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DETERMINATION OF STELLAR MAGNETISM BASED ON THE COMPUTERIZED EVALUATION OF ZEEMAN-SPECTRA

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ABSTRACT A package of computer-programs is presented, which is suited for the evaluation of stellar spectra in regard of line positions in order to determine the magnetic field strength and the radial velocity. The programs have been developed for the calculation of the measuring data obtained from photographic spectrograms but could be generalized for the on-line observation in a spectrograph at the telescope using an electronic detector.
The network of programs may be amplified deliberately as required for any special application. For the exchange of data among cooperating institutes we propose the standardization of programs and data-files as outlined below.

Measurements of the magnetic field strength and, additionally, the radial velocities in stars are bound to line position setting in the stellar spectra produced by the spectrograph of a telescope. The spectra can either be recorded on a photographic plate and measured later on a comparator or received by a CCD-matrix and evaluated instantly by a computer. In any case computer-programs are required, which transform the measured line position values into the corresponding wavelengths and reduce them by line identification and statistical evaluation to the resulting values of the magnetic field strength and the radial velocity.

The technical conditions for the observation of the magnetic field strength in stars are given by an efficient telescope, a spectrograph of high resolution power, and a Zeeman-analyzer, which splits the left and the right circularly polarized light in two separated beams to be recorded on a photographic

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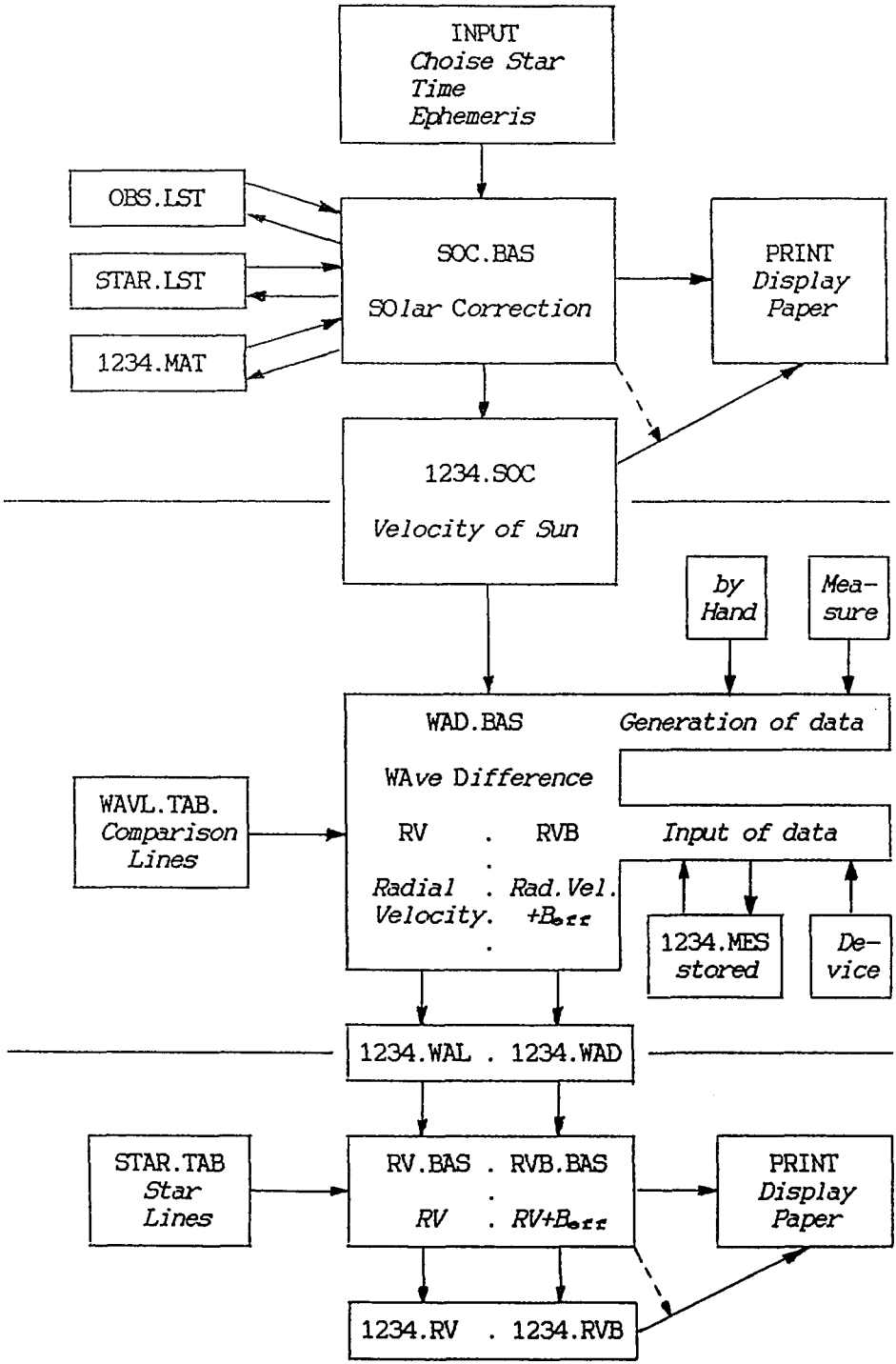

