KINEMATICS OF HALO RED GIANTS

Bruce W. Carney

University of North Carolina

David W. Latham

Center for Astrophysics

V. Straižys

Vilnius Observatory

ABSTRACT. We discuss results from radial velocity data for a sample of metal-poor kinematically-unbiased red giants. We determine the motions of the stars with respect to the Local Standard of Rest, and estimate their velocity dispersions.

1. INTRODUCTION

Many samples of field halo stars have kinematic biases built in due to selection effects, so it is often difficult to determine the true kinematic properties of such stars. Bond (1980) has published a list of 132 metal-poor red giants, identified via objective prism methods, and with the more metal-rich stars excluded via uvby photometry. Composition-luminosity effects and the difficulties in detecting very weak-lined stars may introduce some minor biases in the observed metallicity distribution, but this all-sky sample contains no obvious kinematic biases and thus provides us with a superb data base.

Bond listed new or previously-published radial velocities for 62 of the stars. Since then, new velocities have been or are being published for 8 more stars (Eggen 1979; Griffin et al. 1982; Bessell and Norris 1984; Norris, Bessell, and Pickles 1984). We have obtained new radial velocity measures (often multiple) for 63 stars, including 5 previously measured. Only 4 of Bond's stars now lack radial velocity data. In Figure 1 below we show the distribution of the 128 stars in galactic coordinates, with the origin at $\ell = 0°$, $b = 0°$. Plus signs indicate stars with $v_c > +50$ km sec^{-1}, minus signs represent those

A. G. Davis Philip and David W. Latham (eds.),
Stellar Radial Velocities, 177–181.

with $v_c < -50$ km sec^{-1}, and the circles are those with $-50 \leq v_c \leq +50$ km sec^{-1}. v_c is the radial velocity of each star with respect to the Local Standard of Rest (LSR). Figure 1 (and its many published predecessors) clearly shows the difference in the rotation between the halo population and the LSR.

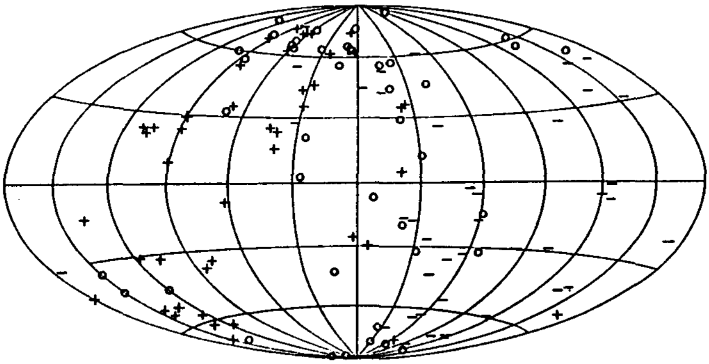

Fig. 1. The distribution of the 128 stars from Bond's survey

2. RESULTS

Our first quantitative result is the difference between the two populations. Following the precepts discussed by Mihalas and Binney (1981), we have computed $\dot{x}$, $\dot{y}$, $\dot{z}$, and K, where the first three terms represent the mean motions along the three orthogonal axes at the LSR, and K is an expansion or systematic errors term. All but $\dot{y}$ are consistent with zero. Upon forcing them to be exactly zero and solving again for $\dot{y}$ alone, we find $\langle\dot{y}\rangle = -214 \pm 26$ km sec^{-1}. In Table I below we compare this with previous relevant results. We distinguish between Θ_o, which is the circular orbital velocity of the LSR, and $|\langle\dot{y}\rangle|$, which is the motion of a population sample with respect to the LSR. If the two are equal, the sample is not rotating about the galactic center and hence defines a spheroidal population. We see that the field halo stars all give results consistent with a weighted average of 228 ± 16 km sec^{-1}. The local field halo stars thus show no net rotation about the galactic center, whereas the globular clusters have

TABLE I

Tests of Halo Rotation

Sample	Measures	Result ($km\ sec^{-1}$)	Reference
H I gas	Θ_o	220	Gunn, Knapp, and Tremaine (1979)
High-velocity halo dwarfs	Θ_o	222 ± 9	Carney and Latham (1985)
RR Lyraes	$\|\langle\dot{y}\rangle\|$	225 ± 25	Woolley and Savage (1971)
Halo AB stars	$\|\langle\dot{y}\rangle\|$	272 ± 41	Pier (1984)
Halo red giants	$\|\langle\dot{y}\rangle\|$	214 ± 26	This paper
Globular clusters	$\|\langle\dot{y}\rangle\|$	160 ± 26	Frenk and White (1980)

a mean apparent rotational velocity of 60 ± 26 km sec^{-1}. Thus either the local field halo stars and the globular clusters belong to slightly different dynamical populations or one of them contains an admixture of some other population group.

