astrophysics. Further details may be obtained from Vito Di Gesù or from Fionn Murtagh.

The foregoing trends serve to illustrate how "computational astronomy" has now become solidly established as a subdiscipline of importance in astronomy and astrophysics, closely following in the footsteps of its sister-subdiscipline, image processing.

References

1. V. Di Gesù, L. Scarsi, P. Crane, J.H. Friedman and S. Levialdi (eds.) (1984): *Data Analysis in Astronomy,* Plenum Press, New York.
2. V. Di Gesù, L. Scarsi, P. Crane, J.H. Friedman and S. Levialdi (eds.) (1986): *Data Analysis in Astronomy II,* Plenum Press, New York.
3. F. Murtagh and A. Heck (1986): An annotated bibliographical catalogue of multivariate statistical methods and of their astronomical applications (magnetic tape). *Astronomy and Astrophysics Supplement Series* (in press); ESO Scientific Preprint No. 465 (Sept. 1986).
4. F. Murtagh and A. Heck (1987): *Multivariate Data Analysis,* D. Reidel, Dordrecht.
5. E.J. Rolfe (ed.) (1983): *Statistical Methods in Astronomy,* European Space Agency Special Publication 201 (270 pp.).

A conference, hosted by the Space Telescope – European Coordinating Facility, on

Astronomy from Large Databases: Scientific Objectives and Methodological Approaches

will be held in Garching from 12 to 14 October 1987.

Topics will include statistical analysis of complex databases, object classification problems, astrophysics from large data collections, together with state of the art reviews of astronomical database technology and expert system applications.

The Proceedings will be published by ESO.

Further information may be obtained from F. Murtagh, ST-ECF, ESO, Karl-Schwarzschild-Str. 2, D-8046 Garching bei München, FRG.

Crowded Field Photometry Using EFOSC and ROMAFOT

K.J. MIGHELL, Kapteyn Observatory, Roden, The Netherlands

EFOSC

The ESO Faint Object Spectrograph and Camera (EFOSC), instrument of the ESO 3.6-m telescope, can be used as a very efficient CCD camera for wide-band photometry of crowded stellar fields. EFOSC was designed to match the RCA SID 501 EX CCD (320 × 512 pixels, 30 × 30 microns pixel size). Each pixel corresponds to 0.675 arcsec and the total field of view is 3.6 × 4.7 arcminutes (1). Using the instrument in direct imaging mode, the limiting magnitude of a 15 minute exposure with seeing of FWHM = 1.3 arcseconds in the V band is about 25.5 for a signal-to-noise ratio of 3 (2).

A typical EFOSC field of the Small Magellanic Cloud will yield hundreds to thousands of stars in less than five minutes! In good seeing conditions the central cores of star images will be partially undersampled due to the 0.675 arcsecond per pixel scale. The combination of crowded stellar fields with partially undersampled data presents a challenge to the astronomer who wishes to do accurate stellar photometry with EFOSC data.

DAOPHOT

In March 1986 I visited ESO Garching to see if the photometric reduction package DAOPHOT (3) was suitable for use with EFOSC data and CCD data from the ESO 2.2-m telescope. Using both real and artificial data, I found DAOPHOT to be potentially useful for the 2.2-m data (0.35 arcsecond per pixel) and totally inadequate for the less well sampled EFOSC data (0.675 arcsecond per pixel). The results of this trial experiment do not bode well for the ability of DAOPHOT to work adequately with data from the Hubble Space Telescope.

ELIA

ELIA (4) was developed at the Observatory of Rome specifically to do photometric reduction in crowded stellar fields – in particular globular clusters. I visited the Observatory of Rome in October 1985 and reduced some EFOSC images of an extremely crowded field in the SMC. Although the image was quite complex, ELIA made excellent fits to over 1,400 stars. ELIA employs a non-linear least squares fitting algorithm which was found to be remarkably successful at ignoring cosmic rays and other image defects.

