THE MESSENGER

EL MENSAJERO

No. 72 – June 1993

Current ESO Activities*

R. GIACCONI, Director General, ESO

1. Introduction

The immediate purpose of ESO is to provide European astronomers with first-rate observational capabilities of a size and complexity which are not achievable in the national programmes of the member states. In achieving this goal ESO can place European astronomy at a competitive level with respect to astronomical research worldwide. ESO's task has not been accomplished by building the NTT, nor will it be accomplished by building the VLT or the VLTI. It should be understood as an ongoing process in which, from time to time specific facilities or instruments are built, but the overarching role is to support and foster astronomical research in the member states and in Europe.

These simple declarations have a number of obvious consequences which it may however be worth stating. The manner in which we conduct the ESO programmes must be directed to maximize scientific returns over the long run. In building new facilities we cannot sacrifice current research which prepares the astronomer who will use them. The operation and effective use of the facilities are as important as their construction. Both should be guided by scientific priorities and end-to-end performance considerations.

The final goal must be excellence in science. The process by which we select facilities and instruments, observing programmes and strategies must insure, in so far as feasible, that we can achieve it. The only process I know is peer review of competitive proposals. If we wish to achieve excellence, ESO itself must have first-rate staff to provide services and must be a first-rate research institution on its own. Finally, if we wish to succeed as a European project we must be willing to give higher priority to scientific, technical and managerial considerations than to national interests.

When I was interviewed by the Council last year, I stated my views essentially in the same terms with a little more emphasis on some managerial aspects. In the first five months here at ESO I have tried to apply these general principles and I have used them as a yard stick to assess the status of the programme. I have reviewed the VLT programme and the Chile situation first because they seemed more urgent.

A number of studies and reviews have been carried out with the following aim:

(1) Establish ground truth for the status of major technical developments and to assess the technical schedule and management risks.

(2) Review all aspects of ESO activities to assess the degree to which they are appropriate and necessary and to determine potential staff reductions and savings in some area for use in other areas of higher priority.

(3) Begin the formulation of a plan which will result in the strengthening of current operations at La Silla and in a scientifically successful VLT and VLTI execution within currently planned yearly funds.

"Future Astronomers of Europe"

The European Southern Observatory is launching a special programme on the occasion of the *European Week for Scientific Culture* (November 22–27, 1993), with support from the Commission of the European Communities.

Read about the exciting essay contest for secondary school pupils in 17 European countries and Chile (page 9).

* Excerpt from the Director General's report to the ESO Council at the meeting in Florence on June 2–3, 1993.

2. The VLT Programme

The major conclusions that I have tentatively reached from this work are as follows:

(1) Although there are very challenging technical problems ahead we see no engineering or scientific reasons that should prevent us from accomplishing the VLT programme.

(2) Several technical and scientific areas have not received the degree of attention that they require due to lack of manpower or expertise.

Areas of particular concern are:

- System engineering
- Performance evaluation and error analysis
- Operations and maintenance
- Software architecture and development
- Data calibration and archiving
- Observational modes (service observing, remote observing, observational strategies, pointing and tracking, etc.)
- VLTI

(3) The programme is delayed with respect to the original schedule. Again this is due to lack of manpower necessary to do all the preliminary studies required to draw up the call for tenders to industry, issue them and evaluate the responses, with the required thoroughness. Furthermore, the manpower to follow up the work of the industrial contractors is wholly inadequate.

(4) The effort expended on VLTI has not been adequate to keep the programme on schedule. Lack of manpower has prevented us to derive the necessary constraints imposed on the rest of the programme by the high accuracy required by VLTI itself.

(5) Finally, but by no means less important, there has been a remarkable lack of scientific input in the programme as a whole. Scientific requirements have not been used as drivers to technical requirements and operational considerations necessary to carry out scientific programmes are not used explicitly or in a documented way to set software and hardware designs.

Remedies can be found to all of the above and a number of actions are already under way which should improve the situation:

(1) Strengthening the involvement and responsibility of scientific staff in the programme should permit us to more clearly identify critical performance requirements and avoid unnecessary overdesign. To this end I am insisting on more involvement by the scientists at ESO in the project in the short run and in a strengthening of the scientific staff in the long run.

(2) Development of a first cut vision of how VLT will operate to carry out scientific programmes will permit us to design into the telescopes and instruments the operability and maintainability standards that are required. To this end we are creating a VLT science operation group within the VLT division led by a scientist and we are making use of expert consultants.

(3) More careful strategic planning of procurement actions could eliminate or substantially reduce the technical and management risks involved in a procurement of this size and complexity.

(4) Prudent use of consultants and industrial consulting services particularly in the system engineering area could significantly help ESO to carry out the prime contractor responsibilities it has assumed. Massimo Tarenghi and I have discussed with industrial contractors the possible mechanisms to provide such support.

(5) More emphasis on VLT operation analysis and planning will be very useful to prevent a number of retrofitting problems downstream and in assuring that VLT once built will carry the science it is supposed to do. Such analysis will affect the requirements we place on instrumentation builders and on software developers. The starting point of this understanding has to be the scientific considerations developed under point 2 but they will have to be fully worked out in a realistic operational setting.

(6) To progress in the VLTI part of the project, the programme will have to be given more means, more independence, more accountability and more emphasis. The total staff (3) now involved in this aspect of VLT must be increased to reduce the current slippage in the necessary studies and procurement actions. Recognizable scientific leaderhip is essential in this programme.

(7) Manpower resources will have to be increased in critical areas. Without adequate in-house staff the VLT programme cannot be accomplished. It is my belief that the necessary staff increases in the areas that are critical can be accomplished without increasing substantially either the run-out cost of the programme or the yearly budget of ESO.

It is difficult at this late date in the programme to fundamentally change the design of VLT or substantially change its scope. Furthermore, I firmly believe that the current programme consisting of an integrated VLT, VLTI and associated laboratories, shops and facilities should be conceived as a single entity whose realization as a whole will place us in a competitive position with respect to other large telescope projects. Although we have examined possible cuts to the programme, we find them to yield quite small financial returns at a disproportionate scientific cost.

The alternate plan we have developed is aimed to carry out the full VLT programme as currently conceived, including a number of necessary activities which were neglected in the original plan but which are essential. It is in my opinion reasonably robust with respect to technical risks, manpower estimates and schedules.

3. Other ESO Activities

I have not yet been able to review in similar detail all other ESO activities although I have formed some opinions on them through visits, in-house reviews, discussions with consultants, etc.

3.1 La Silla Activities

It is quite clear that La Silla will remain for the many years before the advent of VLT the only substantial ground-based astronomical facility available to many European astronomers.

Furthermore, even after the advent of VLT there are a number of programmes which could and should be done on smaller telescopes of the 3–4-metre class. It is not at all obvious that transporting these telescopes to Paranal would be either financially, operationally, logistically or scientifically advantageous. Thus I think one cannot consider for the next several years (or possibly next decade) that La Silla could or should be shut down. Once this is understood there remains the issue of the scope of the work that should be carried out there.

The variety of different facilities, telescopes, modes of operations, developmental programmes, collaborative programmes, remote observing, and service programmes which are being carried out in addition to the basic operations of the major facilities is bewildering and constitutes a fragmentation of effort without a clear idea of priorities. The effort of the working group on "La Silla scientific priorities" chaired by Johannes Andersen will provide important suggestions in this respect.

This effort will be important to improve the quality of work at La Silla and is absolutely essential to permit us to carry out those activities which will allow us to recruit and train the staff required to operate effectively the VLT.

