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Elemental abundances in the centre of the Galactic nuclear disc

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ABSTRACT

We have made the first attempt to derive the chemical properties of the Galactic disc at its very central part using high-resolution infrared spectroscopic observations of four classical Cepheids. These stars are located at Galactocentric distances smaller than 1 kpc. All investigated stars show near-to-solar elemental abundances. By combining these new data with our previous studies, our results suggest that the radial distribution of iron abundance on a logarithmic scale gradually increases from the outskirts of the Galactic disc to Galactocentric distances of about 2–4 kpc. There, it reaches a maximal value of about +0.4 dex, and then declines sharply to about the solar value at the Galactic Centre.

Key words: stars: abundances – stars: variables: Cepheids – Galaxy: evolution.

1 INTRODUCTION

In our two previous papers on the chemical properties of the central part of the Galactic thin disc (see Martin et al. 2015; Andrievsky et al. 2016), it has been suggested that there is a plateau in the metallicity distribution within approximately 2–4 kpc from the Galactic Centre. Here, the maximum metallicity reaches about [Fe/H] = +0.4 dex. This value is attained following the more or less radial monotonic increase of the metallicity from the outer parts of the Galactic disc (16 kpc) to the Galactic Centre, with a slope in the global [Fe/H] abundance gradient of about -0.055 dex kpc⁻¹.

At the same time, several studies (see the compilation in Martin et al. 2015) show that the chemical properties at the very Galactic Centre are almost the same as those at the Galactocentric distance of the Sun. Thus, within the range of 0 to approximately 3 kpc, the metallicity gradient even appears to have a positive slope.

It should be noted, however, that the central part of the Galactic thin disc is poorly sampled (see the figures from Andrievsky et al. 2016). Additional observations are urgently needed to confirm (or disprove) the existence of the metallicity plateau within the very inner disc (which was suspected, in particular, by Andrievsky et al.

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† Visiting astronomer at the Infrared Telescope Facility, which is operated by the University of Hawaii under contract NNH14CK55B with the National Aeronautics and Space Administration. 2016) and also to determine its characteristics (e.g. slope, level) if present.

Of particular interest is the determination of the metallicity in the centre of the nuclear disc. Several studies have been devoted to this topic. Carr, Sellgren & Balachandran (2000) studied the infrared (IR) spectra of M2 IRS, a supergiant that is less than 10 Myr old and is located near the Galactic Centre. They found a solar metallicity for this star (within the measurement errors). Moreover, Ramírez et al. (2000) studied an M supergiant RV 5–7, located at a Galactocentric distance of less than 30 pc, and also found a solar metallicity value for that star. Cunha et al. (2007) also analysed the spectra of several cool supergiants including IRS 7 and VR 5–7. They derived masses of 22 and 14 solar masses for those stars, respectively, indicating relatively young ages. The mean [Fe/H] value derived for the sample of M supergiants was +0.14 dex. Similarly, Ryde & Schultheis (2015) determined the metallicity in M giant stars, and found a mean [Fe/H] = +0.11 dex.

Summarizing, it can be stated that young M supergiants and older M giants located in the Galaxy Centre exhibit solar-like metallicity. It should also be noted that, so far, no one has used Cepheid variable stars to determine the metallicity within the young nuclear disc.

Some similar results have been pointed out from studies focusing on planetary nebulae in the direction of the Galactic Centre (see Gutenkunst et al. 2008; Cavichia, Costa & Maciel 2011). According to those programmes, the abundances of some elements in the very central part of our Galaxy appear to be close to the solar values. This is an interesting result and it requires an independent verification

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Figure 1. Finding charts for the four inner disc Cepheids studied for this programme. The field of view is 60×60 arcsec², similar to the field available for the iShell spectrograph guider; sky images were extracted from the 2MASS in the *K* band. Each individual field is centred on the coordinates for the Cepheids as published by Matsunaga et al. (2016); each target put within the iShell slit is identified by an arrow. The field scale is displayed in the left image. The slit is, by default, at the parallactic angle. We took care that, for each angle, no star other than our target was seen in the slit. The 5-arcsec slit is displayed directly on the target, including the angle of the slit as used during the observation. It is clear that there is no contamination from field stars. North is at the top, and east to the left.

through obtaining and analysing the spectra of stars that definitely belong to the Galactic nuclear disc.

