PROPERTIES OF THE GALACTIC OLD OPEN CLUSTERS SYSTEM

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October 11, 1993

ABSTRACT. The chemical properties of the Galactic Disk and its vertical structure are discussed by means of the population of Intermediate Age and Old Open Clusters. The global distribution of this population, together with its chemical and age properties, suggest a continue and smooth transition from the old thin disk to the thick disk, according to the analisys of Norris & Green (1989). After correcting the observed metal abundance (measured by the index [Fe/H]) for the effect of the radial metallicity gradient (d[Fe/H]/dR=-0.09, Friel & Janes 1993), we show that the metal abundance of a cluster mostly depends on its position, and no age-metallicity relation (AMR) exists.

1. Introduction

The population of Intermediate Age and Old Open Clusters represents a powerful tool to investigate the structure and evolution of the Galactic Disk. These objects in fact span the entire age interval from the disk formation to about 1.0 Gyr ago, cover a large portion (8.0-9.0 Kpc) of the galactic disk, and reach more than 1.0 Kpc above and below the galactic plane. Table 1 summarizes the fundamental parameters of the sample under discussion, while Figg. 1a and 1b show the distribution of these clusters within the Galaxy. In order to perform our tasks (to study the structure and the chemical evolution of the Galactic Disk) the first step is to obtain a correct age ranking. After studing in detail the color magnitude diagram (CMD) of ten template clusters (Fagotto & Carraro 1992; Bertelli et al 1992; Carraro et al 1993a, 1993b) by means of theoretical models and isochrones of the Padova Group (Bressan et al 1993; Fagotto et al 1993), we have obtained an age calibrator (Carraro & Chiosi 1993) to assign age to a sample of 29 clusters, for which homogeneous metallicity determinations are available (Friel & Janes 1993). In other words we have derived a relation between ΔV (the magnitude difference in CMD between the Main Sequence (MS) turn off point (TO) and the clump of He burner stars), the index [Fe/H] and the logarithm of the age in Gyrs. The form of this relation is

$$Logt_9 = 0.45(\pm0.05) \cdot \Delta V + 0.09(\pm0.01) \cdot [Fe/H] + 8.59(\pm0.45). \qquad (1)$$

With these results it is possible to construct an improved (homogeneous in ages and in metallicities) AMR for the Galactic Disk.

Cluster	l	b	[Fe/H]	Age(Gyr)
IC166	130.1	-0.2	-0.32±0.20	0.90
NGC752	137.2	-23.4	-0.16±0.05	1.50
NGC1193	146.8	-12.2	-0.50±0.18	5.00
NGC1817	186.1	-13.1	-0.39±0.04	0.85
NGC6939	95.9	+12.3	-0.11±0.10	1.50
BERKELEY21	186.8	-2.5	-0.97±0.10	2.00
NGC2141	198.1	-5.8	-0.39±0.11	1.80
NGC2243	239.5	-18.0	-0.56±0.17	4.50
NGC6940	69.9	-7.2	+0.04±0.10	0.65
NGC2660	265.9	-3.0	+0.06±0.10	0.75
TOMBAUGH2	232.9	-6.8	-0.60±0.18	1.45
MELOTTE66	259.6	-14.3	-0.51±0.11	5.50
NGC2420	198.1	+19.7	-0.42±0.07	2.10
BERKELEY39	223.5	+10.1	-0.31±0.08	6.50
NGC2477	253.6	-5.8	-0.05±0.11	0.65
NGC2506	230.6	+9.9	-0.52±0.07	1.90
NGC2682	215.6	+31.7	-0.09±0.07	4.80
NGC3680	286.8	+16.9	-0.16±0.05	1.80
NGC3960	294.4	+6.2	-0.34±0.08	0.65
NGC5822	321.7	+3.6	-0.21±0.12	0.48
NGC6791	70.0	+11.0	+0.19±0.19	8.00
NGC6819	74.0	+8.5	+0.05±0.11	2.10
NGC7142	105.4	+9.5	-0.00±0.06	4.90
NGC7789	115.5	-5.4	-0.26±0.06	1.20
NGC188	123.0	+22	-0.06±0.10	7.50
NGC2158	186.7	+1.8	-0.60±0.27	1.50
IC4651	340.0	-8.0	-0.16±0.10	1.60
NGC2204	226.0	-16.1	-0.58±0.10	1.80
BERKELEY19	176.9	-3.6	-0.50±0.10	3.80

TABLE I
Fundamental parameters for the Clusters sample.

