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KINEMATICAL PROPERTIES OF THE SPECTRAL GROUP OF NEARBY DWARFS*

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ABSTRACT

On the basis of the recently available data, we have analysed the kinematical properties of nearby dwarfs, which are grouped by their spectral types and derived their ages from the kinematical properties. The discontinuities in the kinematical properties are found around late F stars, which appear to be caused mainly by the fact that the spectral groups earlier than late F are rather homogeneous in age while the later ones are mixed by two different age groups.

I. INTRODUCTION

It has been known that the dispersions of the space velocities increase steadily from the early types to the late types along the main sequence (Delhaye, 1965) and that a discontinuity in the kinematical properties occurs around type F5 (Parenago, 1950).

On the basis of the recently available kinematical data of nearby dwarfs, it is intended to improve the kinematical properties of spectral groups and to determine their ages from their kinematical properties.

II. KINEMATICAL PROPERTIES OF SPECTRAL GROUPS AND THEIR AGES

a) Kinematical Properties

The kinematical data of nearby dwarfs are adopted from the Catalogue of Nearby Stars (Gliese, 1969) and Nearby Star Data Published 1969~1978 (Gliese and Jahreiss, 1978).

Table 1. Mean Velocity and Velocity Dispersion for the Spectral Group

Spectral group	n	$\langle M_V \rangle$	S_M	$\langle U_{LSR} \rangle$	$\langle V_{LSR} \rangle$	$\langle W_{LSR} \rangle$	σU	σV	σW	σV
Earlier than A9	31	2.0	0.8	3	8	0	17	11	5	21
F0~F4	34	3.4	0.6	−3	7	0	22	16	12	30
F5~F9	103	3.9	0.5	−1	0	−3	29	19	20	41
G0~G4	124	4.8	0.4	−8	−9	3	37	29	24	52
G5~G9	114	5.5	0.6	−2	−12	−1	34	32	20	51
K0~K4	179	6.4	0.7	−5	−6	0	39	28	19	52
Emission line group	24	6.3	0.5	6	1	−2	28	20	13	37
Non-Emission line group	155	6.5	0.7	−6	−7	0	40	29	20	53
K5~K9	168	7.7	0.8	0	−9	0	35	28	21	49
Emission line group	30	7.9	0.6	1	−1	−3	32	13	12	37
Non-Emission line group	138	7.6	0.8	0	−11	0	35	30	22	52
M0~M3	240	9.1	0.8	5	−5	−1	42	31	22	57
Emission line group	86	9.1	0.7	7	1	1	35	20	19	45
Non-Emission line group	154	9.0	0.9	4	−8	−2	45	36	24	62
M3.5~M5	59	11.5	1.1	3	−9	−5	56	30	22	67
Emission line group	29	11.5	1.2	3	5	−4	38	13	13	43
Non-Emission line group	30	11.7	0.9	4	−22	−5	58	40	30	77
>M5	10	14.5	1.3	−25	−16	5	40	33	18	55
Total	1062			−11	−21	−8				

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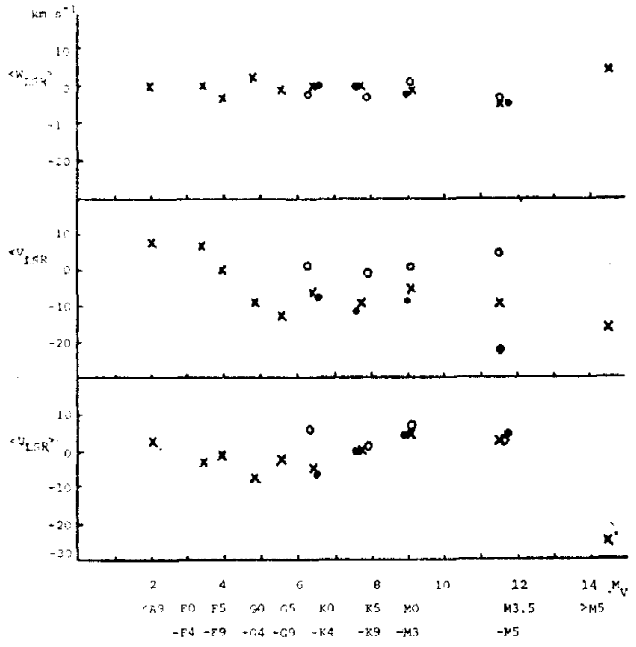

