THE MINNESOTA AUTOMATED PLATE SCANNER: A NEW USER FACILITY

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ABSTRACT. The redevelopment of the Minnesota Automated Plate Scanner (APS) is complete and the system is being used as an astronomical visitor facility. The system consists of the original CDC-Luyten scanner with a new microprocessor-based motion control system, state of the art detection electronics, a PDP-11/60 data acquisition system with all relevant scanning parameters under software control, a Sun 3/110 computer for data reductions and a high speed link to the University of Minnesota Supercomputer Institute Cray 2 for reductions of very large projects. The redeveloped APS is among the fastest plate measuring machines in the world and features a variety of densitometric and isophotometric data acquisition modes. An ambitious project is being undertaken to scan all plates of the first epoch Palomar Sky Survey. Objects will be classified as stars, galaxies, plate flaws, etc., and accurate positions and magnitudes will be determined. This resulting catalog, as well as the raw data archive, will be made available to the astronomical community.

1. OPERATION AND PERFORMANCE

The APS owes its very fast scanning speed to the use of a 'flying' laser spot of 12 micrometers diameter. This spot is swept in the y-direction by a rotating octagonal prism while the plate moves continuously in x. This scans a 12mm wide stripe across the plate with the spacing between successive spot paths determined by the spot velocity and plate carriage speed. It requires only 30 12mm wide stripes to scan Sky Survey plates. Table 1 shows the relation between scan spacing, carriage speed, and laser beam speed, as well as the total scanning time for 14-inch (356mm) plates. The densitometric dynamic range is ~2 in density units, a limitation inherent in all flying spot scanners due to a halo of scattered light.

The detection electronics has four selectable modes for acquiring the data (see Figure 1). The standard mode is isophotometric with four software settable image levels per plate. Automatic background subtraction is accomplished using densitometric data taken during the flyback

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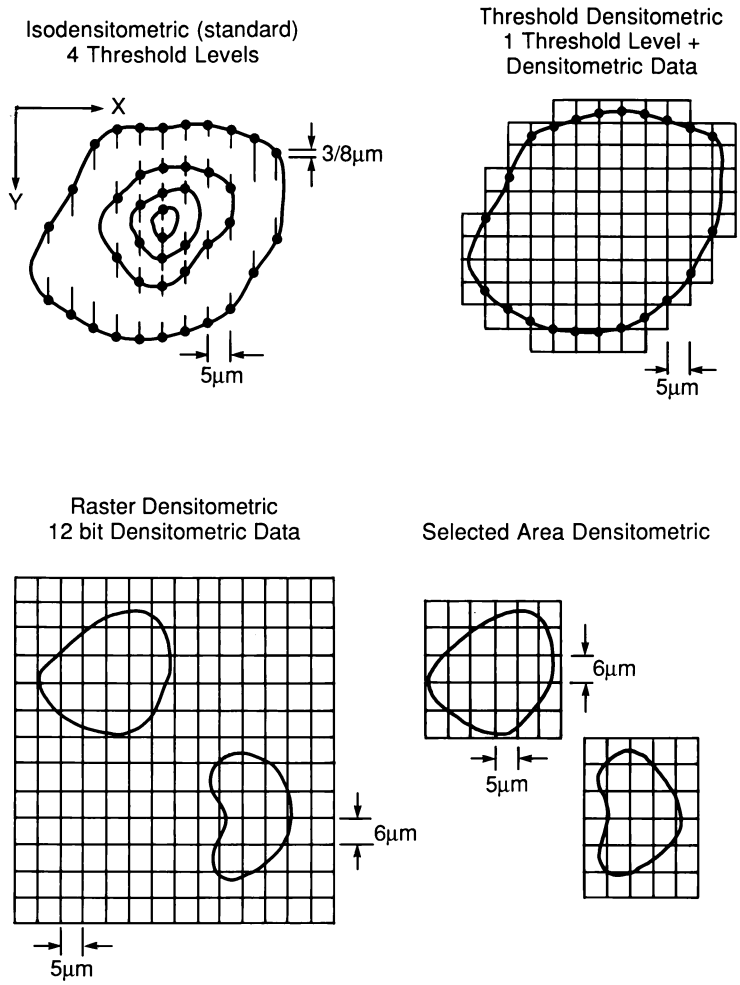

Figure 1. APS Scanning Modes. This shows the four scanning modes available to APS users. Threshold densitometry, top right, will be used to scan the 1950 Palomar Sky Survey.

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after the previous stripe. The second mode is raster densitometric or PDS mode using a 12 bit A/D and no automatic background subtraction. The third mode is threshold densitometric, and yields one level of background subtracted isodensitometric data plus densitometric data within all images above the threshold. The fourth mode is most useful for objective prism plates and uses a previously generated map of image positions to digitize only areas around those images.

TABLE 1. APS Speeds, Scan Spacings, and Timings

	scan separations			
	laser scanning speed(μ/μsec)			scanning time per pair
x-speed	12	6	3	of 14-inch (35 cm) plates
6 mm/sec	10 μ	20 μ	40 μ	1^h6^m
3 mm/sec	5 μ	10 μ	20 μ	1^h40^m
1.5 mm/sec	2.5 μ	5 μ	10 μ	2^h45^m

Software is available on the PDP-11/60 to fully reduce the isodensitometric data and display it on a 1024×1024 by 8 bit color image display system. Some densitometric data may be reduced using IRAF on a SUN 3 with a dedicated interprocessor link to the PDP-11/60. The Sun is on the campus Ethernet and has access to the University of Minnesota Supercomputer Institute Cray 2 running UNIX.

2. SCANNING THE FIRST EPOCH PALOMAR SKY SURVEY

The combination of a very fast scanner and a direct link to the processing power of the Minnesota Supercomputer Institute Cray 2 has placed us in a unique position to do very large projects, making it possible to scan the 1950 Palomar Sky Survey. Glass copies of the POSS are already at Minnesota. From the scanning we will produce catalogs of all stellar images and galaxies/nebulae to within ~0.5 mag of the plate limit. These catalogs will be distributed through the Data Center and may be made available on request for specific areas of the sky shortly after the scanning of the areas is completed. The scanning is beginning this summer and will proceed at an average rate of 2 plate pairs per day. We expect to complete the scanning in two years.

The scanning will be done in threshold densitometric mode for the red and blue pairs of plates. Scanning time, including setup, will be 3 hours. An 'average' plate, $b \sim 20°$, will produce 20,000 images per stripe per plate. With a pixel size of 5×6 microns and an 'average' image size of 50 microns, this yields about 800 KBytes of data per stripe per plate. At the end of each stripe this data will be transferred out of the Scanner system to the Sun 3 computer, allowing the reductions to run concurrently with the scanning on either the Sun or the Cray 2. All three computers will have software to fully reduce the data. The relative processing speeds are 9700 stars/hour on the PDP-11/60, 50,000 stars/hour on the Sun and 100,000,000 stars/hour on the Cray 2. Plates at low galactic latitude will have ~200,000 stars per stripe and severe problems with overlapping images. Image deconvolution

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will increase the processing time by a factor of ~10. The Cray 2 is capable of fully reducing a pair of plates in the plane with image deconvolution in about an hour. As the processing is done concurrently, the reduced data will be available for analysis almost immediately after the completion of scanning, allowing us to complete 2 to 3 plate pairs per day.

The images will be sorted into stars and nebulous objects based on image gradients. The stars catalog should be complete for each plate to within 0.5 mag of the plate limit and have a photometric accuracy of ~0.15 mag for those plates for which we have or can obtain photometric sequences. The nebulous objects will be further sorted into galaxies and nebulae. This is the only reduction step that will require some operator input for unique or difficult objects (interacting galaxies, etc.). The final galaxies catalog should be complete to an integrated magnitude of ~18 with no more than 2% confusion of misclassified objects.

3. GENERAL USE

Current projects by outside users include population studies in the Galaxy and nearby galaxies, proper motion studies, variable star detection, W-R candidate detection, and classification of galaxies. The APS is available for use by the astronomical community on a no-cost basis. Prospective users may contact the authors to request time on the APS.

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