If the globulars or a subset of them differ from the local field halo stars, we expect to also see differences in the derived velocity dispersions. In Table II below we summarize such results. The errors in all cases are regrettably large due to the small sample sizes and the fact we only have radial velocity data available. The field stars results are similar, except for the vertical component. Our red giants show a much larger velocity dispersion than either of the other two field samples. If we nonetheless assume all three such samples come from the same parent population and take weighted averages, we see they differ slightly from the globular clusters in that the latter appear to be more confined to the disk.

3. FUTURE WORK

Further progress toward unravelling the puzzle of the joint or differing dynamical histories of the metal-poor field and cluster population(s) will be slow and difficult, for we have exhausted the brighter, nearer data samples. What we need now are more studies of field stars extending to the distances typical of globular clusters, such as the red giant work of Ratnatunga and Freeman (1984), and the RR Lyrae surveys of the Lick group (Kinman, Wirtanen, and Janes 1965, 1966), Saha (1984), and Hawkins (1984). It should also prove valuable,

TABLE II

Velocity Dispersions

Sample	$\langle R^2 \rangle$	$\langle \Theta^2 \rangle$	$\langle \Phi^2 \rangle$	Reference
RR Lyraes	2.14 ± 0.59	1.51 ± 0.55	0.52 ± 0.37	Woolley and Savage (1971)
Halo AB	1.33 ± 0.43	0.22 ± 1.05	0.93 ± 0.23	Pier (1984)
Halo red giants	2.30 ± 0.35	1.51 ± 0.39	1.85 ± 0.39	This paper
AVERAGE	1.95 ± 0.25	1.51 ± 0.39	1.02 ± 0.17	
Globulars	1.37 ± 0.33	2.52 ± 0.65	0.64 ± 0.93	Frenk and White (1980)

although very time consuming, to see if there are any serious differences in the elemental abundance patterns among those samples or subsamples as an additional means of identifying differing places or times of formation.

REFERENCES

Bessell, M. S. and Norris, J. 1984 preprint.
Bond, H. E. 1980 Astrophys. J. Suppl. 44, 517.
Carney, B. W. and Latham, D. W. 1985 in IAU Coll. No. 88, Stellar Radial Velocities, A. G. D. Philip and D. W. Latham, eds., L. Davis Press, Schenectady, p. 139.
Eggen, O. J. 1979 Astrophys. J. 229, 158.
Frenk, C. S. and White, S. D. 1980 Monthly Notices Roy. Astron. Soc. 193, 295.
Griffin, R. F., Griffin, R. E., Gustafsson, B., and Vieira, T. 1982 Monthly Notices Roy. Astron. Soc. 198, 637.
Gunn, J. E., Knapp, G. R., and Tremaine, S. D. 1979 Astron. J. 84, 1181.
Kinman, T. D., Wirtanen, C., and Janes, K. A. 1965 Astrophys. J. Suppl. 11, 223.
Kinman, T. D., Wirtanen, C., and Janes, K. A. 1966 Astrophys. J. Suppl. 13, 379.
Mihalas, D. and Binney, J. 1981 Galactic Astronomy, W. H. Freeman, San Francisco, pp. 389-393.
Norris, J., Bessell, M. S., and Pickles, A. J. 1984 preprint.
Pier, J. R. 1984 Astrophys. J. 281, 260.
Ratnatunga, K. U. and Freeman, K. C. 1984 preprint.
Saha, A. 1984 Astrophys. J. in press.
Woolley, R. and Savage, A. 1971 Roy. Obs. Bull. 170.

DISCUSSION

WHITE: The inhomogeneity, and inaccuracy, of the field RR Lyrae stars and the globular star cluster radial velocity data are extreme. Better and more homogeneous data will be available soon (RR Lyr; Latham & Co.; Glob. Cl.; Hesser & Shawl); better not to place too much credence in the information available "historically".

CARNEY: Thanks for the warning. My real concern at the moment, however, is the difference in velocity dispersions we find versus that found by Norris, Bessell, and Pickles (preprint), even though both data samples are kinematically-unbiased metal-poor red giants.