To achieve these goals it is difficult to see how the level of personnel and expenditure at La Silla can be reduced in the foreseeable future.

3.2 Scientific Staff

I have mentioned in several instances the apparent lack of scientific input in several of the most important activities of ESO. This may be in part due to a policy of separation between the Science Division and the VLT project and the La Silla Operations.

I hold the view that an enterprise such as VLT cannot be done without the enthusiastic commitment of a first-rate scientific staff. My concept is that all astronomers at ESO should be required to both do service and carry out their own research. A review of each scientist commitment to service has been undertaken and it is clear that little more can be squeezed out of the current staff complement. I therefore believe that a vigorous campaign to attract and retain first-rate scientists is essential. Furthermore, the very mechanisms for hiring and promotions must be rearranged in order to give the scientists as a whole a feeling of involvement and responsibility in the improvement of the situation.

I have started treating the scientists as a faculty and I will insist that they take on the task of self-improvement. This could be very greatly aided by the creation of a Visiting Committee of distinguished scientisits from both within and outside ESO member states to examine the overall scientific health of the organization. Council has in principle approved this concept.

I also believe that it is important to more deeply and broadly engage the European astronomical community in planning the scientific programme to be carried out by VLT/VLTI. This is necessary to more clearly focus ESO's priorities in the many trade-offs which occur during the development phase of the programme and to permit the efficient scientific use of the facility during operations.

4. Final Remarks

In my report to Council, I also included a very provisional assessment of the need to achieve optimal operations at La Silla and Paranal. We are now looking into a number of approaches to achieve this result and will be guided by the La Silla priorities' study. At the same time, I am taking steps to change the pyramidal managerial structure which I have found at ESO and which I consider unsuited to carry out the variety of complex activities which ESO has undertaken.

Relations Between the Republic of Chile and ESO

In 1963, the Government of the Republic of Chile and ESO concluded a Treaty (Spanish: Convenio) which has formed the basis for the formal relationship between the signatories during the past three decades.

Recently, two issues were raised by the Chilean side which implied important changes in the established Treaty relations between ESO and the Republic of Chile. The first concerned the access of Chilean astronomers to ESO facilities at this organization's astronomical observatory and the second the question of labour relations between ESO and its employees of Chilean nationality.

In 1992/1993, a joint Chile/ESO Committee with representatives from the Chilean Ministry of Foreign Affairs on one side and the ESO Executive and Council on the other side was constituted to look into these matters. The joint Committee met in Santiago de Chile on April 19 and 20, 1993. During these negotiations, ESO proposed that the Republic of Chile might become a full member of the organization. Both sides emphasized the efficient and mutually respectful interaction during the past 30 years and their wish to achieve an acceptable solution which would ensure ESO's continued activities in the Republic of Chile.

Later in April, the Chamber of Deputies (one of the chambers of the Chilean Parliament; the other is the Senate) adopted a resolution formulated by the Commission for Foreign Affairs of the Chamber of Deputies, which formally requested the Government of Chile to re-negotiate the 1963 Treaty with ESO and also mentioned the possibility that the Chilean Government could make use of its right to revoke this Treaty.

ESO was preoccupied by this development after thirty years of smooth collaboration with the Chilean Government and the Chilean astronomical community, taking also into account its considerable investment in Chile. The revocation of a host state agreement with an international organization would have constituted an extreme precedent in international cooperation between states and international organizations.

During the recent meeting of the ESO Council in Florence on June 2–3, 1993, the relations between ESO and Chile were thoroughly discussed. Council also gave specific instructions concerning the various aspects of the future scientific and technological cooperation to the high-level ESO delegation which participated in the next meeting of the joint Committee, which took place in Santiago de Chile from June 18 to 22. As a result of this meeting, a Joint Press Release by the Ministry of Foreign Affairs of the Republic of Chile and the European Southern Observatory, was issued in Chile on June 23, 1993 (Spanish text) and from the ESO Headquarters (Germany) on June 24, 1993 (English text). The English text of this Press Release is given hereafter.

The Editor

Supplementary and Modifying Agreement Regarding the 1963 Convention Between The Government of Chile and The European Southern Observatory (ESO)

The delegations of the Government of Chile and of the International Organisation ESO report on the outcome of their discussions regarding the installation of the largest telescope in the world "The Very Large Telescope" and "Very Large Telescope Interferometer" (VLT/VLTI) at Cerro Paranal (in the Chilean region II – Antofagasta) and the clarification of the future relations between ESO and Chile. The object of these discussions was a closer cooperation between ESO and Chile to the mutual benefit of this country and the eight European member countries of ESO.

On October 5, 1962, a Convention was signed in Paris between Belgium, France, Germany, the Netherlands and Sweden in order to establish the European Organisation for Astronomical Research in the Southern Hemisphere (ESO). Subsequently, Denmark (1967), Switzerland and Italy (1982) joined the Organisation.

On November 6, 1963, Chile and ESO signed a Convention by means of which Chile granted facilities for the installation and operation of an astronomical observatory (La Silla) on the territory of Chile.

On November 11, 1991, the Government of Chile requested ESO to modify the Convention of 1963 in view of the construction of the Observatory on Cerro Paranal and because of the necessity of including important aspects for Chile, especially in the scientific and technological fields.

Initial negotiations took place in Santiago on April 18 and 19 of this year. Those participating included the Director General of ESO, Members of the ESO Council, a group of consultants and, for Chile, representatives of the Ministries of Foreign Affairs, Education, Labour and the Office of the General Secretary of the President, together with legal and scientific consultants.

During further meetings held in the chancellery from June 18 to 22 of this year, the delegations of the Government of Chile and of ESO decided on the text of a Supplementary and Modifying Agreement regarding the Convention of 1963.

The following aspects were included in the Agreement:

- Construction and installation of the VLT: The Government of Chile confirmed to the ESO delegation its invariable support for the development of the VLT/VLTI project at Paranal which represents a capital Investment of approximately 570 million DM.
- Legal aspects: A Supplementary and Modifying Agreement regarding the Convention of 1963.
- Labour aspects: It was agreed to modify the ESO Regulations for the local personnel hired in Chile by the incorporation of elements of Chilean labour law, specifically the right to associate and the right of collective bargaining. An ad-hoc tribunal will resolve collective conflicts.
- Scientific aspects: The Chilean delegation pointed out the necessity of regulating the access of the national scientific community by a fixed percentage of observation time at all ESO installations. For this purpose, it was agreed on 10 per cent of the observation time available to ESO for scientists affiliated to Chilean institutions, on the basis of the merit of the projects and at all of the telescopes already installed and to be installed at La Silla and Paranal, with the exception of the VLT and VLTI (The Very Large Telescope).
- In addition, scientists affiliated to Chilean institutions shall be entitled to up to 5 per cent of the observation time at the VLT and VLTI. This percentage will be reached gradually within a period of five years, starting from the date of commissioning of the first unit telescope. Moreover, this percentage may be increased up to 8 per cent, provided a sufficient number of high-quality Chilean projects are available.
- Collaboration Chile-ESO: ESO will continue to support the development of astronomy in Chile with training programmes and by means of contributions submitted via a joint Chile/ESO Committee.
- The Government of Chile, on its part, will attach increasing importance to the financing of training and research activities in the field of astronomy and related disciplines and technologies with the aim of supporting the efficient use by Chilean scientists of the astronomical installations located in Chile.

The Supplementary and Modifying Agreement will establish a sound basis for scientific and technological collaboration between the European member countries of ESO and the Republic of Chile.

The "Mega-Project" in Northern Chile (the VLT/VLTI) will open up a giant eye towards the Universe which is unique in the world.