Fig. 1. Mean Velocity for the Spectral Group (Open circle: emission line star group, Filled circle: non-emission line star group)

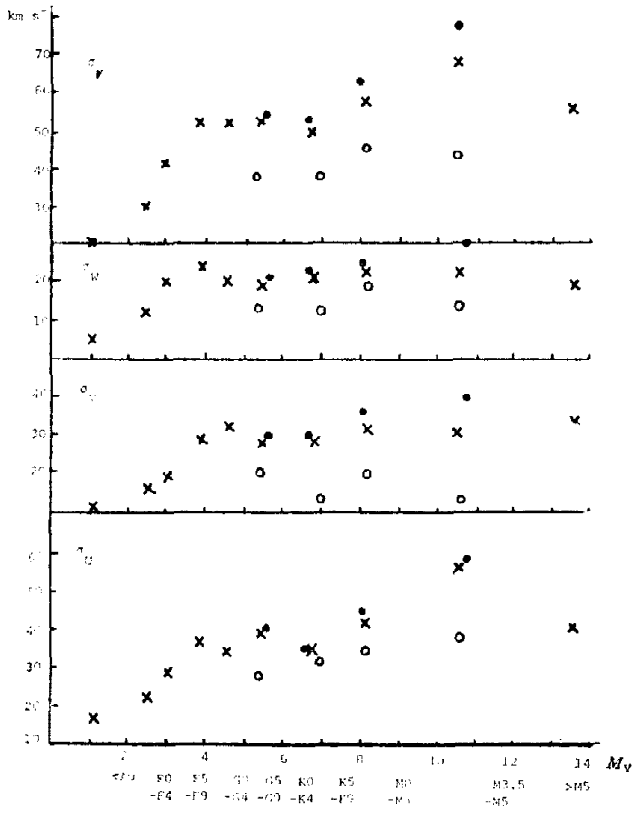

Fig. 2. Velocity Dispersion for the Spectral Group (Open circle: emission line star group, Filled circle: non-emission line star group)

The nearby dwarf are divided into the groups according to their spectral types, which are assigned as stellar groups of earlier than A9, F0-F4, F5-F9, G0-G4, G5-G9, K0-K4, K5-K9, M0-M3, M3.5-M5 and later than M5. The spectral groups later than K type are subdivided into two groups of stars with emission lines and without emission lines.

The resulting absolute magnitudes of stars in Gliese's Catalogue are adopted. And the space velocity components of stars are converted to those relative to the local standard of rest, by taking the standard solar motion $(U_S, V_S, W_S) = (10, 15, 7)$ km sec^{-1}. U, V and W components of space velocity are directed towards the galactic center, the direction of galactic rotation, and the galactic north pole, respectively. The velocity dispersion of each spectral group is defined as the root mean square of the space velocity or its components for all stars in the group.

The results on the kinematics of the spectral groups are summarized in Table 1, which includes their mean absolute magnitudes and standard deviations. The solar motion $(U_S, V_S, W_S) = (11, 21, 8)$ km sec^{-1} relative to the local standard of rest, is obtained from these program stars, which is rather large as compared to the adopted standard solar motion. However, this is expected because the stars listed in the Gliese catalogue are biased by selection effects (Wielen, 1974).

From the variations of the mean velocity and the velocity dispersion along the spectral groups shown in Figure 1 and Figure 2 it is noted that the velocity dispersion increases from early

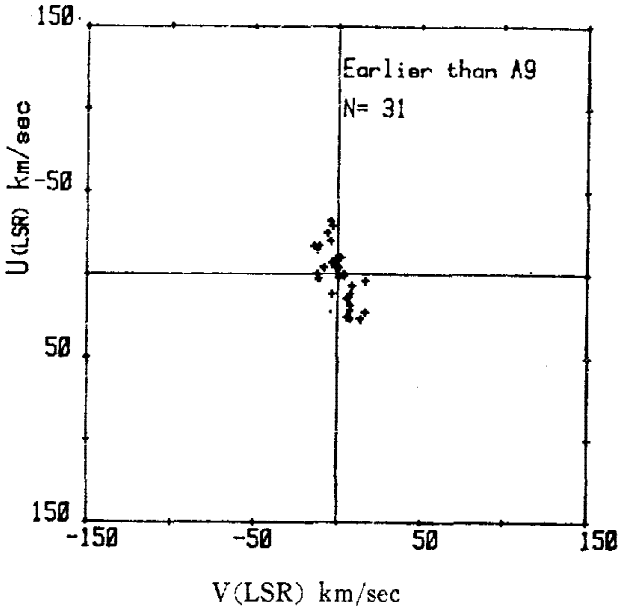

Fig. 3. Velocity Distribution of stars earlier than A9.

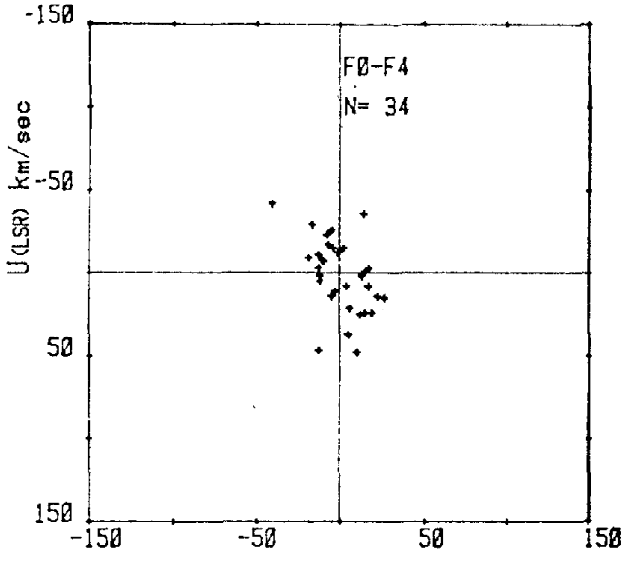

Fig. 4 Velocity Distribution of F0-F4 Stars.

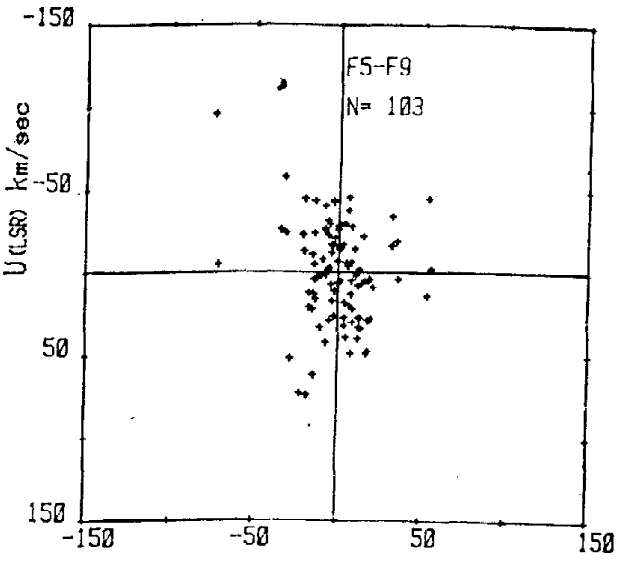

Fig. 5. Velocity Distribution of F5-F9 Stars.

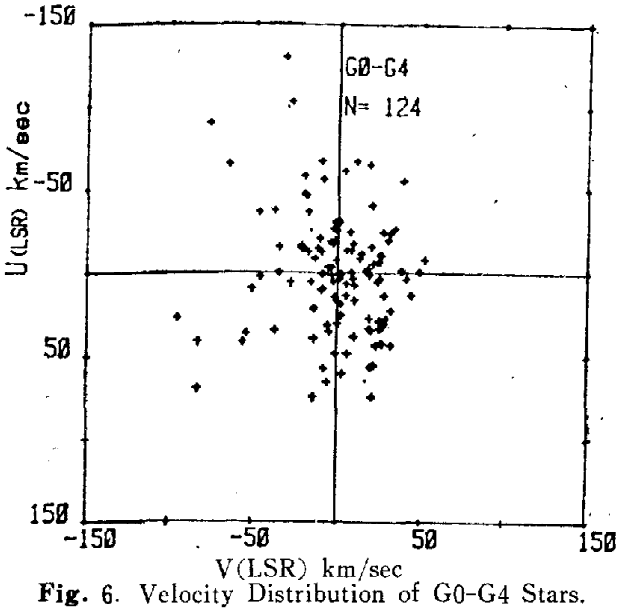

Fig. 6. Velocity Distribution of G0-G4 Stars.

