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Novel Algorithms for Astronomical Plate Analyses

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Abstract. Powerful computers and dedicated software allow effective data mining and scientific analyses in astronomical plate archives. We give and discuss examples of newly developed algorithms for astronomical plate analyses, e.g., searches for optical transients, as well as for major spectral and brightness changes.

Key words. Astronomical plates—plate archives archives—astronomical algorithms.

1. Algorithms for automated analyses of digitized spectral plates

We have developed and tested algorithms for automated classification of spectral classes, searches for spectral variability (both continuum and lines), searches for objects with specific spectra, correlation of spectral and light ganges, and searches for transients. An important part here is the algorithm for an automated recognition of a low dispersion spectral image and its comparison with atlas images (specimen of stellar spectra of sample stars with defined spectral type). In addition, spectral changes can be exploited and followed as well as searches for objects with strange spectra. The algorithms should be able to take into account the background in the photographic emulsion which is not trivial as the background is variable. One method on how to solve this is the histogram implementation resulting from digitized plate and reflecting the parameters of real sky plates, yielding optimized threshold filter. Then segmentation algorithm follows which recognizes the spectral elongated image. A recursive function as well as various convolution filters are used. The function to control the edge-surroundings gradient was also tested and added. The recognized spectral images are then normalized, and consequently the layered neuron network are used to analyze the vectors. The neuron network is then responsible for selection and allocation of model spectra (Hudec 2007).

2. Algorithms for optical transients

Another example is how to identify brief (less than 1 h) optical transients (OTs) on sky archival plates. The methods of comparing plates and/or comparison with

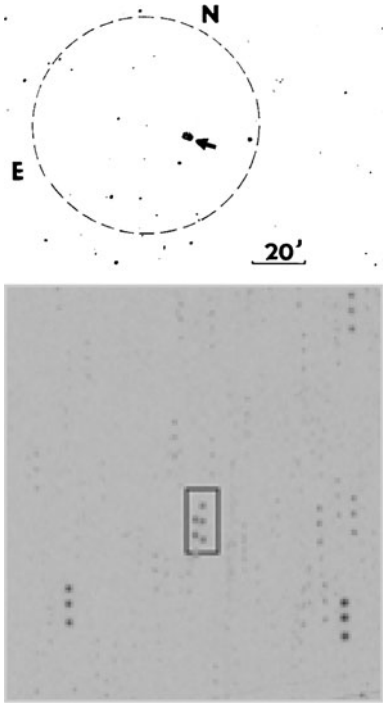

Figure 1. The example of an OT found on the astronomical plate by optical miscroscope supervised survey (top). The example of an OT found by the tested software – the flare duration was less than 30 min in this case as the OT image is represented by 2 points while the normal stars by 3 points (bottom).

catalogues are still not very effective and reliable. We have proposed and tested an alternative method using multiple times exposed astronomical plates based solely on the information in the plate itself (Fig. 1). Such plates are available in various sky plate archives, e.g., at the Royal Observatory, Brussels. These plates contains several (typically 2 to 10) identical star field images on the same plate. This means, each star inside the field of view (FOV) of the telescope, is represented several times. Such plates have been obtained by multiple exposures on the same plate with tiny shifts between the exposures. We note that these algorithms and programs find applications also in blazar and AGN investigations, as can be applied to find large optical flares on these objects, analogous to those found in the past based on plate surveys (Vrba *et al*. 1994; Hudec *et al*. 1996).

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