The Agreement will be submitted for ratification to the Congress of Chile and to the Council of the ESO.

(From ESO Press Release 06/93)

The VLT: Important Contracts Concluded

M. TARENGHI, ESO

VLT Enclosures

The manufacture of the VLT Telescope Enclosures has been awarded to the SEBIS Consortium in Italy. The leader is the Company SOIMI S.p.A., Milan, and the other members are EIE S.r.l., Mestre, BERENGO SpA, Marghera, IDROMACCHINE S.r.l., Marghera, and SOIMI COSTRUTTORI S.p.A., Marghera.

EIE and SOIMI are also member of the AES Consortium, now in process of executing the Contract for the VLT Telescope Structures. The proposed technical solution offers substantial modifications as compared to the original ESO design concept, with a simplification and optimization of the general architecture of the enclosures and of some subsystems (e.g. rotation system, cladding, roof cover, air conditioning and control system). Figure 1 shows the model which was submitted as part of the original SEBIS offer.

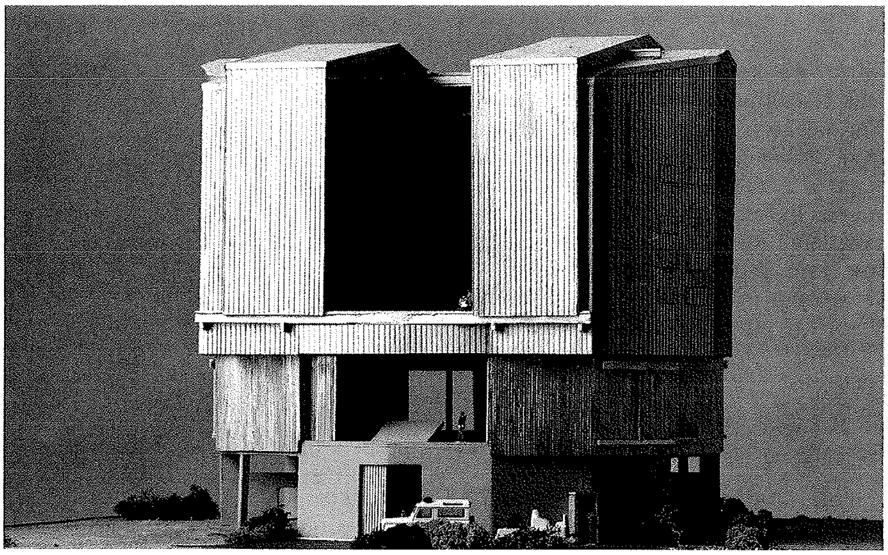

Figure 1

The Contract will include the complete engineering, the fabrication, the packing and transport to the VLT Observatory, the erection on-site in Chile, the start-up and the final acceptance.

The Contractor has demonstrated the necessary experience in engineering and construction of large steel structures overseas and in a desert environment. The beginning of the erection in Chile is foreseen in 1994.

M1 Mirror Cell and Tertiary Mirror

Two identical Contracts for the preliminary design, development and detailed design of the M1 Mirror Cell and Tertiary Mirror were awarded, the first to the Company GIAT INDUSTRIES (France) and the second to the Consortium CARL ZEISS/MAN GmbH (Germany).

The main functions of the M1 Unit are to support the Primary Mirror and to provide interfaces to the M3 Unit and the Cassegrain instruments.

The Primary Mirror requires 150 axial supports and 64 lateral supports located at the outer edge. The axial supports have a passive hydraulic stage to take on the gravity load and a computer-controlled active force actuator to maintain the mirror figure. Each support has its own microprocessor-based control loop. All supports are controlled by a local control unit which serves as interface to the main computer. The lateral supports are passive and consist of hydraulic pools connected together in order to equilibrate the loads.

These two Contracts include the final and detailed mechanical design of the cell, of the axial and lateral supports, the design of the local control unit, the construction and tests of a qualification prototype of the axial support.

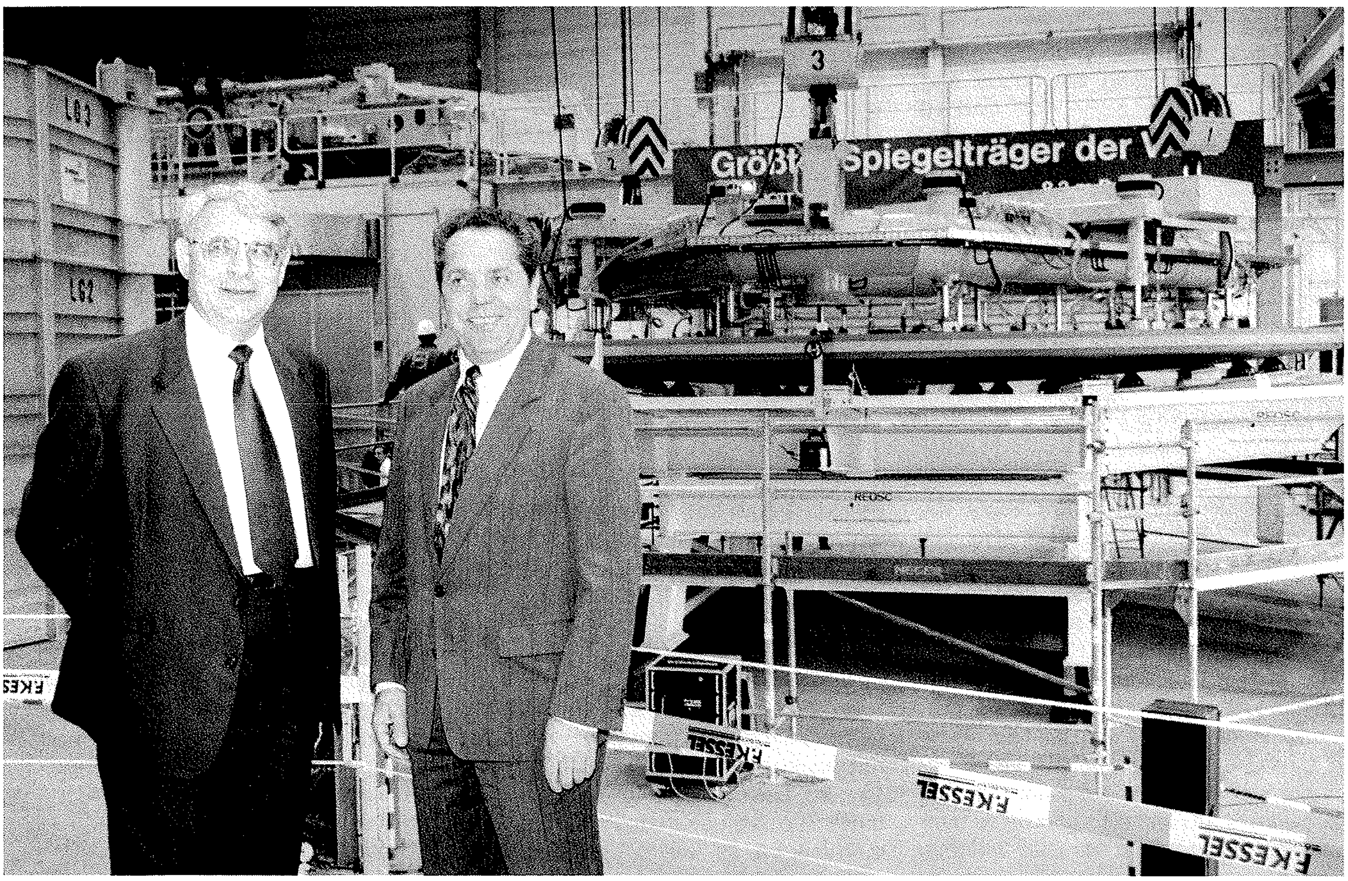

Figure 2: *On Friday, June 25, 1993, Schott Glaswerke (Mainz, Germany) officially handed over to ESO the largest mirror blank ever made. Weighing 22,000 kilograms and with a diameter of 8,2 metres, the Zerodur blank has a thickness of only 177 millimetres. It is therefore quite flexible and must be handled with great care. It is the first of four such blanks for ESO's Very Large Telescope (VLT). The photo shows Professor Riccardo Giacconi (left), Director General of ESO, and Mr. Erich Schuster (right), member of the Board of Directors of Schott, during the handover ceremony at the Schott factory. At this moment, the thin blank had just been placed onto its support system in a specially designed transport box in which it will be moved by barge to the REOSC optical facility near Paris. Here, the giant mirror will receive its final, exceedingly accurate surface form during a two-year polishing process. See also the centerfold in this Messenger issue. (Photo: Schott)*

