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The chemical abundances of open clusters: NGC 752, NGC 1817, NGC 2360 and NGC 2506

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Abstract. Since the Galactic Open Clusters (OCs) provide a sample of stars homogeneous in age and chemical composition and their distances are well determined, they were recognized as suitable candidates to study the chemical evolution of Galaxy. We have analyzed high-dispersion echelle spectra (R≥50,000) of 3-4 red giant members for each open cluster to derive abundances for a whole range of elements including light as well as heavy elements. The membership to the cluster has been confirmed through their radial velocities and proper motions. The spread in temperatures and gravities being very small, nearly the same stellar lines were employed thereby reducing the random errors. Most of these clusters are located in Galactic anti-center direction and we found [Fe/H] values of −0.02±0.05 for NGC 752, −0.07±0.06 for NGC 2360, −0.11±0.05 for NGC 1817 and −0.19±0.06 for NGC 2506. Abundances relative to Fe for elements from Na to Eu are equal within measurement uncertainties to published abundances for thin disk giants in the field with the possible exception of mild anomalies for Mn, Cu, Ba, Ce and Nd. This supports the view that field stars come from disrupted open clusters.

Keywords : Galaxy: abundances – stars: abundances

1. Summary

Open clusters (OCs) are believed to be coeval groups of stars born from the same proto-cluster cloud which may have been part of a larger star-forming region in the Milky Way. Since all stars in most OCs are at the same distance and have the same chemical composition, basic stellar parameters like age, distance, and metallicity can

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be determined more accurately than for field stars. Thus, OCs provide an excellent opportunity to map the structure, kinematics, and chemistry of the Galactic disk with respect to Galactic coordinates and time. The existing chemical homogeneity among cluster members, see, for example, De Silva et al. (2009) and references therein, signifies that the proto-cloud is well mixed, and hence, the abundance pattern of a cluster bears the signature of chemical evolution of the natal cloud.

Clusters were selected from the *New catalogue of optically visible open clusters and candidates*[1]. Observations were conducted during February 6-10, 1999 with Tull echelle coudé spectrograph (Tull et al. 1995) on the 2.7-m Harlan J. Smith telescope at the McDonald observatory. Spectroscopic reductions were done with the **IRAF** software of *NOAO*[2] within the *imred* and *echelle* packages, involving bias subtraction, scattered light correction, flat-fielding, order tracing with optimal extraction, wavelength calibration and continuum fitting.

Initial estimates of the effective temperature and gravity for each of the selected red giants from each of the clusters were derived from the photometric relations. Later, the spectroscopic abundance analysis was performed with the 2010 version of the local thermodynamical equilibrium (LTE) line synthesis program MOOG[3] by adopting the recent atomic data from various sources in the literature. Further, we performed a check on the adopted spectroscopic atmospheric parameters. We compared the stellar spectra to the synthetic spectra to derive abundances for the lines having intrinsic multiple components and lines affected by blends. We evaluated the sensitivity of the derived abundances to the variations in adopted atmospheric parameters by varying the temperature by 100 K, gravity by 0.25 cms^{-2} and microturbulence by 0.2 kms^{-1}.

2. Results

The four clusters support the widely held impression that there is an abundance gradient such that the metallicity [Fe/H] at the solar galactocentric distance decreases outwards at about -0.1 dex per kpc: (R_{gc}, [Fe/H]) = (8.3, -0.03) for NGC 752, (9.3,-0.07) for NGC 2360, (9.9, -0.12) for NGC 1817, and (10.5,-0.20) for NGC 2506.

Our cluster mean abundances match the abundances of the field giants from Luck & Heiter's (2007) to within about ±0.15 dex except for Mn, Cu, Ba, Ce and Nd for which differences are all less than 0.30 dex. Luck & Heiter's results for field giants are generally confirmed by Takeda et al. (2008) for other large samples of field giants. One may note that Takeda et al.'s Mn, Ce and Nd abundances (relative to Fe) agree

[1] http://www.astro.iag.usp.br/ wilton/
[2] http://iraf.noao.edu/
[3] http://www.as.utexas.edu/ chris/moog.html

well with ours while in our analysis ionization equilibrium is attained for Sc, Ti, V and Cr species.

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