ROMAFOT and the Personal Astronomical Work Station

At the Rome Observatory, ELIA serves as a complete image processing system. Thus there are programmes to read and write FITS tapes, programmes to flat-field images, programmes to plot data, etc. By using the ESO Munich Image Data Analysis System (MIDAS) as my main image processing system, I only needed to use the few programmes which actually did photometric reduction. I have converted these programmes to run on VAX computers and have renamed the package ROMAFOT.

I have also written a C language programme "Personal Astronomical Work Station" (PAWS) which effectively transforms a standard Commodore Amiga personal computer into a complete MIDAS work station consisting of emulations for (1) a VT-100 terminal, (2) a HP graphics terminal and (3) a DeAnza image display. By replacing the Tektronix terminal that ELIA previously required with an Amiga running PAWS, I have been able to substantially improve the performance of ROMAFOT. By judiciously using coloured images (instead of shades of green), ROMAFOT has been improved to make it easier for the user to quickly produce more accurate results. The combination of ROMAFOT with MIDAS provides the astronomer with a very powerful tool to do accurate photometric reduction of crowded stellar fields.

ROMAFOT/MIDAS Features and Abilities

- Reads FITS tapes
- Automatic location of most stars on a CCD image

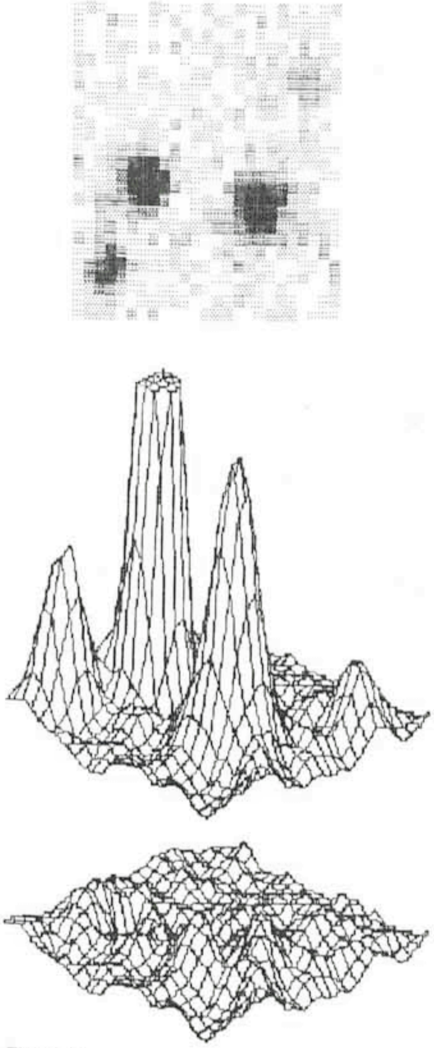


Figure 1.

- Examination of each stellar image to check for image quality, potential blending and missed fainter stars
- Fast nonlinear least squares fitting routines that allow up to five blended components to be fitted simultaneously
- Accurate and believable error estimates are determined for all fitted parameters
- Examination of the final fits by displaying the original data and residuals
- A proficient user can process 500 to 1,000 stars per day (depending on the crowding complexity of the field)
- Transformation of coordinates from one CCD frame to the system of another frame
- Transformation of instrumental magnitudes to a standard photometric system
- Plots the results on a standard HR diagram
- Artificial stars can be randomly inserted into the data at known flux levels to allow the user to find the systematic measurement errors.

A visual example of how ROMAFOT and MIDAS can be used to do photometric reduction in crowded stellar fields is shown in Figure 1 (all plots were made with PAWS).

Figure 1a shows a gray-scale represention of a crowded stellar field near the centre of Carina, a dwarf spheroidal galaxy in the Local Group. The data were collected with the ESO 3.6-m telescope using the EFOSC instrument with seeing of FWHM = 1.35 arcseconds in the V band. The integration time was 30 seconds. The subfield is 16.9 by 16.9 arcseconds in size. The intensity scale is linear with black representing the maximum and white representing the minimum intensity.