After the completion of these two studies ESO will select the solution which will be implemented at the VLT unit telescopes. The selected industrial firm will be responsible for the construction of the first unit, the qualification tests of this unit with a concrete dummy mirror, the construction and tests of 3 additional identical units, the packing, transport and integration into the VLT telescopes in Chile. The completion of these two studies is planned for the end of 1994.

First 8.2-m Mirror Blank Ready at Schott

Major progress has been made in the production of the 8.2-m mirror blanks with the delivery by Schott of the first unit on June 25, 1993 (see Fig. 2).

The production of the first element of the telescope steel structure, the azimuth tracks, has also begun (Fig. 3).

The ESO VLT team has completed a detailed review of the VLT Programme covering managerial, financial, time planning, manpower and technical aspects.

The conclusions were presented to the ESO Council. The new planning, now under detailed definition, is following the constraint to obtain the first light of the first telescope properly instrumented and including the coudé and adaptive optics in early 1998 and to start interferometry as soon as possible in parallel with the 8-m activities.

Figure 3.

ESO C&EE Programme: a Progress Report

R. M. West, ESO

This is a progress report about the ESO C&EE Programme, see also *The Messenger* 71, page 9. As will be remembered, copies of the Application Document were sent to about 1000 addresses in late January 1993. Moreover, the guiding principles of this Programme are that support will be provided *on the basis of scientific and technical merit*, in order *to help C&EE astronomers to do good research at their home institutes* and also *to provide benefits to astronomy in the ESO member states.*

In early March 1993, the Director General established an ESO C&EE Committee with the following members: Nicolai Chugai (Moscow), James Lequeux (Paris), George Meylan (ESO), Giancarlo Setti (Bologna), Jean-Pierre Swings (Liège) and Richard West (ESO), who was requested to act as Committee Secretary.

1. Response to the First Round

By April 15, 1993, 284 applications had been received from 936 applicants, requesting a total of DM 5,450,304. This amount corresponds to about eleven times the annual budget of the Programme, i.e. an "oversubscription" that reminds of that encountered by the OPC at some of the ESO telescopes. Of this, about ⅓ was for Research Grants, and ⅔ was mostly for equipment, especially powerful PCs and a few Sun workstations, CCDs and electronic components for telescope instruments, etc., and to a lesser extent for travel-related expenses. Some applicants sent more than one application; altogether there were 805 individual applicants from 22 countries.

The ESO C&EE Committee held its first meeting at the ESO Headquarters on April 19 and 20, 1993. It first discussed a number of policy matters, many of which had surfaced under the previous months and partly in response to the Application Document. Among others, it was decided to:

1. spend about ½ of the 1993 budget in the first round, in order to "show the flag" and to achieve an immediate and significant effect;
2. evaluate and classify the proposals into three classes, according to merit: Class I (Excellent), Class II (Good) and

Class III (Insufficient), with the appropriate subclasses.
3. allocate at this moment support only to Class I proposals, but to let all Class II proposals participate in the next round (July 15) without the need for resubmission;
4. fix Research Grants in the republics on the territory of the former USSR at DM 400/year, i.e. at about the level of the current local salary there, and proportionately higher in other countries;
5. allocate the same Research Grants to all successful applicants, irrespective of their positions at the C&EE institutes, and to give no more than one Research Grant per person, even if an applicant has more than one successful application;
6. provide standardized computer equipment in the form of 486 PCs with appropriate accessories (at DM 4,500 per computer), and normally only one per institute;
7. make the Principal Investigators (PIs) of Type A programmes responsible for the use of allocated equipment, especially PCs, and to insist that it is made available to other institute staff, as far as possible;
8. not support conferences which are not organized and/or sponsored by ESO, but to leave this field to IAU, EAS, etc.; and
9. have all applications involving observing time at La Silla first pass through the normal OPC evaluation and only provide support if observing time is indeed allocated.

The Committee then evaluated the 284 proposals according to the above-mentioned criteria, and with the result that 68 of these were classified in Class I and will therefore receive support. They involve 243 applicants, so that more than one quarter of all applicants will receive support already in the first round. About half of the applications will again be considered in the second round. A total of about DM 270,000 was allocated from the 1993 budget.

The main data have now been entered into a STARCAT-based archive which permits efficient and time-saving programme administration. Miguel Albrecht and Olivier Hainaut, both at ESO Headquarters in Garching, have provided very significant help for this. This made it possible to send individual reply letters to all 936 applicants within two weeks after the Committee meeting. By the end of May, the first responses to these were being received at ESO, as expected in particular from satisfied applicants who will now receive support within this Programme. The Committee is presently investigating the best ways of transferring the promised support.

ESO Visitor Programme at Garching

In order to promote closer interactions between the astronomers in the ESO astronomical community, ESO has a Visitor Programme in which experienced astronomers from the member states spend periods ranging from a few months to a year working at ESO headquarters in Garching.

Major activities at ESO Garching include the design and development of the VLT and its instrumentation, activities related to the La Silla observatory (including remote observing), the development of data analysis software, and the European Coordinating Facility for the Space Telescope (ECF). The scientific research of the staff astronomers, fellows and students at ESO and the ECF covers a wide range of astronomical subjects. The ESO headquarters building is located on a research campus together with several other institutes including the Max-Planck Institutes for Astrophysics and Extraterrestrial Research.

Visitors are expected to take an active role in the scientific life of ESO, giving seminars and interacting with ESO staff on scientific or technical matters. They are given appropriate financial support to help cover travel and living expenses in Garching. ESO has a number of modern apartments in Garching to accommodate its visitors.

Persons interested in this Visitor Programme may submit a request to ESO at any time. Enquiries regarding application procedures should be addressed to:

European Southern Observatory
Visitor Programme
Karl-Schwarzschild-Str. 2
D-85748 Garching bei München
Germany

The deadline for the next round is July 15, 1993, but already now (beginning of June), more than 50 new applications have been received. Although it is not yet possible to anticipate the total number, it may again be substantial.

2. Preliminary Conclusions

The rather impressive response to the announcement of the ESO C&EE Programme shows that its existence has quickly become well known among C&EE astronomers and that it effectively responds to a real need. It is also gratifying that there have been quite a few expressions from various sides about a positive psychological impact of this Programme.

An analysis of the applications to the first round shows that while salaries for scientists in many C&EE countries are very low, many serious C&EE scientists with excellent research proposals consider that their activities and efficiency are first of all limited by the fact that they only have access to outdated equipment. It therefore appears that at least for the time being – and until the expected and probably unavoidable further cuts in the institute budgets are made by the national funding bodies – these astronomers are best helped by making more modern equipment available at their places of work, e.g. PCs for computation and instrument control. In this way, they will have the opportunity to produce front-line science and thereby to collaborate with Western colleagues on a much more equal level, with the obvious mutual benefits. Still, it is also clear that many excellent, but very poorly paid (especially younger) astronomers will be greatly helped in their daily lives and personally stimulated by the modest Research Grants now allocated.

The first experience has also shown that the scientific merits of the received proposals to some extent depend on the institutes of origin and the distribution of support in the first round has therefore not been completely uniform in geographical terms; this is also not the intention. Nevertheless, almost all major C&EE institutes have submitted proposals which were rated in Class II, and it is therefore likely that more of them will be successful in the second round.

Already in the first round, the ESO C&EE Programme has been able to provide support to a significant number of C&EE astronomers and the impact will soon be felt at many institutes.

A meeting between the ESO Executive and Professor Paolo Fasella of DG XII of the EC will take place in Brussels on July 13, 1993. On this occasion, ESO will inform about the early results and experience of its C&EE Programme and also how this organization is obviously in a good position to judge the true needs of C&EE astronomy. The initial response to the ESO Programme has clearly shown that the overall resources which are needed to provide efficient help to deserving C&EE astronomers are demonstrably much larger than those which can be mustered by the ESO Programme. It will therefore be interesting to explore the possibility of some kind of EC/ESO collaboration in this field.

Finally, in view of the present UN embargo, the question of support to astronomers within the ESO C&EE Programme to astronomers in Yugoslavia (Serbia and Montenegro) has been the subject of some discussions. In its meeting on June 2–3, Council decided not to consider scientists from Serbia and Montenegro under the ESO C&EE Programme.

The ESO-Portugal Cooperation

When Portugal and ESO signed an Agreement for cooperation in astronomy in 1990, cf. *The Messenger* 61, p. 1, the stated, common goal was to contribute to the rapid and efficient build-up of astronomical resources in this country. After a transition period, the entry of Portugal into ESO is planned to take place within the next decade. Now, three years later, it is gratifying to see that the number of Portuguese astronomers as well as the diversity and complexity of their research programmes is steadily increasing.

Under the terms of this bilateral Agreement, Portugal will provide a yearly increasing amount of support to its still relatively small astronomical community, hereby helping institutes and individuals to establish themselves nationally as well as internationally. This support is given by the Ministry of Science and Technology, through the Junta Nacional de Investigação Cientifica e Tecnológica (JNICT), the Science Research Council of Portugal. In practice, the available funds are allocated after a competitive application procedure and by recommendation of an Astronomy Panel, appointed by the Portuguese Secretary of State for Science and Technology. The Panel also includes two representatives of ESO.

This Panel has just met in Lisbon at the Headquarters of JNICT on May 24, 1993, to make its recommendations for the distribution of money from the 1993 budget, the third year since the start of this programme. For the current year, the amount of support available corresponds to 70 % of what Portugal's contribution to ESO would have been, had the country already become a member. The sum to be allocated corresponded to almost 1 million DM.

Despite the still limited size of the Portuguese astronomical community, there were a considerable number of applications, and the Panel spent more than eleven busy working hours to consider their individual merits. The themes ranged from laboratory studies of the surface chemistry of the icy moons in the outer solar system, multi-band observations of young stellar objects, the properties of stellar clusters in the inner galactic bulge, to observational and theoretical aspects of gravitation. Many of the proposals were excellent and bear witness to the recent progress in Portuguese astronomy. In the end it was decided to recommend to JNICT that most of them be supported.

The Panel also noted with satisfaction that several Portuguese post-doctoral fellows are expected to return later this year to their home institutes after having obtained Master and PhD degrees at the end of prolonged stays at foreign universities. They will form the spearhead of the new generation of scientists who will carry Portuguese astronomy into a new age.

It is now crucial that they be offered the possibility to continue their work in their home country and the Panel, at the end of its meeting and having discussed in some detail the long-term aspects of this programme, therefore formulated the following recommendation: "Taking into account that it is of decisive importance for the success of the Portugal/ESO accord that the young PhDs in the area of astronomy be able to continue their research in Portugal, the Panel recommends that a substantial part of the funds allocated for the astronomy programme and not attributed be reserved for Post-doc positions in this area."

The day following the Panel discussions, the Portugal/ESO Committee (T. Lago and F. Bello from Portugal; P. Shaver and R. West from ESO) which was set up to monitor the developments within the Portugal/ESO Agreement met to evaluate the progress so far. The Committee concluded that, following a period of initial consolidation during which an important part of the funds available under this programme has been used to build up the infrastructure at the astronomical institutes in Portugal, it now appears that, as expected, individual projects will play an increasingly prominent role, as more and more young astronomers enter into the field.

The Committee noted with great interest and enthusiasm the current plans to establish a Portugese national observatory on the island of Madeira. The projected observatory, which will also be open for international participation, is considered an undertaking of national importance and is now under discussion at government level. If all goes well, a final decision may be possible already within the current year and the construction of the infrastructure could then start in 1994.

The Editor

FELLOWSHIP ON LA SILLA

A post-doctoral fellowship is offered on La Silla starting at the beginning of 1994. The position is open to a young astronomer with an interest in observational astronomy. The ESO fellowships are granted for a period of one year, normally renewed for a second and exceptionally for a third year.

The successful applicant will be required to spend 50 % of his/her time doing support activities and 50 % of the time on research.

Applicants normally should have a doctorate awarded in recent years. Applications should be submitted to ESO **not later than 15 September 1993**. Applicants will be notified by October 1993. The ESO Fellowship Application Form should be used and be accompanied by a list of publications. In addition, three letters of recommendation should be obtained from persons familiar with the scientific work of the applicant. These letters should reach ESO **not later than 15 September 1993**.

The research interests of the members of the staff in the Astronomy Support Department include low-mass star formation, formation and evolution of massive stars and starbursts, post-AGB stellar evolution and planetary nebulae, supernovae, active nuclei, high redshift galaxies and galaxy clusters. Staff members and senior fellows act as co-supervisors for students of European universities that spend up to 2 years on La Silla working towards a doctoral dissertation.

Enquiries, requests for application forms and applications should be addressed to:

European Southern Observatory
Fellowship Programme
Karl-Schwarzschild-Straße 2
D-85748 Garching bei München
Germany

"Future Astronomers of Europe"

ESO's Contribution to the European Week for Scientific Culture

The European Southern Observatory is pleased to announce the launch of its new programme "Future Astronomers of Europe". It is organized in conjunction with the European Week for Scientific Culture (November 22–27, 1993), with support from the Commission of the European Communities.

The main event of the ESO programme is a series of national essay contests among secondary school pupils who expect to obtain their baccalaureate in 1994 or 1995. The contests will take place this autumn in seventeen European countries and Chile.

The subject of all contests is the same: "An Observing Night with the ESO Very Large Telescope."

The participants are requested to describe an astronomical research programme of their choice that they would like to carry out with this optical telescope which will be the world's largest when it is ready in the year 2000. No boundaries are set for the curiosity and phantasy of the "future astronomers" of Europe and the organizers look forward to receiving a lot of exciting, imaginative entries.

The National Contests

The national contests will be arranged in 17 European countries in September–October 1993. These are Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxemburg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom. Because of its special relationship with Chile, ESO will also arrange a similar contest in that country. The exact timing of the contest will vary from country to country due to the different school calendars.

The practical arrangements are in the hands of national committees that have been set up in each of these countries and which comprise educators, scientists and ministerial representatives. The addresses are given on this page.

In each country, the national winners will be selected by a national jury. The prizes will be presented during national award ceremonies in the capitals, at the beginning of November 1993. The local media will receive full information about these events in due time directly from the national committees.

The National Committees

Further information about the "Future Astronomers of Europe" programme may be obtained from the National Committees at the following addresses:

Austria	Prof. H. Mucke, Planetarium der Stadt Wien, Oswald Thomas Platz 1, Vienna 2 Tel. +43-222-24 94 32, Fax +43-222-8 89 35 41
Belgium	Dr. C. Sterken, Vrije Universiteit Brussel, Campus Ofenplein, Pleinlaan 2, B-1050 Brussels Tel. +32-2-6 41 34 69, Fax +32-2-6 41 34 95
Chile	ESO "Future Astronomers" Programme, European Southern Observatory, Alonso de Córdova 3107, Vitacura, Casilla 19001, Santiago 19 Tel. +56-2-2 28 50 06, Fax +56-2-2 28 50 06
Denmark	Mr. B. F. Jørgensen, Tycho Brahe Planetariet, Gl. Kongevej 10, DK-1610 Copenhagen V Tel +45-33-14 48 88, Fax +45-33-14 28 88
Finland	Mr. M. Hotakainen, Tahtitieteellinen Yhdistys Ursa Ry, Laivanvarustajankatu 3, SF-00140 Helsinki Tel. +358-0 22 47 1 87, Fax +358-0 65 77 28
France	Mr. B. Pellequer, Geospace d'Aniane, Boîte Postale 22, F-34150 Aniane Tel. +33-6-7 03 49 49, Fax +33-6-7 75 28 64
Germany	Dr. H.-U. Keller, Planetarium Stuttgart, Neckarstraße 47, D-70173 Stuttgart Tel. +49-7 11-16 29 20, Fax +49-7 11-2 16 39 12
Greece	Dr. D. Simopoulos, Eugenides Foundation, Astronomy Department, 387 Sygrou Avenue, Palaio Faliro, GR-175 64 Athens Tel. +30-1-9 41-11 81, Fax +30-1-9 41-73 72
Ireland	Dr. T. Ray, Institute for Advanced Studies, 5 Merrion Square, Dublin 2 Tel. +353-1-6 62 13 33, Fax +353-1-6 62 14 77
Italy	Dr. B. Monsignori-Fossi, Osservatorio Astrofisico di Arcetri, Largo Enrico Fermi 5, I-50125 Florence Tel. +39-55-2 75 22 46, Fax +39-55-22 00 39
Luxemburg	Dr. Jeannot Hansen, Ministère de l'Education Nationale, 29 Rue Aldringen, L-1926 Luxemburg Tel. +352-47 81, Fax +352-4 78 51 30
The Netherlands	Dr. P. Wisse, Museon, Stadthouderslaan 41, NL-2517 The Hague Tel. +31-70-3 38 13 38, Fax +31-70-3 54 18 20
Norway	Prof. Jan-Erik Solheim, IMR, Nordlysobservatoriet, Universitetet i Tromsø, N-9037 Tromsø Tel. +47-83-4 51 50, Fax +47-83-8 98 52
Portugal	Dr. T. Lago, Centro de Astrofisico, Universidade do Porto, Rua do Campo Alegre 823, P-4100 Porto Tel. +351-2-6 00 16 72, Fax +351-2-6 00 36 54
Spain	Mrs. A. Sanchez, Planetario de Madrid, Parque Tierno Galvan, E-28045 Madrid Tel. +34-1-4 67 38 98, Fax +34-1-4 68 11 54
Sweden	Dr. Aa. Sandquist, Stockholms Observatorium, S-13336 Saltsjöbaden Tel. +46-8-16 44 47, Fax +46-8-7 17 47 19
Switzerland	Mr. M. Wieland, Schweizer Jugend Forscht/La Science Appelle les Jeunes, Technoramastrasse 1, CH-8404 Winterthur Tel. +41-52-2 42 44 40, Fax +41-52-2 42 29 67
United Kingdom	Dr. P. Moore, Farthings, West Street, Selsey, Sussex, England Tel. +44-24-3 60 36 68, Fax +44-24-3 60 72 37

The 1st Prizes

The 18 national winners of the 1st prizes will be invited to spend two weeks at ESO during the second half of November 1993. They will participate in a specially conceived programme which will be the dream of any young astronomy fan: it includes "complete immersion" in a professional research environment, with the opportunity to travel to a remote observatory and to perform obervations with one of the world's best astronomical telescopes. The participants will be part of a multinational group of young people sharing their interest for astronomy, but with very different backgrounds, thus providing plenty of opportunities for cultural enrichment. As far as the time permits, an interesting social programme will also be arranged.

The participants will first travel from their home countries to the ESO Headquarters in Garching near Munich (Germany). Here, they will receive preliminary instructions from professional European astronomers, which will enable them to prepare a real observational research programme in all details. Next, they will travel together to the ESO La Silla observatory in Chile, where they will perform real astronomical observations with a major telescope, under the guidance of ESO astronomers. The observations will be reduced, interpreted and prepared for publication. The participants will therefore experience the entire scientific process, from the conception of a programme to the results of the observations.

This unique event will be given full media coverage in the form of associated press conferences before and after the trip to South America.

How to Participate in the Essay Contest

More complete information about this essay contest and participation forms will be available from the national committees in late July 1993. Information packages will be made available to all secondary schools in the mentioned countries.

Change of Editor

Dear readers:

This will be the last issue of *The Messenger* prepared under my editorship. Beginning with the September 1993 issue, *Marie-Hélène Ulrich*, ESO staff astronomer, will take over and from now on, all related correspondence should be directed to her (email: mulrich@eso.org; Internet).

The ESO Director General has kindly agreed to relieve me from this most interesting, but time-consuming job because of my other duties at ESO, in particular as Secretary to the ESO C&EE Programme.

I take this opportunity to thank most cordially all contributors to the Messenger issues during the past years. It has been an exciting and very rewarding experience to have been so closely involved in spreading the word about the numerous activities in and around ESO.

Please continue to give the same friendly and efficient support to my successor; I am sure that she will in return provide you with a most efficient vehicle to let the world learn about your achievements.

Throughout my two terms as Messenger Editor (1976–1979 and 1986–1993), I have always enjoyed to work with the Technical Editor, *Kurt Kjär*. I am happy that he will continue to put all of his long and irreplaceable experience into the timely and efficient preparation of each issue. I am extremely thankful for his friendly and competent help and also his willingness to work long hours whenever needed in order to bring out a new Messenger issue in time. If you have liked reading this journal over the years, and if you have had difficulties in finding more than a few errors, it is above all due to his devotion. *R. M. WEST*

ESO Exhibition in Florence

As any visitor will testify, Italy is the land of contrasts, of a striking, yet harmonious cohabitation of breathtaking masterpieces of art from many epochs, be it paintings, music or architecture – and similar expressions of ultramodern life.

This was not different when on March 27, ESO's travelling exhibition opened its doors at the Sala D'Arme of the 14th Century Pallazzo Vecchio, one of the most prestigious locations for exhibitions in Florence.

On this Saturday morning, about 200 guests attended the inauguration ceremony, held at the magnificent Salone

Figure 1: *Pallazzo Vecchio (the Old Palace), the site of the ESO exhibition in Florence.*

FIRST ANNOUNCEMENT

The Third CTIO/ESO Workshop

"The Local Group: Comparative and Global Properties"

will be held in La Serena, Chile, from January 24 to 28, 1994.
Further information can be obtained from the following addresses:

e-mail (Internet): lgroup@ctios3.ctio.noao.edu
FAX: +56051205342
mail: CTIO/ESO Workshop, CTIO, Casilla 603, La Serena, Chile

Figure 2: *There were many guests at the opening.*

dei Cinquecento of Pallazzo Vecchio with short speeches by Undersecretary of State for Education, Dr. Matulli, by Dr. Spinetti from the Italian Ministry of Foreign Affairs, by ESO Council President Prof. Franco Pacini and other representatives of the organizing and supporting bodies. The inauguration was followed by a guided tour through the exhibition proper, with the many guests being divided into groups.

Carrying the title "Frontiers of Astronomy", the exhibition was divided into five sections, with the first two being devoted to current front-line research in astronomy, followed by another two sections about ESO and the VLT. Finally the Astrophysical Observatory of Arcetri presented examples of its work as well as other national and international projects with Italian involvement, including the COLUMBUS telescope.

Figure 3: *Massimo Tarenghi (ESO) describes the VLT site at Paranal.*

The contrast between the renaissance surroundings and the exhibition was mirrored in the exhibition itself, as the Museum of Science History had kindly put a series of old instruments on display, including a copy of Galileo's first telescope. ESO's video about the VLT, which takes its starting point in Galileo's first use of an astronomical telescope, provided an audio-visual interface between the exhibition elements of past times and the VLT.

The exhibition was jointly prepared by ESO, the Arcetri Astrophysical Observatory and the Museo di Storia della Scienza in Florence, and was open to the public during 6 weeks. Two other events during that period added to the impact of the exhibition – the first being the 3rd National Science week ("Terza settimana della cultura scientifica"), followed by the Annual Meeting of the Italian Astronomical Society, also in Florence.

C. MADSEN, ESO

"Astronomical" Organ Concert in the La Serena Cathedral

Once again visiting astronomer Dominique Proust from the Meudon Observatory (France) will travel to the ESO La Silla Observatory for another observing run in Sepember 1993. This time he will use quite different instruments.

He will first observe with the 3.6-m telescope and OPTOPUS for one of the ESO key programmes, a redshift survey in the south galactic pole region by Vettolani and collaborators. And a few days later, he will change instrument to perform on September 17 a beneficial organ concert at the La Serena cathedral for "Hogar de la Esperanza", an association which helps youthly victims of drug and alcohol misuse. The musical programme will centre on the French school, but also includes works by Johann Sebastian Bach and the astronomer/composer William Herschel.

Dominique Proust, in addition to being a full-time astronomer, is also a well-known and successful musician in his own country. His recently published CD with the major organ works of William Herschel (DOM DC 1418) was very well received by the critics. It was recorded in the church of Notre-Dame de l'Assomption in Meudon, on the 1887 Cavaillé-Col organ there.

Ray Tracing Twenty Years at ESO

J. ANDERSEN, Chairman, ESO-STC

In a bottom corner of an inconspicuous page of the last issue of *The Messenger* was a laconic note which is nevertheless momentous to all telescope aficionados and friends of ESO: Senior Physicist Raymond N. Wilson retired from ESO on March 31, 1993.

As a long-time friend of Ray's and currently a spokesman of sorts for the ESO community in matters of instrumentation, I cannot resist taking this opportunity to convey a few words of appreciation to Ray and recall some of his contributions to ESO's current eminence in telescope technology.

My first encounter with Ray remains unforgettable: Returning from my first observing run at La Silla in March 1973, I came on a fine morning to the newly-established ESO TP-Division in Geneva to visit a Danish colleague. Treated to my then standard sermon on spectrograph design, he quickly introduced me to the new Head (and only member) of the Optics Group with a comment that *we* might have common interests to discuss. Indeed we had: After what seemed like five minutes, the office cleaner politely suggested that we get out of his way; everybody else had gone home long ago!

Many readers will recognize in this episode two of Ray's enduring characteristics: Enthusiasm in everything he does and readiness to listen seriously to everyone, regardless of rank and seniority – even a green rookie like me. To these qualities, his long-time associates will add those of absolute honesty and loyalty to his work and his colleagues. It is, I am sure, a tribute to Ray's quiet leadership that while a large fraction of the staff decided to remain in Geneva when ESO-TP moved to Garching, the entire (French-speaking) Optics Group came along; almost all of them are still at ESO.

For myself, this first meeting resulted in a long collaboration on telescope planning and testing, spectrograph design for the 3.6-m telescope, and much more, all required to conform to another of Ray's beliefs: "If something is worth doing at all, it is worth doing well." I still consider this time to be some of the most enjoyable and useful I have had so far.

Personality apart, Ray had impressive professional credentials when he took over the responsibility for optics at ESO in September 1972, a critical time in the 3.6-m telescope project. Trained as an optical engineer at Imperial College in London, he already had a distinguished 11-year career behind him at Zeiss (Oberkochen) as Head of the Design Department for telescopes and precision measuring instruments. However, as he once told me, if you love optics but want nothing to do with its military applications, working on telescopes is the fulfilment of a dream. Luckily so for ESO: In the many large optical contracts ESO has dealt with since then, his profound insight in not only optical design, but also in the industry and the thinking on the other side of the negotiating table have been invaluable time and again.

Figure 1: *Ray Wilson during a quiet moment, checking optical measurements during the commissioning of the Danish 1.5-m telescope on La Silla, November 1978.*

Chances are that Ray Wilson will be remembered by astronomers primarily as the "Father of the NTT". And it is true

ESO at CNRS Plenary Meeting

On April 22–23, 1993 the Second Plenary Session of the National Committee of the "Centre National de la Recherche Scientifique" (CNRS) took place at the Palais des Congrès in Strasbourg. The focus was on "European aspects of scientific research" and about 600 delegates from France as well as 100 foreign guests participated. The meeting was opened by the recently installed French minister for Research, François Fillon, and resulted, as a conclusion, in 12 practical "proposals" aiming at the optimization of the French research in the new European environment.

ESO had mounted an information stand in the area just outside the main meeting room, and many participants and members of the press used the occasion to inform themselves about the present status of the VLT project.

C. MADSEN

Figure 1: *The ESO stand at the CNRS Plenary Meeting.*

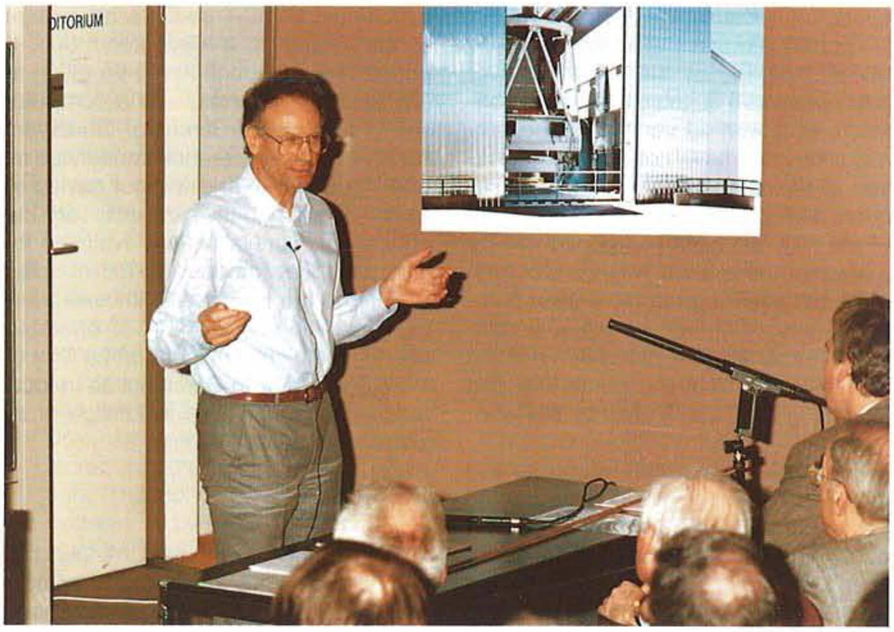

Figure 2: *Ray Wilson giving his retirement speech at ESO Headquarters in Garching, April 2, 1993.*

that those stunning first-light images in March 1989 (*The Messenger* No. **56**) changed overnight and forever the way that large telescopes will be designed: On-line wavefront analysis and active optics will be – no, *are* already – a must. A number of professional honours have been bestowed on him for this achievement, and well deserved they are.

In a wider perspective, the NTT demonstration also gave confidence that the thin VLT mirrors can be adequately controlled in practice. This not only considerably eases the figuring tolerances, but the novel feature that Cassegrain, Nasmyth, and coudé foci can be fed with a single secondary mirror depends on the ability to adjust the shape of the active VLT primaries.

Yet, achieving and maintaining the best optical quality of *all* telescopes has been Ray's lifelong ambition, a sustained long-term effort with the NTT as its splendid culmination. Figure 1 shows Ray back in 1978, contemplating on the carefully designed system for aligning and testing the optics of the Danish 1.5-m telescope – another effort promptly rewarded with success (*The Messenger* **17**, 14). With on-line, turnkey wavefront analysers rapidly becoming available, poorly-supported and -collimated mirrors will soon be as socially unacceptable as dirty ones, also on smaller telescopes.

Thus, although it is hard to believe, Ray celebrated his 65th birthday on March 23 and left ESO after more than twenty years. On April 2, the occasion was marked with a small symposium in Garching. In his final address (Fig. 2) he conveyed, true to form, the lessons and admonitions the rest of us should keep in mind after his retirement (note how little this young man changed between Figures 1 and 2!).

"Retirement" is, however, a rather misleading term for Ray's present activity: He is hard at work for a stern taskmaster – himself. The first draft of a two-volume book collecting a lifetime's experience with astronomical optics is ready, but he expects another year of full-time work before it is completed to his satisfaction. Uniquely, it will treat both the design, testing, alignment, and support of telescope optics – no doubt an indispensable reference for telescope builders for decades to come. Meanwhile, Ray defers all social invitations until "WTBIF": When The Book Is Finished!

Remote Observing with the NTT and EMMI/SUSI: a First Assessment

D. BAADE, T. BEDDING, M. CAROLLO, H. KJELDSEN, M. KOLB, G. MARCONI, C. OUNNAS, V. REYES, J. RODRIGUEZ, and A. ZIJLSTRA, ESO

Introduction

Although some observatories started earlier and others are catching up very quickly, ESO at the moment probably is the ground-based optical/IR observatory with the largest experience in routine remote observing. The Coudé Echelle Spectrometer (CES) at the Coudé Auxiliary Telescope (CAT) on La Silla has been used regularly by Visiting Astronomers at ESO Headquarters in Garching since 1988/89. In the present Period 51, usage will reach almost 110 nights or about 60 % of the available time. During 497 nights in the four years of 1989–1992, the availability averaged 98.9 %, and the downtime has always been less than that caused by instrument or telescope failures (for a more detailled report see Baade 1993).

Recently, a technically rather different system has been put into operation for remote observations with the New Technology Telescope (NTT), the ESO Multi-Mode Instrument (EMMI) and the SUperb Seeing Imager (SUSI). Its technological foundations have been described by Wallander (1990, 1993) and permit it to be used also from places other than Garching (Balestra et al. 1993, Franchini et al. 1993). Here we wish to give a first assessment of the performance of this remote control (RC) system during observing programmes carried out by Visiting Astronomers.

Does it Work?

Although this is still the most often heard question, already our first test nights convinced us that the answer is yes. The more relevant question is how competitive remote observing will be. We now believe that, as for the CAT/CES, the limiting factor will eventually be tact us. (From June 1, the scientific responsibility for remote observing has been passed from DB to George Meylan.)

References

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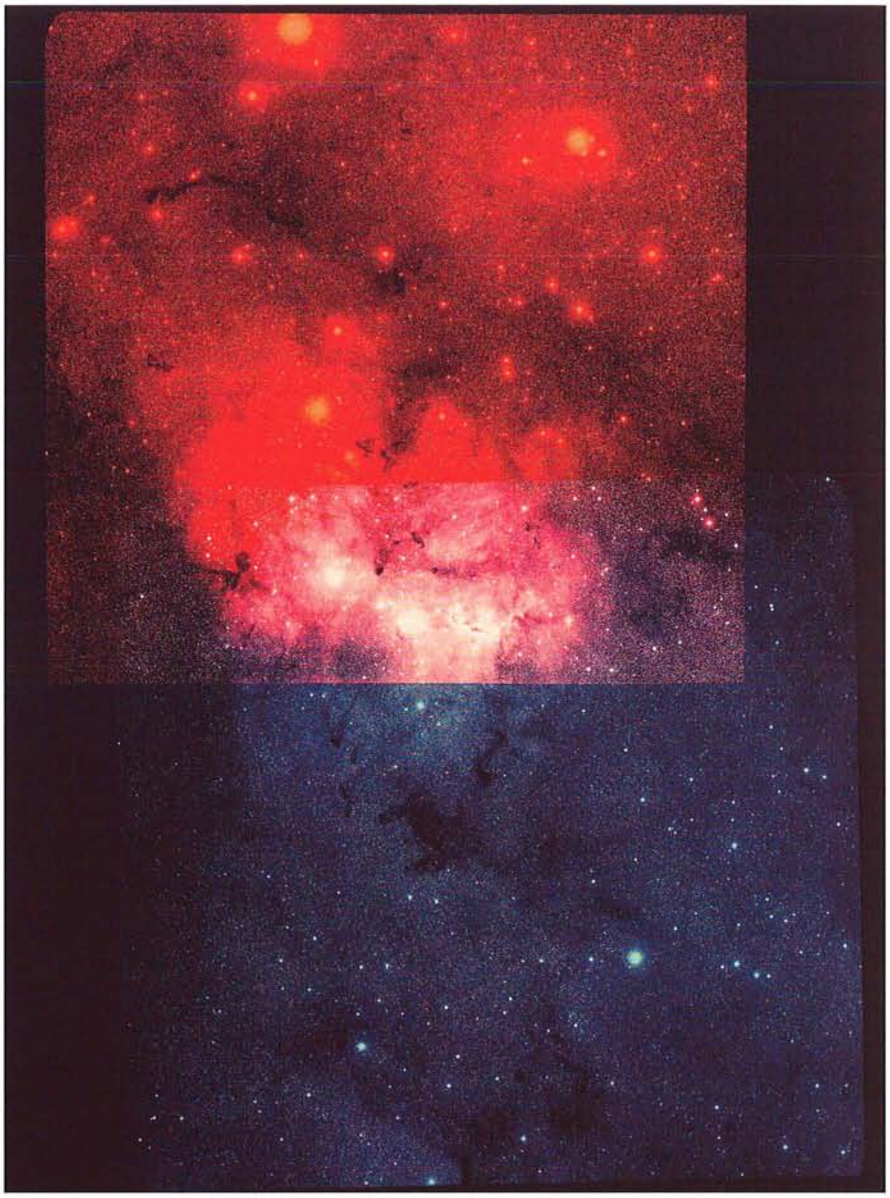
Franchini, M., