LUMINOSITY CALIBRATION OF LATE-TYPE STARS BY STATISTICAL PARALLAX USING AGK3 PROPER MOTIONS

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1. INTRODUCTION

The luminosity of individual late-type stars is estimated mainly by spectral features in the MK spectral classification system or by means of the Wilson-Bappu effect. The MK spectral type is given for spectra with a dispersion of about 100 Å mm^{-1} which is within the reach of some Schmidt telescopes with objective prisms. On the other hand, the Wilson-Bappu effect is measured from spectra with a dispersion of about 10 Å mm^{-1}, obtained by coudé spectrographs. In either case the luminosities must be calibrated by knowledge of apparent magnitudes and distances for some stars.

Trigonometric parallaxes are one of the basic means of calibrating intrinsic luminosity. This most fundamental method can be applied successfully to main sequence stars of classes F5 through M, and with great care to giants of G5 to late K type. Zero-age main sequence fitting using cluster members is a usual means for calibrating high luminosity stars. The luminosity calibration of F, G, K and the later type giant stars depend primarily on the statistical parallax method.

Statistical parallaxes have been calculated for a large number of stars with AGK3 proper motions by making use of radial velocities in Wilson's (1963) and other catalogues. They have been published for carbon stars (Mikami 1975), M type stars (Mikami 1976), and F, G, and K type stars (Mikami 1977). The complete lists of those stars and their statistical material are available upon request from T. Mikami. Some results will be summarized briefly here.

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2. CARBON STARS

There are 321 carbon stars classified in the C system in the present sample. The major source of spectral types is Yamashita (1972, 1975). It is found that their mean distance is over 1 kpc. Their mean distances can be derived from radial velocities and the first order differential galactic rotation equation. Mean visual absolute magnitudes thus obtained are $M_V=-1^m.3$ for C0-3, $-2^m.7$ for C4-5 and $-2^m.4$ for C6-7. Ninety stars have AGK 3 proper motions. Mean visual absolute magnitudes calculated with secular parallaxes are about $0^m.8$ fainter at each spectral subtype, although the difference is within the range of the probable error of the absolute magnitude derived by the secular parallaxes. The proper motion stars are subsamples of the radial velocity stars. It is likely that the stars with AGK3 proper motions are nearby stars and that, therefore, they are picked up more completely to fainter absolute magnitudes. It is suggested as a result that there exists a range of at least one magnitude of intrinsic dispersion in the visual absolute magnitude in each spectral subtype of carbon stars.

3. M-TYPE STARS

The sample includes 1490 M-type stars with luminosity classes in the MK or Mount Wilson system. A good correlation between the spectral types in the two systems was confirmed and they were combined in the analysis. There are 1116 giants with radial velocity data and 627 giants among 710 AGK3 proper motion stars. The mean distance of the giants is less than 1 kpc. Both p_U and p_T were calculated by the secular parallax method with radial velocity data and AGK3 proper motions. The mean visual absolute magnitudes obtained are listed in Table I. Mikami's values for M1 through M3 are $0^m.6$ brigher than those of Blanco (1965) which are mainly based on a distance modulus of $3^m.03$ of four giants in the Hyades based on the Wilson-Bappu effect. These values support Jung's (1970) values obtained by the statistical parallax method for stars in the Yale Catalogue of Bright Stars (Hoffleit 1964). Mikami's (1976) calibration of absolute magnitudes of the latest M-type giants are the first reliable ones available.

4. F, G AND K-TYPE STARS

In the sample of F, G and K-type stars there are 5384 stars with radial velocity data and 3574 stars with AGK3 proper motions. Most types are nearly equally divided into giants and dwarfs and the sample is also divided nearly equally into F, G and K star groups, though the majority of F stars are dwarfs and the majority of K stars are giants. Their mean distance is

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TABLE I

MEAN VISUAL ABSOLUTE MAGNITUDES FOR M GIANT STARS

SP	Blanco (1965)	Jung (1970)	Mikami (1976)	Blanco -Mikami	n
M0	$-0^{m}.3$	$-1^{m}.2$	$-0^{m}.4$	$+0^{m}.1$	96(109)
M1	-0.5	....	-1.1	+0.6	60(67)
M2	-0.8	-1.5	-1.5	+0.7	126(114)
M3	-1.1	....	-1.6	+0.5	92(106)
M4	-1.0	-1.7:	-0.7	-0.3	119(123)
M5	-0.9:	....	-0.9	0.0	65(103)
M6	-0.9	....	+0.1	-1.0	44(86)
M7	-0.9:	....	+0.5	-1.4	25 (48)
M8	....	....		....	(12)

from 230 pc for K giants to 30 pc for K dwarfs. Both p_U and p_T were calculated by the secular parallax method. The calculations were made for each Mount Wilson luminosity class and the results were converted to those in the MK luminosity class with FitzGerald's (1969) correlation tables. The resultant values of the absolute magnitude of dwarfs and subgiants confirm Blaauw's (1963) values. However, Mikami's values for K giants are $0^{m}.7$ brighter than Blaauw's (1963), and agree with those carefully derived from trigonometric parallaxes by Ljunggren and Oja (1966), as shown in Table II.

5. CONCLUDING REMARKS

AGK3 proper motions have been successfully used to derive

TABLE II

MEAN VISUAL ABSOLUTE MAGNITUDES FOR K GIANT STARS

Sp	Blaauw (1963)	Ljunggren & Oja(1966)	Mikami (1977)	Blaauw -Mikami	n
K0	$+0^{m}.8$	$+0^{m}.1$	$+0^{m}.1$	$+0^{m}.7$	148(212)
K1	+0.8	+0.8	+0.4	+0.4	114(171)
K2	+0.8	-0.1	+0.3	+0.5	113(172)
K3	+0.1	-0.2	-0.4	+0.5	116(180)
K4	+0.1	-0.9	-0.6	+0.7	130(187)
K5	-0.3	-1.4	-1.2	+0.9	160(251)

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statistical parallaxes of late type giant stars. It seems that a revision is needed to the calibration formula of the Wilson-Bappu effect. Statistical parallaxes might depend on local peculiarities of the kinematical characteristics of field stars in the solar neighborhood. The consistency with results derived by other independent methods offer support for the results discussed here.

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