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The Program System

SPECTRUM EVALUATION

SOC

* manages lists of stars and observatories (STAR.LST,OBS.LST),
* calculates Julian Date and Local Stellar Time,
* actualizes the stellar coordinates,
* determinates ephemeris of rectangular coordinates,
* transforms the coordinates to heliocentric position,
* corrects the coordinates by matrix multiplication (*.MAT),
* stores the data on disk for following evaluation in the file *.SOC,
* recalls onto screen or prints out on paper,
* stores input data and results.

WAD

* generates the data by hand or uses a measuring device,
* manages the lists of measuring data computer-appropriately,
* stores the measuring data for later evaluation or the exchange with other users in the files *.MES,
* uses the measuring data of line positions in the spectrum,
* separates the comparison lines from the star lines,
* identifies comparison lines by the wavelengths (WAVL.TAB),
* derives and optimizes the dispersion curve by iteration,
* determines the wavelengths of the measuring data of the star lines using the solar correction calculated by SOC and stored in the files *.SOC,
* arranges the wavelength values of the Zeeman-pairs in polarization-correct order and calculates the mean wavelengths with the differences caused by the Zeeman-effect,
* stores the wavelength series
  either for RV in the file *.WAL
  or for RV + B_{eff} in the file *.WAD.

RV/RVB

* uses the output of the stellar wavelengths resp. differences from WAD (*.WAL or *.WAD),
* identifies the measured lines by means of a star line table STAR.TAB, containing the information of element, multiplet, and Landé-factor (z-value),
* derives the radial velocity and the magnetic field strength,
* calculates the whole set of data statistically using inner weighting and iteration methods,
* stores the lists of the measured and evaluated lines on disk in the files *.RV or *.RVB,
* inserts the resulting data in *.SOC for further treatment.

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plate or a CCD-matrix with a displacement of the line profiles due to the magnetic field.

The technical conditions for the measurement are given by a comparator (as described by GERTH et al. [1977]), which measures the line positions of the partial Zeeman-spectra. The measurement can be performed by eye and hand, whereby the measuring data are input, stored and evaluated in a computer. Aspired to would be the automized measurement of the line position using a frequency distribution evaluation of the line profiles by computer and the length determination by a micrometer. At the AIP in Potsdam there has been realized a LASER-interference micrometer connected to the *Modified Abbe-comparator.*

The set of programs presented here takes account of all observing and measuring conditions, manages tables of stars, wavelengths, and observatories, stores measuring and resulting data. Its main purpose, however, is the correct statistical evaluation of the measuring data and the optimization of the results. The programs are written in GW-BASIC.
The set consists of three parts, which are interconnected and menu-guided. They represent three steps of evaluation. The efficiency of the single steps is specified and the interconnections are demonstrated in the tables contributed to this paper.
I. The first part SOC (SOlar Correction) manages lists of stars and observatories, performs transformations of coordinates and time and gives the preliminary evaluation resp. preparation of the observation. It is especially suited for the direct connection to the observing telescope.
II. The second part WAD (WAve Difference) manages the input measuring data, the wavelength table of the comparison lines, and derives the dispersion function for the determination of the wavelengths corresponding to the measuring values. In this part a decision is come to for the calculation either of the magnetic field strength (B+RV) or the radial velocity (RV) alone.
III. The third part (RVB, RV) derives the final results by a comprehensive table of star informations and keeps them ready on files for further treatments.

Reference:
Gerth, E., Hubrig, H.-J., Oetken, L., Scholz, G., Strohbusch, H., Czeschka, J.: 1977, Jena Review, 87