spectroscopy of Early-Type, High Galactic Latitude Stellar Candidates from the UKST UBVRI Survey

1. Introduction

In recent years a number of apparently normal, population I B-type stars have been discovered at large z-distances from the galactic plane. The origin and nature of these stars has been the subject of much discussion in the literature — if all the candidates so far discovered are subluminous for some reason (subdwarf or post-AGB stars for example) then their existence can be quite naturally accounted for by the currently accepted models of galactic structure and star formation. If, on the other hand, these stars have the apparently normal bolometric luminosities inferred from observational data and derived atmospheric parameters, their ensuing distances make them somewhat unusual members of the galactic halo. Establishing accurate atmospheric parameters, element abundances, total luminosities and subsequent distances is therefore vital to these studies, and by comparing high resolution spectra with model atmospheres in order to derive such data, compelling evidence for normal B stars at large z-distances has been presented — see Keenan et al. (1986a), Keenan et al. (1986b), Conlon et al. (1989) and references therein. The presence in the halo of many of these stars can be accounted for by ejection from the plane of the galaxy by various mechanisms (Conlon et al. 1990); however, there appears to be a subset of these stars for which formation in the halo is the only possible explanation of their existence (Conlon et al. 1992).

2. This Survey

We are currently undertaking a wide-field magnitude limited survey for these peculiar halo objects by exploiting the UKST UBVRI survey database — this is based on COSMOS measures of intermediate to high galactic latitude UKST plates — see Mitchell, Miller & Boyle (1990) for more details. This database is an ideal source of information for both galactic and extra-galactic surveys, being over a wide field and reasonably photometrically accurate in five colours. Low dispersion spectra of candidates initially selected from UBV colours was presented in Holmgren et al. (1992); high resolution spectra of five promising young B-type stars have been obtained on the William Herschel Telescope in order to derive atmospheric parameters, metal abundances and kinematic information so as to determine which, if any, may have formed in the halo.

3. Results

By comparing hydrogen and helium line profiles and metal line equivalent widths from Kurucz (1979) model atmospheres with those from the spectra, the parameters shown in Tables 1 and 2 are found (for more details on the precise methods, see Hambly et al. [1993]). Figure 1 shows a comparison between the observed and modelled spectra for two of the stars in the range 3990 to 4170 Angstroms, with lines identified and used in the analysis indicated. Table 1 gives atmospheric parameters and inferred masses and ages for the stars; Table 2 indicates the mean elemental abundances obtained for the two best candidates. Comparing these values with those of young population I disk stars, candidates 791-2, 866-1, 863-4 and 867-5 appear to be good candidates for normal B-type stars high in the galactic halo, while 867-2 is fairly conclusively a subdwarf. Table 3 presents kinematic results from radial velocities and inferred distances assuming the parameters in Table 1. Following the analysis in, for example, Conlon et al. (1988) and Conlon et al. (1989), the best candidate for formation in the halo is 791-2, with an evolutionary time much less than its time-of-flight required to attain its current position from the star forming regions within the galactic plane. For the other candidates, evolutionary times and flight times are comparable, although for 863-4 the ejection velocity from the plane is somewhat larger than can be accounted for by plausible ejection mechanisms (Conlon et al. 1990). However, it is necessary to exercise caution before concluding too much from the current results. The values in Table 3 assume that the radial velocity gives a good