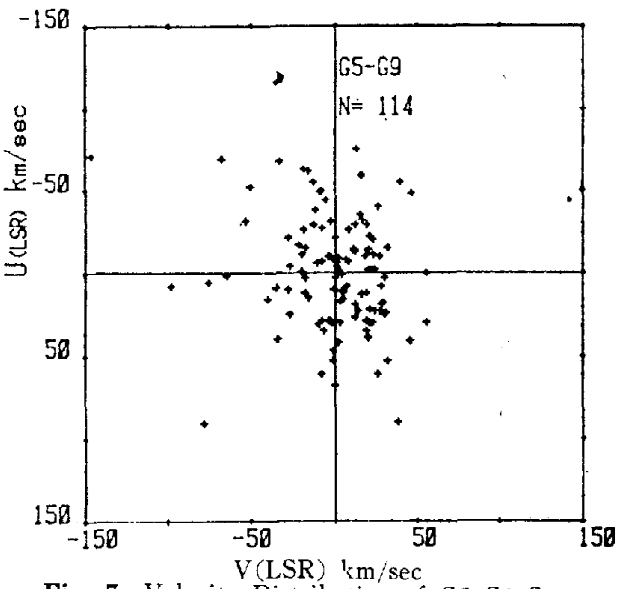

Fig. 7. Velocity Distribution of G5-G9 Stars

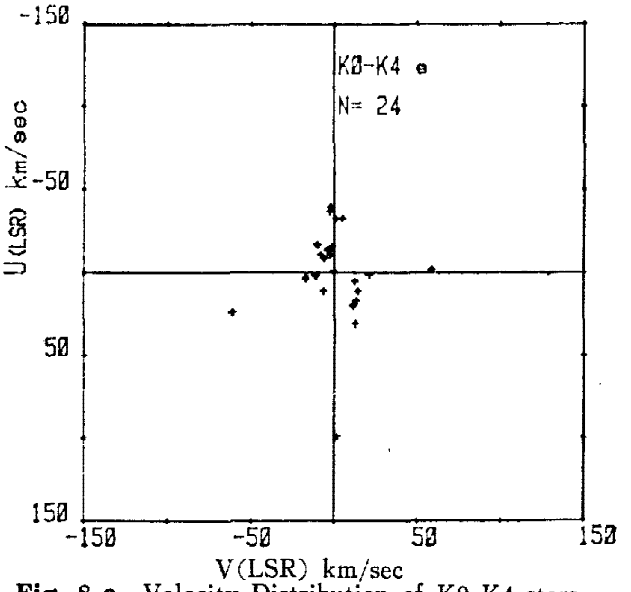

Fig. 8-a. Velocity Distribution of K0-K4 stars with emission line.

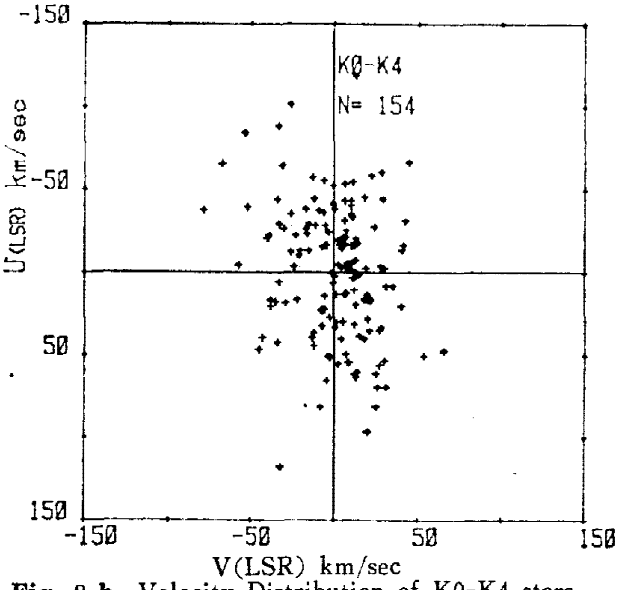

Fig. 8-b. Velocity Distribution of K0-K4 stars without emission line.