At present, existing theoretical models that focus on the chemodynamical evolution of the Galaxy disc use modern data on the elemental yields in stars of different masses. These models take into account interstellar gas flows in the disc and halo, as well as the the dynamic influence of the Galactic bar on the chemical properties in the Galactic Centre, etc. Therefore, elemental distributions in the disc obtained from observations are important criteria for verifying the reliability of these models.

For instance, using models, Minchev, Chiappini & Martig (2013) performed a study of the chemical evolution of the Galaxy's thin disc. According to their results, the metallicity of [Fe/H] in the disc gradually increases from a Galactocentric distance of 15 kpc to 2 kpc, reaching a plateau in the range of 0-2 kpc, with a maximum value of [Fe/H] of about +0.7 dex (see their fig. 2). Similarly, Cavichia et al. (2014) obtained a plateau in the range 0-4 kpc. They obtained a maximum value for [Fe/H] of +0.4 dex.

Additionally, Kubryk, Prantzos & Athanassoula (2015) have developed models including calculations up to a Galactocentric distance of 1 kpc. Although their [Fe/H] value at a distance of 3–4 kpc from the Galactic Centre is in good agreement with our observational data from Andrievsky et al. (2016) (a small plateau in the iron abundance distribution within this zone with [Fe/H] \approx +0.4 dex; see their fig. 5), their model predicts a steady growth of metallicity toward the Galactic Centre with [Fe/H] \approx +0.7 dex at a Galactocentric distance of 1 kpc.

Recent results presented by Toyouchi & Chiba (2018) show that their model predicts a metallicity [Fe/H] at the level of about +0.6dex at a Galactocentric distance of 2 kpc (which is close to our observational result; see Andrievsky et al. 2016). Unfortunately, they did not study the chemical properties of the stellar disc component in the centre of the Milky Way.

Dékány et al. (2015) and Matsunaga et al. (2015) have reported the photometric discovery of several classical Cepheids that are distributed around and behind the Galactic Centre. It is very difficult to observe the Galactic Centre Cepheids spectroscopically. Extremely strong light absorption makes it impossible to obtain high-resolution spectra of those stars in the visible. Therefore, we decided to observe several targets from the list of Matsunaga et al. (2016) in the spectral H band in order to avoid significant light absorption. It should also be noted that Inno et al. (2019) recently applied the IR spectra of medium resolution (R = 3000) of five newly discovered Cepheids in the direction of the Galactic Centre, but their programme stars are situated at a few kpc from the centre.

2 OBSERVATIONS AND DATA REDUCTION

Near-IR spectroscopic observations were carried out in remote observing mode on two half-nights (2017 May 11 and May 17), with the Infrared Telescope Facility (IRTF) 3-m telescope on Mauna Kea. We used the recently commissioned cross-dispersed echelle spectrograph iShell (1.08–5.3 μ m, R = 80000; Rayner et al. 2016). The detector was binned 2×2 resulting in a spectral resolution R \approx 35 000; a 0.75 \times 5 arcsec² slit was used for all observations. With the H1 instrumental configuration for the spectrograph, the wavelength coverage extended from 1.48 to 1.67 μ m, a bandpass including important spectral lines needed for the abundance analysis of our programme Cepheids. Observations were conducted under photometric skies, with a seeing of 0.5–0.8 arcsec in the visible. For each Cepheid star (typical magnitude $H \approx 12$), exposures were 6×600 s (co-adds). The latter strategy was selected to achieve a signal-to-noise ratio $(S/N) \ge 30$, a minimum necessary to perform the analysis of the main spectral lines within the H1 bandpass; the exposure times were estimated using the iShell performance established during commissioning of the instrument by the IRTF.

A reference solar spectrum $(4 \times 5 \text{ s})$ was also obtained by observing the Moon. This spectrum is used to verify values for transition oscillator strengths known from the literature. A series of spectra was also obtained on several well-studied F and G supergiants.