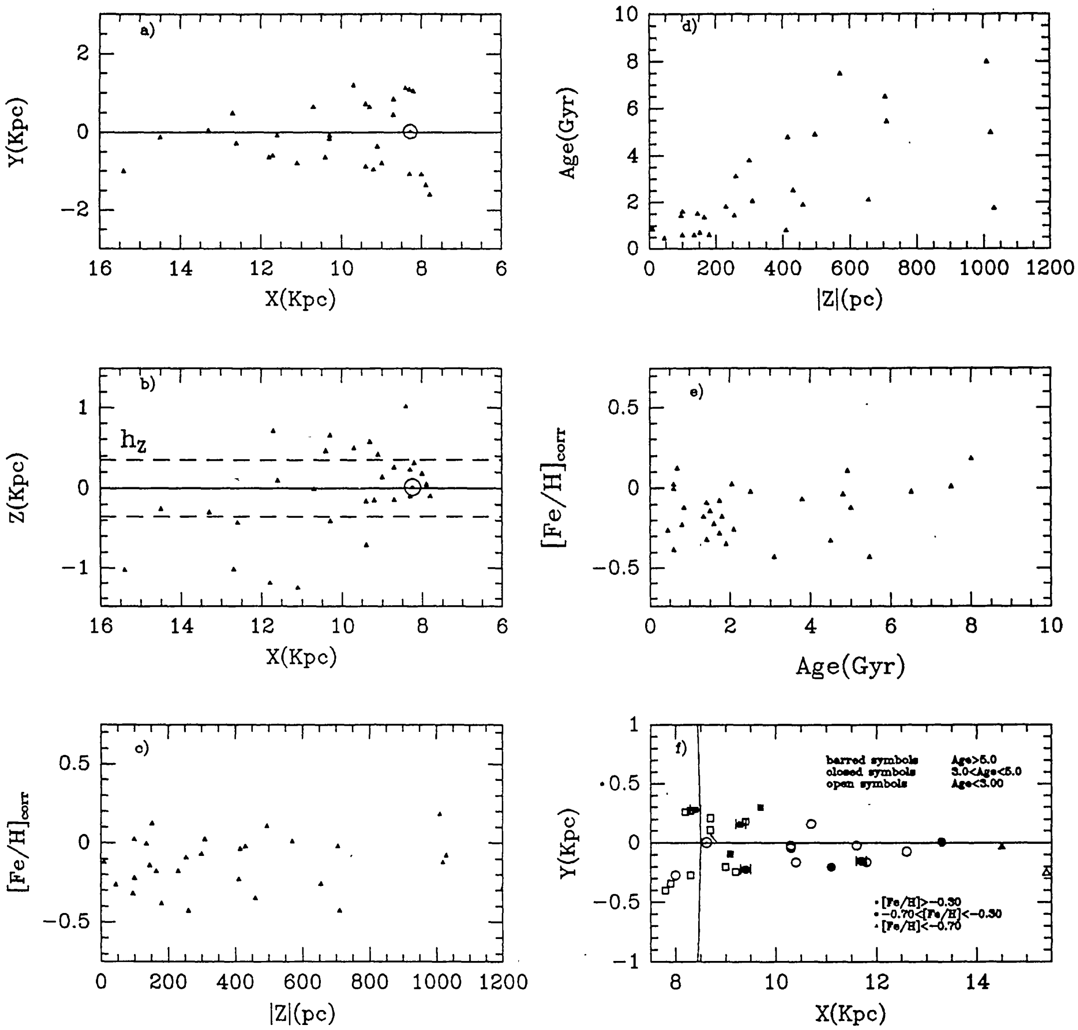

Fig. 1. General properties of the Clusters sample: see the text for more details.

2. The Thin-Thick Disk Connection

The relations of [Fe/H] (corrected for the radial abundance gradient effect) and age with the height above the galactic plane are shown in Figg. 1c and 1d respectively. Combining the results shown in Figg 1b-1d the following remarks can be made. The bulk of our clusters sample occupies the old thin disk region, at scale height h_Z around 350 pc, while an handful reaches galactic heights more appropriate to a thick disk population, suggesting a continue transition from the thin to the thick disk (see Sandage 1988 for a definition of thin and thick disk). This is confirmed by the general trend of an increasing age with Z (see Fig. 1d). As far as the metallicity is concerned no trends appear looking at Fig. 1c: nevertheless if one considers the highest clusters, and removes NGC 6791, a supersolar metallicity cluster in the inner region of the disk (toward the Galactic Center), the result is that the highest clusters are on the average more metal deficient than the lowest ones. In such a way we confirm the picture of the Disk as a superposition of different zones in which the various properties change smoothly, i. e. the metallicity decreases and the age increases at increasing height above the plane (see Norris & Green 1989), together with the possibility of a different evolution for the inner (with respect to the solar ring) and the outer population.

3. An AMR for the Galactic Disk

Friel & Janes (1993) have recently proposed an AMR for the Galactic Disk adopting their new determinations of metal abundance: their results are the absence of a general trend for the AMR, and the presence of a gap in the age distribution between 5.0 and 8.0 Gyrs ago. With this new homogeneous age ranking, we obtain a more uniform age distribution, with no gaps, but we confirm the lack of a global trend for the AMR (see Fig. 1e): the Galactic Disk has been homogeneous and well mixed in [Fe/H] since 8.0 Gyr ago (this is the age of NGC 6791, the oldest open cluster). To summarize, in Fig. 1f we show the location of our sample in the galactic plane, together with the distribution of their ages and metallicities. An accurate inspection of this figure clearly demonstrates that the metal abundance of a cluster is related to its position, and independent of its age.

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