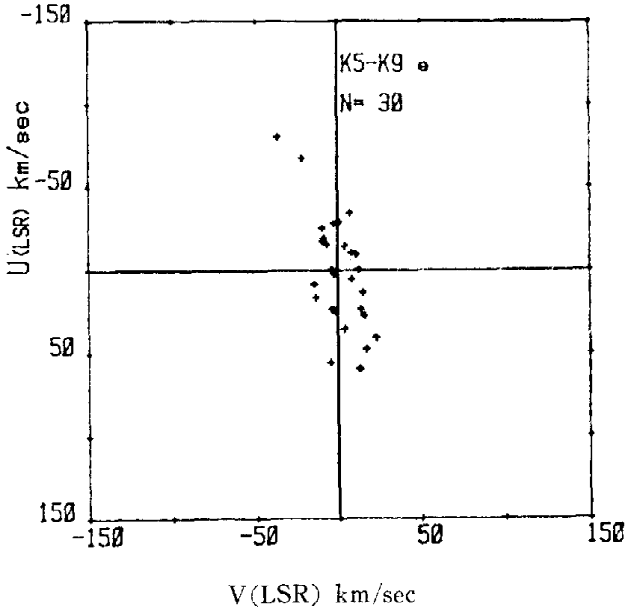

Fig. 9-a. Velocity Distribution of K5-K9 stars with emission line.

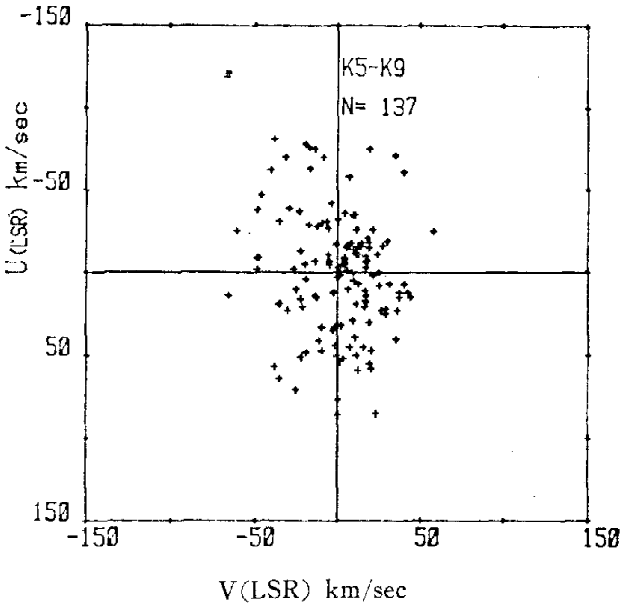

Fig. 9-b. Velocity Distribution of K5-K9 stars without emission line.

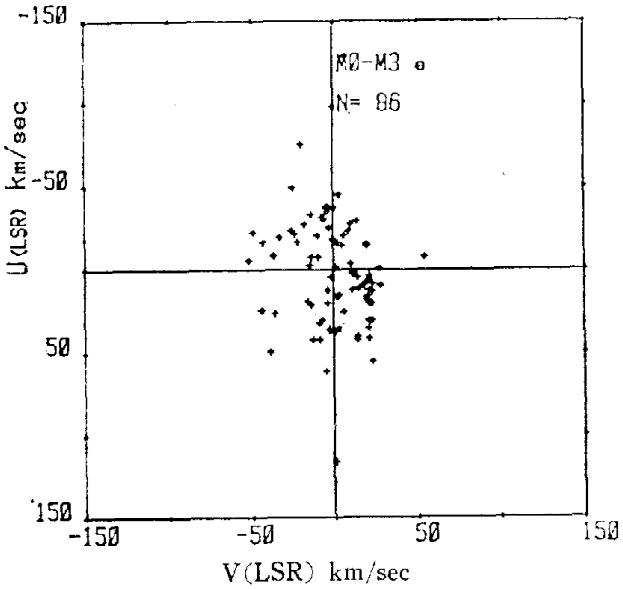

Fig. 10-a. Velocity Distribution of M0-M3 stars with emission line.

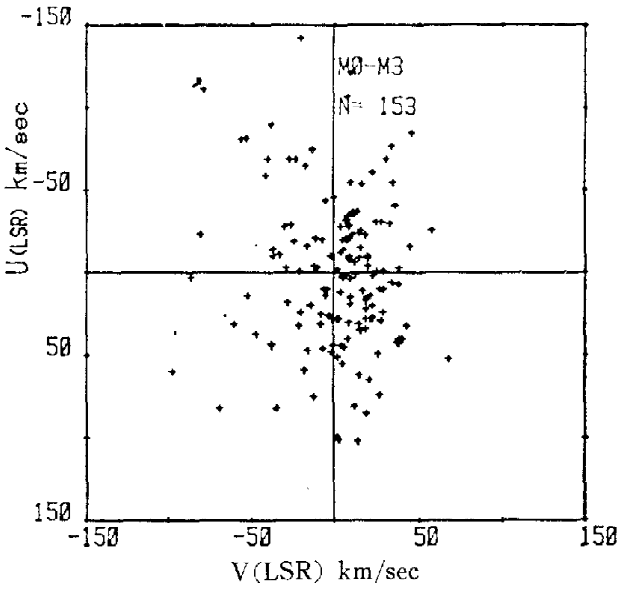

Fig. 10-b. Velocity Distribution of M0-M3 stars without emission line.

to late type stellar groups and a kinematical discontinuity occurs around late F stars. These results agree well with most of the former works. On both figures, the open circle indicates the emission line star group and the filld circle does the non-emission line one. It is also noticed that the kinematics of the emission line group is quite similar to that of the stellar group earlier than G type, rather than that of the non-emission line group of the same spectral type.

The velocity distribution in the U, V plane for each spectral group, as shown in Figs. 3~12, indicates that the vertex deviation appears distinct in the stellar groups of earlier than A9, F0-F4, F5-F9 and the emission line groups of later spectral type while it disappears in the stellar groups of G0-G4, G5-G9 and the non-emission line groups of later spectral type.

Therefore, it is most likely that the groups earlier than G type and the emission line groups of later spectral type belong to a rather homogeneous age group. In other words, they may be a spectral sequence of a homegeneous group of stars formed some time ago during a certain period of time.

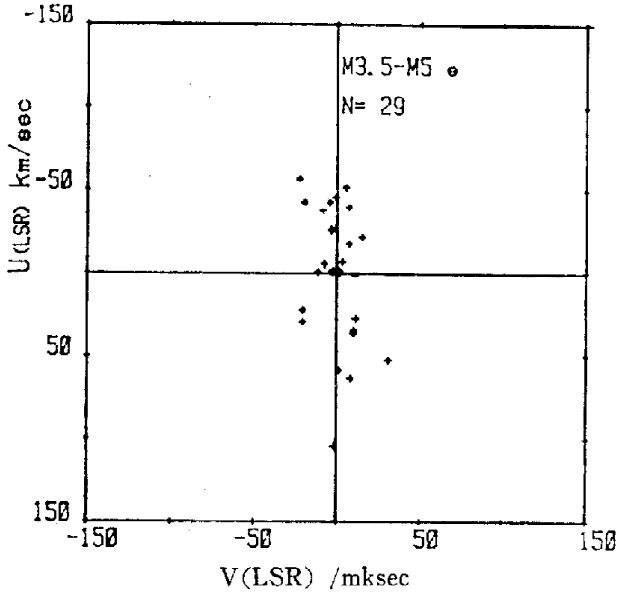

Fig. 11-a. Velocity Distribution of M3. 5-M5 stars with emission line.

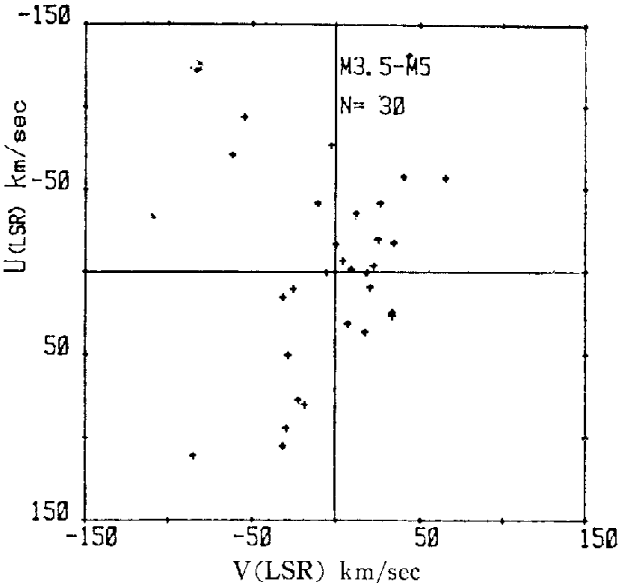

Fig. 11-b. Velocity Distribution of M3.5-M5 stars without emission line.

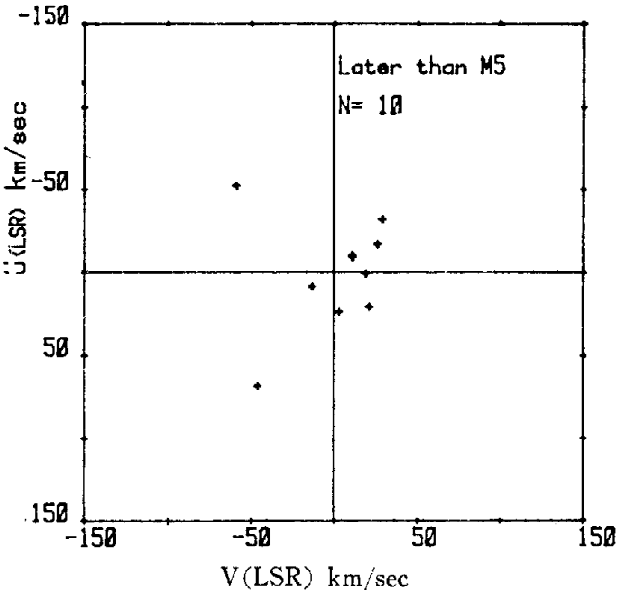

Fig. 12. Velocity Distribution of stars later than M5.

b) Ages

In order to get the age of each spectral group, the relation between age and velocity dispersion is derived from Figure 4 given by R. Wielen(1974). Table 2 lists the average age of each spectral group.

The mean age of the groups, including F0-F4, F5-F9, and the emission line groups of later spectral type is roughly 3.1×10^9 years with standard deviation of 0.8×10^9 years, while that of G0-G4, G5-G9, and the non-emssion line groups of later spectral type is around 6.4×10^9 years with standard deviation of 1.2×10^9 years.

III. CONCLUDING REMARK

From the dichotomic characteristics in kinematical properties of nearby dwarfs we could conclude that the stellar groups of spectral type earlier than late F and the emission line groups of later spectral type are of a same homogeneous age group.

In late F and G stars, the different kinematical properties of the weak line and strong line star groups(Roman, 1954 and 1955) also imply that two different groups of age are mixed together.

Therefore, the earlier spectral group is homogeneous in age while the stellar groups later than F type are mixed by two different age

Table 2. Age of the Spectral Group

The Spectral Group	earlier than A9	F0-F4	F5-F9	G0-G4	G5-G9		K0-K4	K5-K9	M0-M3	M3.5-M5
Age(10^9 years)	0.6	1.9	3.7	5.8	5.5	Emission line group	2.9	2.5	4.3	3.3
						Non-Emission line group	5.8	5.6	7.1	8.7

groups: one of them is as young as the earlier spectral group and the other is more than twice as old. From early F to late spectral type, there is a sequence of one homogeneous age group whose age is about 3×10^9 years old and from the later than F type, another spectral sequence of homogeneous age group whose age is about 6×10^9 years remains still on the main sequence.

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