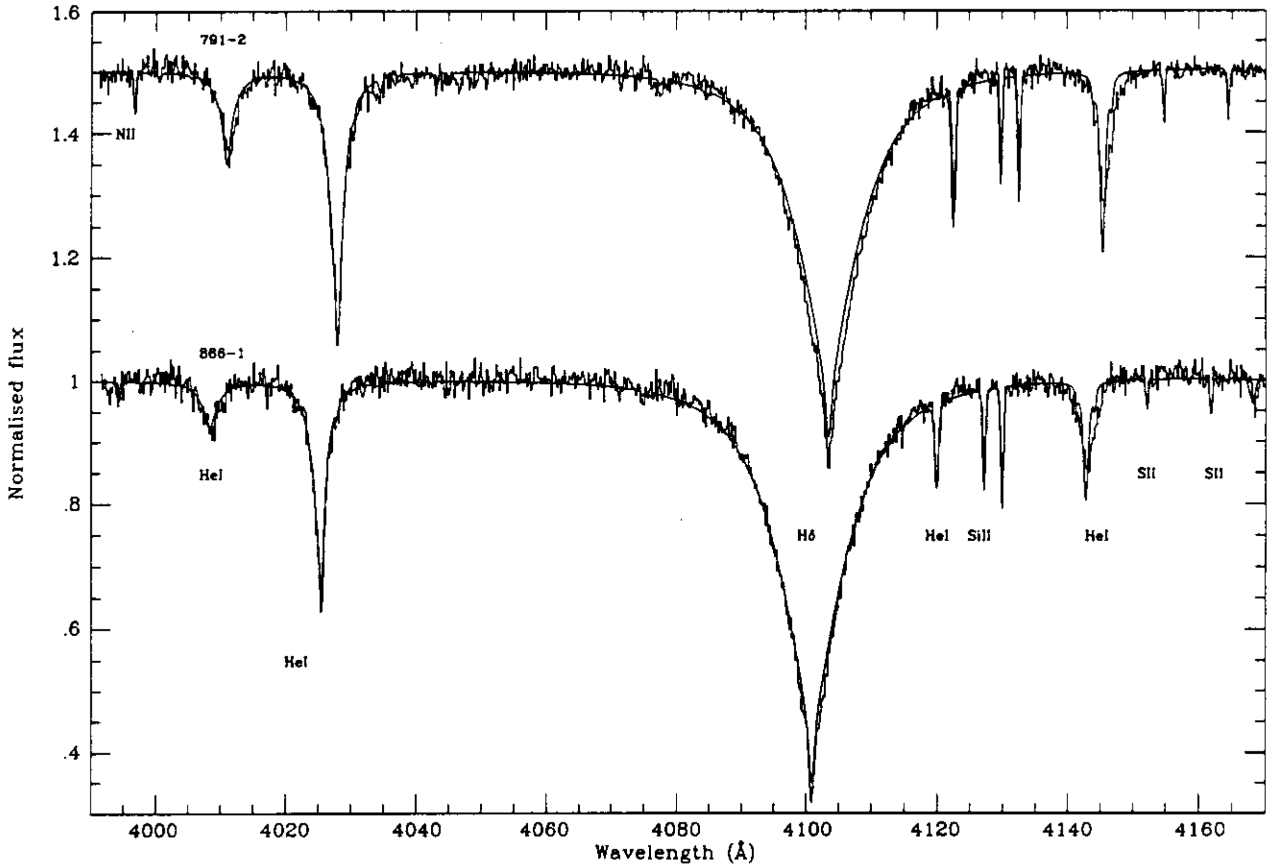

Figure 1. Comparison between observed (histograms) and modelled (solid curve) spectra for the two stars 791-2 and 866-1. Some of the measured lines are identified. These two stars are apparently normal, population I type objects at high galactic z-distances.

approximation to the velocity in the z-direction (reasonably true at these higher galactic latitudes); also the assumption that 863-4 and 867-2 have normal main-sequence like luminosities is based on relatively poor s/n spectra, with no independent method of checking the effective temperatures. All four stars are, nonetheless, worthy of further study. A more detailed analysis of these results and their implications will appear in Hambly et al. (1993).

4. Conclusions and Future Work

We have identified four excellent young, high galactic latitude candidates from the UKST UBVRI survey by model atmospheric analysis from high resolution spectra. Further analysis of this data, along with more spectra of brighter candidates from the survey will enable us to estimate possible stellar formation rates in the galactic halo. This work will also benefit from the superior photometric and astrometric data resulting from the completion of second generation whole-sky surveys (e.g. those currently underway at the Palomar and United Kingdom Schmidts) and the advent of better measuring machines (e.g. SuperCOSMOS).

Table 1. Atmospheric parameters for the program stars

Star name	Effective temperature (K)	log(g)	Mass (solar units)	Log (age)	BC	Luminosity (solar units)
791-2	19000 ± 1000	4.3 ± 0.2	6.0 ± 0.4	<6	-1.96	2.99
867-2	25000 ± 1000	5.4 ± 0.2				
866-1	16000 ± 1000	4.2 ± 0.2	4.5 ± 0.5	7.4	-1.55	2.66
863-4	12500 ± 1500	3.5 ± 0.5	3.2 ± 0.8	7.8	-0.86	2.79
867-5	12000 ± 2000	4.2 ± 0.5	3.0 ± 0.8	7.9	-0.78	1.99

Table 2. Mean abundances for the two stars 791-2 and 866-1. The normal B-star abundance for neon comes from Gies and Lambert (1992); the rest are from Keenan et al. (1986)

Element	791-2	866-1	Normal B star value
He	10.7 ± 0.1	10.7 ± 0.1	10.9
C	7.9 ± 0.2	8.1 ± 0.2	8.2
N	7.6 ± 0.3		8.0
Ne	8.5 ± 0.1	8.2 ± 0.1	8.5
Mg	7.4 ± 0.2	7.2 ± 0.2	7.4
Al	6.2 ± 0.2		6.2
Si	7.5 ± 0.1	7.2 ± 0.1	7.5
S	6.9 ± 0.1	6.9 ± 0.2	7.2
Fe	7.5 ± 0.2	7.0 ± 0.2	7.5

Table 3. Kinematic parameters for the stars

Star	RA			Dec			b	Radial	z	Age	Flight time	Ejection velocity
	h	m	s	d	am	as		km/s	Kpc	Myr	Myr	km/s
791-2	13	15	1.0	-7	42	0.3	54	+134 ± 5	3.02	1	19	178
866-1	14	9	50.7	-1	2	1.2	56	-57 ± 1	3.23	25	77	134
863-4	13	26	13.7	2	6	44.1	63	+130 ± 20	21.11	63	86	347
867-5	14	38	35.2	2	22	3.3	54	0 ± 50	7.09	79	74	184

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Wide Field Cometary Polarimetry using a Novel Device

Abstract

The polarization of cometary comae and tails had already been detected by Arago in the comets 1819-III and 1835-III-Halley, but it was Öhman in 1941 who found for the first time that two mechanisms produced the polarization of comets: the scattering of sunlight by the cometary dust particles and the fluorescence of the molecular cometary plasma.

Due to the strong and variable polarimetric contribution of the moon-lit or dusk/dawn night sky, the study of polarimetry of comets is one of the most difficult tasks in observational astronomy. It demands that the Stokes parameter for linear polarization are obtained simultaneously, otherwise too many systematic errors make a quantitative interpretation of the observations unsafe.

Recently I have developed a new type of polarimetric device for simultaneous astronomical point sources and extended object linear polarimetry, and which is presently being tested at our observatory.

The device consists of a double Wollaston calcite prism, the two halves of which are arranged in a special way. The device is inserted into the exit pupil of a telescope – focal reducer and splits a point source into four images, each having by 45° different polarization angles. For extended astronomical objects like comets, surface polarimetry is possible by a masking technique (multi-object observing mode) in the focal plane of the telescope.

1. Introduction

Together with laboratory experiments, the polarization measurements of comets and generally for all solar system bodies is an important observational approach for the understanding of their constituents of their outer layers.