Figure 1b shows the same subfield in the form of a three-dimensional plot. The brightest star has a flat core because it was clipped for the plot to show better the fluctuation of the background. The second highest peak is composed of two closely spaced stars.

Figure 1c shows the residual field after all five stars were fitted. The visual magnitudes of the stars are 19.16 $\pm$ 0.01, 20.56 $\pm$ 0.05, 21.38 $\pm$ 0.11, 21.03 $\pm$ 0.06, 22.00 $\pm$ 0.16, respectively. The peaks of the two closely spaced stars (V = 20.31, V = 21.13) are separated by only 2.12 pixels. The full width at half maximum (FWHM) for these data is only 2.00 pixels, so these two stars are just barely resolved.

The above example shows how EFOSC can be used to obtain useful photometry for many faint stars with short exposures. The ability to reach a visual magnitude of 22 in just 30 seconds will be very useful to those astronomers who would like to determine the colour-magnitude diagrams of globular clusters and stars in the Galaxy and nearby Local Group galaxies.

The Future of ROMAFOT

Roberto Buonanno (Observatory of Rome), Rein Warmels (ESO) and I will be working in the next few months to officially implement the ROMAFOT package as a part of MIDAS. The exact form of the MIDAS version of ROMAFOT has yet to be finalized but it will probably be very similar to the system I have described above.

References

(1) D'Odorico, S., Dekker, H., "The Five Observing Modes of EFOSC, the ESO Faint Object Spectrograph and Camera Designed Around a CCD Detector".

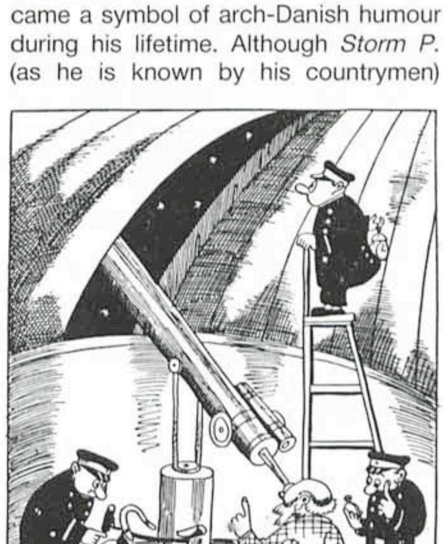
(2) *The Messenger* **41**, p. 26, 1985.

(3) Stetson, P.B., "DAOPHOT User's Manual", Dominion Astrophysical Observatory, Herzberg Institute of Astrophysics, 5071 West Saanich Road, Victoria, British Columbia V8X 4M6, Canada.

(4) Buonanno, R., Corsi, C.E., De Baise, G.A., Ferraro, I., 1979, in *Image Processing in Astronomy*, eds. G. Sedmak, M. Capaccioli, and R.J. Allen, Trieste, Italy, p. 554.

Storm Petersen and Astronomy

Robert Storm Petersen (1882–1949) started his career as a butcher, but became a symbol of arch-Danish humour during his lifetime. Although *Storm P.* (as he is known by his countrymen) wrote prolifically, he is more famous for his drawings which appeared regularly in Danish newspapers from 1905 to his death. Many of the early drawings dealt with social injustice, but he soon found his own, less offensive way of expression. A museum dedicated to his works has been opened in Copenhagen and also exhibits many of his cartoons. Many of them concern the exact sciences which Storm P. approached with a sound measure of down-to-the-earth scepticism. But his dry humour always treated members of the astronomical profession and other employees of the state with due reverence . . .



'The police now collaborates with the astronomers to determine the exact time when bicycle lights must be lit.'

EDITOR'S NOTE

The information about the bright supernova 1987A in the LMC which is brought on the following pages was received on March 2, 1987. The publication of this issue of the Messenger was delayed in order to include a first overview of the exciting results.