An observational challenge for our programme was to identify the targets correctly when positioning them within the spectrograph slit, because all inner disc Cepheids are obviously located in very crowded fields. To achieve this, first we applied offsets relative to nearby reference stars, instead of only relying on the accuracy of the telescope absolute pointing. These telescope offsets were calculated using the precise coordinates given by Matsunaga et al. (2016) for our four Cepheids. From our experience, this technique brought the targeted Cepheid within a few arcsec of the spectrograph slit. Then, we compared the guider field of view with finding charts (see Fig. 1) centred on the Cepheid coordinates taken from Matsunaga et al. (2016) and extracted from *K*-band images from the Two-

Cepheid	Ν	RA (J2000.0)	Dec. (J2000.0)	Date (UTC)	JD(start) (2457000+)	Phase	Integ. time (s)	S/N	$V_{\rm bary}$ (km s ⁻¹)	$V_{\rm LSR}$ (km s ⁻¹)	Airmass
GCC-a	13	17:46:06.0	-28:46:55.1	2017 May 18	892.0150	0.86	7×600	30	155.0	165.4	1.52
GCC-b	12	17:45:32.3	-29:02:55.3	2017 May 18	891.9552	0.29	6×600	35	-84.0	-73.7	1.60
GCC-c	11	17;45:30.9	-29:03:10.6	2017 May 12	886.0177	0.56	6×600	33	-70.2	-59.9	1.51
GCC-d	10	17:44:56.9	-29:13:33.8	2017 May 12	885.9623	0.79	6×600	37	-11.9	-1.7	1.61
HD 172594		18:41:42.5	-14 33 51.3	2017 May 12	886.0595	_	2×20	100?	-2.8	11.2	1.21
HD 179784		19:13:15.4	$+15\ 02\ 08.3$	2017 May 18	892.0755	-	3×10	100?	-21.2	-2.6	1.00
HD 182296		19:23:38.7	+08 39 36.0	2017 May 18	892.0781	_	4×10	100	-12.0	5.6	1.02

Table 1. Journal of observations. The name of Cepheid is from Matsunaga et al. (2015). The number N is given according to the designation of Matsunaga et al. (2016). Phases were calculated according to the data of Matsunaga et al. (2015).



Figure 2. Radial velocity curves of the programme Cepheids. Open circles indicate data from Matsunaga et al. (2015) and black squares represent our data. Dashed lines schematically show the radial velocity curves of the Cepheids according to the data from Matsunaga et al. (2015) (see their fig. 6). Deviations of our points from the curve data might be caused by evolutionary changes of periods.

Micron All-Sky Survey (2MASS) using the Finder Chart tool.¹ All Cepheid stars of our programme were clearly visible in the guider; direct comparison with the 2MASS finding charts was possible because we also used a *K*-band filter in the telescope guider (with a field of view of 42 arcsec). A final (manual) offset was then applied to bring the target Cepheid precisely within the narrow slit of the spectrograph. As shown in Fig. 1, the iShell slit is only 5 arcsec in length, and we were also careful to avoid spectral contamination by other stars within the field, at least from objects we could visually detect within the guider.

For wavelength calibration and for removing the telluric absorption lines, we also observed telluric standard stars (B- and A-type dwarfs). Spectra were combined into a single spectrum for each target. The telluric absorption lines of the target were subtracted using a spectrum of the corresponding telluric standard.

As an additional check that we did indeed observe the same Cepheids as sampled by Matsunaga et al. (2015), we measured the radial velocities of our targets using telluric lines as the wavelength reference frame. The details of observations and our results are provided in Table 1. The velocities obtained were then transformed into barycentric velocities, V_{bary} , and velocities relative to the local standard of rest (LSR), V_{LSR} , assuming the standard solar motion (see Table 1; Reid et al. 2009). All radial velocities show a good fit

with the radial velocity curves given in Matsunaga et al. (2015) – see our Fig. 2 and their fig. 6. Pulsational phases were calculated according to the data of Matsunaga et al. (2015). To control our results, we also determined the radial velocities of the F and G supergiants observed for our programme. Our results are in good agreement with the data from the literature (see Table 2). Note that HD 182296 is a spectroscopic binary star. Thus, we are confident that our faint targets have been correctly identified.

