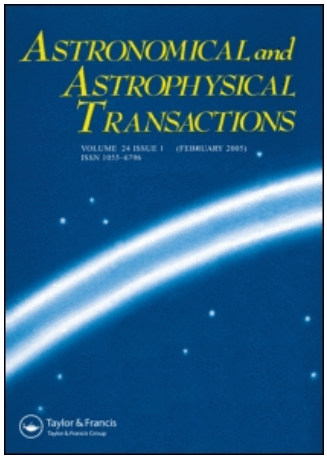

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Simultaneous linear and circular polarimetry of variable stars in the 2.6 m Shain telescope computer program for data reduction

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The new computer program PolarObs-2006 is described, which allows us to reduce the observations obtained with the 2.6 m Shain (ZTSh) telescope which is equipped with a new photometer–polarimeter. The program is used to investigate variable stars of different types.

Keywords: Variable stars; Data reduction; Polarimetry

Polarimetric studies of variable stars of different types have been carried out at the Crimean Astrophysical Observatory for decades. Recently, the photometer–polarimeter [1] that is used with the 2.6 m Shain (ZTSh) telescope has been modified to enable us to measure all Stokes parameters, in contrast with the previous device. Because of the new observation possibilities, new software is needed. Moreover, the possibilities using the old program (compiled under MS DOS) were limited, in comparison with those for programs developed for MS Windows.

We have developed the computer program PolarObs-2006 which may run either under MS Windows or in the LINUX operating systems with installed WINE (which allows to Win32 programs to be run).

The new photometer–polarimeter contains a rotating $\lambda/4$ phase plate and an immobile analyser. Data are saved in a file as eight columns of counts.

All data files consist of series of observations. Any series (observations of a star, background, comparison star and standard star) have properties: the filter and the exposure time. When opening the data file, the program automatically determines the type of series, at the same

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time enabling the user to apply or change these properties. This style minimizes the number of keys per file to be pressed.

After opening a data file, the program shows two curves: the light curve of the object at the top, and the measurements of the background at the bottom of the workspace (for between one and eight channels). After smoothing the values of the background by a polynomial, the background values are subtracted from the signal separately for all channels.

The user can smooth the measurements of the comparison star to determine the brightness of the object.

After this, the program calculates the linear combinations of counts in the channels, hereafter called the 'vectors' S1–S4. The first and second vectors determine the circular polarization, and the third and fourth vectors the linear polarization.

After this step, it is possible to save the 'P-file', containing the photometry and non-normalized Stokes parameters as these vectors. This file can be viewed later.

The next step will be to analyse the diagram of the vectors S2 on S1 and S4 on S3. Under the graphs, the values of the polarization, position angle and other information are given.

If the user is processing observations of the zero or non-zero polarization standard, these values are the final result.

While processing the star (object), it is possible to rotate the diagram of circular polarization for adduction of the axis connecting 0 and the centre of distribution in the Ox direction and the linear polarization to an angle determined for the non-zero linear polarization standard. It is also possible to rotate by an angle, which is manually inserted (e.g. a correction by an angle determined from the linear polarization standard).

It is possible to approximate the vectors by a polynomial or to determine the mean points and their accuracy estimates. To determine the statistically optimal number of points for smoothing, we use three test functions, which are listed in a list box. The first is an unbiased estimate of accuracy of one measurement, the second is the mean accuracy estimate of the smoothing point and the third is the amplitude signal-to-noise ratio (see [2] for details).

In the program PolarObs2006, we have used some modules, which were developed earlier for our program Variable Stars Calculator [3], such as the approximation by a polynomial and a component for drawing the graphs. The light curve and polarization curve may be modelled using polynomial fits with determination of the statistically significant order.

Many processes, including a search of data files on the user's disk, are automated; this makes the work easier.

The program settings allow us to change an interface and some parameters.

While processing observations, the user can save files in different formats; so they can be used by other software as well.

Help is available as a pop-up transparent window, which also contains all tips and messages.

The program has passed practical tests in reduction in the observations of magnetic cataclysmic variables AM Her, V405 Aur, BY Cam, QQ Vul and V1432 Aql at the Shain telescope of the Crimean Astrophysical Observatory.

The results of these observations are compared with those obtained previously by different researchers. For example, the light curve of AM Her shows a two-peak structure which is explained by periodic variations in the orientation of the accretion column. The phase curve of the circular polarization also has a two-peak structure and a phase interval with zero polarization, which corresponds to an eclipse of the region of polarized emission by a white dwarf. The timings of a characteristic point on the curves are used to study the changes in the orientation of the accretion column. The flickering agrees with a 'shot noise' model of blobby accretion.

The computer program PolarObs-2006 may be applied for processing polarimetric observations of any astronomical objects (stars, comets and asteroids) and will be used by our group and other scientists making observations using this photometer–polarimeter.

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