

PRECISE MEASUREMENTS OF RADIAL VELOCITY USING A LIREPHO MICROPHOTOMETER

P. Heinzl, P. Hadrava, Faculty of Mathematics and Physics, Charles University, Praha

Received 20 June 1974

A simple method suitable for precise radial-velocity measurements by means of the Zeiss-Lirepho microphotometer is briefly described. The testing showed that the precision of the new method is quite comparable to the precision reached with a classical Abbé comparator. In addition, the method allows for measuring velocities of broad or asymmetric lines and of the weak lines invisible in the comparator.

Точные измерения лучевой скорости с применением Lirepho-микрофотометра

Кратко описывается простой метод, разработанный для точных измерений лучевых скоростей при помощи микрофотометра Zeiss-Lirepho. Проверка этого метода показала, что его точность вполне сравнима с точностью достигаемой на обычном компараторе Аббе. Кроме того, метод позволяет определить лучевые скорости по расширенным, слабым или асимметричным линиям, измерение которых на компараторе Аббе связано с большими ошибками или совершенно не возможно.

1. Introduction

It is well-known that the classical method of visual measurements of the radial velocity using an Abbé comparator is quite insufficient in the case of broad and weak lines. Recently, the problem was solved at some observatories by the use of the Grant oscilloscopic measuring machine. Unfortunately, neither the Grant machine (or a similar instrument), nor a precise multi-channel microphotometer are easily accessible to most observatories because of their high price.

That was the reason why we tried to develop a suitable method of precise radial velocity measurements applicable to the Zeiss-Lirepho microphotometer (for its description see W. Falta and E. Winter (1959) or firm literature).

2. Development of the Method

The main problem in the measurements of precise wavelengths using a one-channel microphotometer is to record the exact position of the comparison lines into the record of a stellar spectrum.

First, we tried to record the comparison lines by means of marks made at moments when the comparison lines were seen just in the middle of the control slit. The internal error of such measures was good, but the resulting value of velocity was incorrect. It was affected by a systematic error arising from an unknown and variable shift between the measuring and control slits of the instrument.

Also a more refined procedure — overlapping of two records carried out in opposite directions fails to provide good results — the error in the values of the radial velocity was still too large.

3. "P-Tracing" Method

Though rather questionable at first sight, the following method turned out to be suitable:

The stellar spectrum is recorded on the microphotometer tracing. When a comparison line approaches the control slit, the stage-table with the plate is moved perpendicularly to the direction of recording, so that the profile of the comparison line is recorded. In recording the spectrum the comparison lines from both sides of the stellar spectrum are used alternately. The only disadvantage of this method is that the parts of the stellar spectrum in the neighbourhood of the comparison lines used are lost. It is possible, however, to measure the plate once more using other comparison lines.

The position of any point on the tracing can then be measured using a normal linear ruler and transformed to wavelengths by means of the dispersion curve, defined by comparison lines recorded.

This method (which will be referred to as the "P-tracing" method) was verified on the coude spectrograms taken with the Ondřejov 2m-telescope. The radial velocities or wavelengths were determined using the computer program written by J. Krpata for a Minsk-22 computer. The testing of the "P-tracing" method is based on the fact that for symmetric lines velocity measurements performed by Lirepho and by Abbé comparator can easily be compared. Moreover, in the case of α Tau the standard value of the radial velocity was used ($RV = (+54.1 \pm 0.1)$ km/sec) — see Transactions (1955). All the measurements are presented in Tab. 1. On several spectrograms some atmospheric lines were also identified. Their wavelengths, measured using this method, agree with the

Table 1
Comparison of the measurements

Star	Plate No.	Instrument	Dispersion of		Number of lines	RV_{hel} [km/sec]	RMS error
			plate [Å/mm]	tracing [Å/cm]			
α Tau 29139	561	Lirepho	12	1	25	54.3	0.6
		Abbé		—	37	54.2	0.4
EW Lac 217050	958	Lirepho	8	1	4	—20.2	3.5
		Abbé		—	28	—19.1	0.5
	1285	Lirepho	8	1	21	—11.5	0.6
				1	21	—12.0	0.6
		Abbé		—	23	—12.8	0.6
	1287	Lirepho	8	0.5	8	—12.5	0.4
				0.5	8	—12.3	0.8
				1	18	—12.0	0.6
				1	4	—12.3	2.6
		Abbé		—	26	—12.5	0.3
	1295	Lirepho	8	1	21	—15.3	0.6
		Abbé		—	22	—15.1	0.4

tabulated values within 0.015 Å (i.e. $\Delta RV \sim 0.7 \text{ km/sec}$).

We, therefore, conclude that the accuracy of the value of the radial velocity (or wavelengths), derived by the “P-tracing” method, is quite comparable to the one reached by an usual Abbé comparator. Moreover, the tracing provides the whole line-profile and wavelength may be determined at its arbitrary point.

Acknowledgments

The authors would like to thank Dr. P. Harmanec and P. Koubský who gave kindly to our disposal the Abbé and some “P-tracing” measurements of EW Lac used in Tab. 1. Valuable discussions with the members

of the Ondřejov group of Stellar Department are highly appreciated.

REFERENCES

Falta W., Winter, E.: 1959, Jenaer Rundschau **4**, 7.
Transactions of the IAU IX (1955), 442.

P. Heinzel
Department of Astronomy and Astrophysics
P. Hadrava
Department of Theoretical Physics
Faculty of Math. and Phys.
Švédská 8
150 00 Praha 5
Czechoslovakia