3 SPECTROSCOPIC ANALYSIS

In order to normalize the individual spectra to the local continuum, to identify the lines of different chemical elements and to measure the equivalent widths (EWs) of the absorption lines, we used the DECH 30 software package.² Fragments of the spectra of our programme Cepheids are shown in Fig. 3. As we can see from the figure, the spectra are noisy but some lines can be measured with reasonable precision.

The effective temperatures ($T_{\rm eff}$) of our programme F–G supergiants have been estimated using the calibrating IR line depth ratios, as explained in Fukue et al. (2015). In Table 2, we give the resulting temperature values determined using IR and visual spectra. The values of $T_{\rm eff}$ for visual spectra are based on the method used by Kovtyukh (2007) to calibrate the line depth ratio. As can be seen, independent estimates are in fairly good agreement.

The effective temperatures of our programme Cepheids have also been estimated using the calibrating line depth ratios from Fukue et al. (2015) (see Table 3).

For bright supergiant stars, the surface gravity is estimated from the ionizational balance for iron using the visual spectrum; this value is then adopted for the near-IR spectroscopic analysis (measurable Fe II lines are not available in the *H*-band region). Because we did not have enough FeII lines for Cepheids, we were not able to estimate surface gravity using the typical condition of ionization balance. In this case, we roughly evaluated log g with the help of the approximate relation between the surface gravity of Cepheids and their pulsational period (see fig. 5 in Andrievsky, Luck & Kovtyukh 2005).

The microturbulent velocity Vt for our programme stars was found by avoiding any dependence between the iron abundance as produced by individual Fe I lines and their equivalent widths.

The resulting atmosphere parameters and other information for the studied stars are listed in Table 3.

The approximated accuracy of our parameter determination is estimated to be $\Delta T_{\rm eff} = \pm 200$ K, $\Delta \log g = \pm 0.3$ dex, $\Delta Vt = \pm 0.5$ km s⁻¹ and Δ [Fe/H] = ± 0.2 dex.

Table 2. Comparison of the temperature and radial velocity values for supergiants determined from visual and *H*-band spectra for three supergiants. *N* is the number of temperature calibrations used. Typical literature *V*r values can be found, for example, in SIMBAD (SB).

	Spectral type	$T_{\rm eff}$ (visual) (Kovtyukh 2007)		$T_{\rm eff}$ (<i>H</i> -band) (this paper)			Radial velocity (<i>H</i> -band) (Literature)		
		T _{eff} (K)	σ_{mean} (K)	Ν	T _{eff} (K)	σ_{mean} (K)	Ν	Vr (km s ⁻¹)	Vr (km s ⁻¹)
HD 172594 HD 179784 HD 182296	F2 Ib G5 Ib G3 Ib	- 4956 5072	$\begin{array}{c} - \\ \pm 42 \\ \pm 50 \end{array}$	- 55 77	- 5054 5059	$\begin{array}{c} - \\ \pm 123 \\ \pm 88 \end{array}$	- 8 3	-2.8 -21.2 -12.0	-2.41 -21.67 -9.35 to -14.0 (SB)



Figure 3. Fragments of the spectra of programme Cepheids. A portion of the continuum for each spectrum is shown on the left by a solid line.

4 ABUNDANCE ANALYSIS

The local thermodynamical equilibrium elemental abundances in our programme stars were calculated using the WIDTH9 code and ATLAS12 atmosphere models. For this purpose, we used newly evaluated astrophysical oscillator strengths and damping parameters adopted by the Apache Point Observatory Galactic Evolution Experiment (APOGEE; Shetrone et al. 2015, their table 7).

Abundances in two supergiants were derived in order to check the reliability of our *H*-band spectroscopic analysis. For these stars, we compared abundances derived from *H*-band spectra with abundances derived from the visual spectra. Results for *H*-band spectra are presented in Table 4 for one star, HD 179784. The resulting abundances for our programme Cepheids are given in Table 5.

5 RESULTS AND DISCUSSION

The steady decrease of metallicity with Galactic radius, as observed for Cepheids, can be interpreted in a simple way. Excluding the possibility of a large radial excursion of the Cepheids, as these stars are very young, their metallicity reflects the local abundance of the interstellar medium, at their current Galactic radius. The enrichment of the interstellar medium is mostly due to the explosion of supernovae (Matteucci et al. 2009). Because the initial mass function seems to be universal, the formation rates of stars of all masses are in proportion to the initial mass function. A region where the density of stars is large is a region where the star formation rate and the duration of the star-forming process are large. Therefore, we expect that the metallicity at a given radius of the disc should be proportional to the stellar density. Thus, it is important to establish what the stellar density is in the thin disc as a function of radius. Many authors consider that the disc density is exponential (Robin et al. 2003) according to a law that extends (or not) up to the centre. A disc profile proposed by Kormendy (1997), mostly based on observations of external galaxies, seems close to reality. The law for the surface density is $\Sigma = \Sigma_0 \exp[-r/\alpha - (\beta/r)^n]$, where α is the scalelength of the disc and β is the 'size' of the hole; *n* is taken equal to 2. This law produces a decrease of Σ for values of *r* smaller than β . The metallicity data are on a logarithmic scale, so we should compare the data with log (Σ). If we adopt β of the order of 2 kpc, following Lépine & Leroy (2000), this disc profile predicts a maximum metallicity around r = 2 kpc, in satisfactory agreement with the data for our Cepheids.

However, the central region of the Galaxy is far from being axisymmetric, because of the presence of the bar. Recently, Michtchenko et al. (2018) have presented a schematic diagram of the bar (their fig. 15), with its extension and orientation in a direction not far from that of the Sun (about 20°). In the plane of the Galaxy and for radii < 3 kpc (in the direction of the axis of the bar), the bar dominates the stellar population. There is no star formation in an extended region. The masers with precise very-long-baseline interferometry (VLBI) distances measured by Reid et al. (2014), which are associated with massive stars, are plotted in the same figure. The presence of masers signals the regions where very young stars are present. We can see that there are masers all around the bar, but not inside it. Observations of external barred galaxies confirm that most bars have a yellowish colour, which indicates that they are mainly constituted of old stellar populations. Except perhaps for some very late-type, low-mass or weakly interacting barred spirals (see Martin & Friedli 1997), there are no O-B stars in the bar, except at their extremities and at their very centre. This also explains the absence of numerous Cepheids in the Galactic radius range 1-3 kpc.

The region very close to the centre ($R_G < 1$ kpc) is different from its surroundings. It contains at least one maser with distance determined by VLBI measurements, at least four Cepheids (the ones studied in this work) and a major molecular cloud, Sagittarius B2. The physical conditions in this area are possibly different from those prevailing in the solar neighbourhood. There is possibly an inflow of matter with a high metallicity coming from internal regions to the disc, flowing across the bar, and possibly an inflow of low metallicity gas from the spheroidal bulge. It is beyond the scope of the present work to develop a specific chemical evolution model for the Galactic Centre.

In Fig. 4, we show the iron abundance distribution from the Galactic Cepheids based on our previous studies (for references, see Martin et al. 2015; Andrievsky et al. 2016) and the central value obtained in the present study. We are especially interested in the iron content, as this element has the largest number of lines in the spectra

Cepheid	Ν	P (d)	JD 245 7000+ (start)	$\langle H \rangle$ (mag)	T _{eff} (K)	log g	Vt (km s ⁻¹)	R _G (kpc)
GCC-a	13	23.52	892.0150	12.02	4850	1.0	3.5	< 0.2
GCC-b	12	19.96	891.9552	11.96	5050	1.2	3.0	< 0.2
GCC-c	11	22.75	886.0177	12.39	5000	1.2	3.0	< 0.2
GCC-d	10	18.87	885.9623	12.14	5580	1.4	3.5	< 0.2

Table 3. Physical parameters of the investigated Cepheids. The number N is given according to Matsunaga et al. (2016).

Table 4. Comparison of abundances in HD 179784 derived from visual and *H*-band spectra. Stellar atmosphere parameters are presented in the form $T_{\text{eff}}/\log g/Vt$.

Ion	HD 1 4	HD 179784 (Visual) 4956/1.8/2.3			HD 179784 (<i>H</i> -band) 5054/1.8/2.2				
	[M/H]	σ	Ν	[M/H]	σ	Ν			
6.00	-0.18	0.24	3	-0.40	0.18	6			
7.00	_	-	-	0.37	-	1			
8.00	0.16	-	1	-	-	-			
11.00	0.40	0.02	2	0.38	0.16	2			
12.00	-0.11	-	1	0.21	0.04	2			
13.00	0.18	0.13	2	-	-	-			
14.00	0.07	0.08	10	-0.03	0.14	13			
15.00	-	-	-	0.36	0.19	3			
16.00	0.35	-	1	0.04	0.12	8			
20.00	0.02	0.08	3	0.24	0.07	3			
21.01	0.05	0.11	5	-	-	-			
22.00	-0.21	0.13	14	0.12	0.10	6			
22.01	-0.16	0.13	3	-	-	-			
23.00	-0.13	0.12	7	0.02	0.53	5			
23.01	0.10	0.13	4	-	-	-			
24.00	-0.17	0.10	11	0.02	0.02	3			
24.01	0.22	0.10	3	-	-	-			
25.00	0.10	0.11	5	-0.04	0.40	6			
26.00	0.00	0.10	82	0.12	0.15	156			
26.01	0.02	0.12	14	_	-	-			
27.00	-0.03	0.14	8	0.16	0.46	6			
28.00	-0.03	0.10	36	0.04	0.13	8			
29.00	-0.41	0.00	1	-0.11	0.33	2			
39.01	0.22	0.07	4	0.36	-	1			
40.01	-0.03	0.02	2	-	-	-			
57.01	0.17	-	1	-	-	-			
58.01	0.01	0.04	4	_	-	-			
59.01	-0.06	0.05	2	_	-	-			
60.01	0.12	0.07	5	-	-	_			
63.01	0.21	0.01	2	-	-	-			
64.01	0.38	-	1	-	-	-			

studied, and its content was found with a sufficiently high accuracy. We also have the largest statistics on abundance distribution in the disc for iron. In our previous papers, we reported on the elemental distribution in the range of Galactocentric distances extending from about 2 to 16 kpc.

The Cepheids of our present programme cover a similar range of pulsation period as the stars included in our previous samples; thus, they share a similar age range. Following the period–age relation for classical Cepheids as proposed by Bono et al. (2005), the age range of the Cepheids in our sample is roughly 20–70 Myr. So, these are young stars, and they should be situated very near their birthplaces.

The average iron abundance at the Galactic Centre taken from the literature is presented in Martin et al. (2015) and Andrievsky et al. (2016). This value was mostly determined from the stars

covering a larger age range (some of them are members of the Arches/Quintuplet clusters with ages of about \approx 3–9 Myr, while there are field stars with ages of ≈ 1 Gyr). Our data on four young classical Cepheids apparently suggest that the metallicity at the very centre of our Galaxy disc is approximately solar. This is the main result of this paper. Looking at Fig. 4, we can see that the metallicity gradually increases from the outer part of the thin disc. reaching a maximum value of about +0.4 dex at Galactocentric distances in the range 2-4 kpc, and then decreases to about the solar value in the Galaxy Centre. In the range 2-4 kpc, we still cannot confirm or disprove some kind of plateau-like structure in the metallicity distribution, as first supposed in Andrievsky et al. (2016), even with our additional data. More observations will be needed. Independent arguments supporting our result can be found in a recent paper by Bovy et al. (2019), who analysed the APOGEE observational data. They clearly found a zone of increased metallicity at a Galactocentric distance of about 4 kpc, while the metallicity at the Galactic Centre was similar to that measured at the solar Galactocentric distance (see their fig. 4).

How reliable is our conclusion regarding the maximum abundance at 2-4 kpc? The answer depends greatly on the position of two stars (i.e. SU Sct and ASAS 181024-2049.6), which were previously analysed in Martin et al. (2015) and Andrievsky et al. (2016). In those papers, we proceeded from the assumption that both are classical Cepheids. Jayasinghe et al. (2018) performed the All-Sky Automated Survey for Supernovae and, as a by-product, they discovered a large number of new variable stars. In particular, they found that SU Sct could be a W Vir star (i.e. a Cepheid of type II). If this classification is correct, then the distance used in our previous programme may be wrong. Nevertheless, it should be noted that Jayasinghe et al. carried out an automatic classification of a large sample of stars without a careful investigation of the individual objects. Therefore, it cannot be excluded that, in the case of SU Sct, the classification presented may be erroneous. Moreover, type II Cepheids are known to show strong emission in H α near maximum, whereas classical Cepheids, as a rule, do not show it. The star of our programme, SU Sct, does not show emission in H α (we have five spectra of this Cepheid at our disposal; see fragments of those spectra in Fig. 5). In addition, type II Cepheids have a metallicity below zero, while SU Sct shows a metallicity of about +0.3 dex. So, it is highly probable that SU Sct is a classic Cepheid. Also, ASAS 181024-2049.6 (three spectra obtained in different phases) does not show any H α emission, and it is also likely a classic Cepheid. Moreover, both these stars are situated very close to the Galactic disc (b is about -6° and -1° , respectively), which is not typical for type II Cepheids.

6 CONCLUSION

For the first time, we have derived the elemental abundance in young disc stars (i.e. Cepheids), which are located in the very centre of our Galaxy. We used high-resolution near-IR spectra of

Ion GCC-a (13) GCC-b (12) GCC-c (11) GCC-d (10) [M/H] Ν Ν [M/H] Ν [M/H] N [M/H] σ σ σ σ 6.00 -0.210.21 4 -0.300.16 5 -0.400.22 3 -0.250.11 5 11.00 0.61 0.09 2 0.46 0.09 2 0.84 1 0.62 0.04 2 12.00 0.38 2 -0.092 0.03 0.05 2 0.17 0.30 0.11 1 14.00 0.04 0.18 8 0.01 0.21 13 0.41 0.28 5 -0.140.03 3 2 16.00 -0.190.22 -0.440.10 6 -0.050.20 6 0.09 0.12 6 -0.022 3 20.00 0.30 -0.363 0.18 -0.070.43 22.00 0.37 0.33 4 0.01 0.39 2 0.27 0.11 2 _ _ 1 2 23.00 -0.421 -0.040.39 0.25 24.00 0.27 0.36 2 -0.230.11 3 0.44 1 26.00 -0.040.13 57 -0.010.22 106 0.16 0.21 49 0.04 0.18 122 27.00 -0.242 -0.080.03 2 0.10 0.38 1 7 28.00 8 0.13 0.20 -0.052 0.18 4 0.13 0.22 0.13 0.33 39.01 0.11 1 -0.481 -0.011





Figure 4. [Fe/H] versus R_G . The filled circles show the compilation of iron abundance determinations in Galactic Cepheids from our papers published between 2002 and 2016 (for references, see Martin et al. 2015; Andrievsky et al. 2016). The iron abundance in the Galactic Centre Cepheids is from this paper (the [Fe/H] values are indicated by the open circles with error bars). Two points at approximately 2 and 3 kpc correspond to the ASAS181024–2049.6 and SU Sct positions, respectively. The approximate position of a plateau-like region (if it really exists) is schematically shown by a thin continuous line. The position of the Sun is at the intersection of the dashed lines.



Figure 5. Variation of the H α profile in the SU Sct spectra with the pulsation phase. None of the spectra (including the spectrum that was observed at the maximum light) shows any emission feature in this line. Three spectra were collected by Prof. George Wallerstein using the facilities of the Apache Point Telescope (private communication) and the other two spectra were investigated by Martin et al. (2015).

four stars observed with the iShell spectrograph attached to the NASA IRTF. Our local thermodynamic equilibrium analysis shows that these Cepheids have metallicities close to solar values, which is a new result for the very central part of the Galactic nuclear disc.

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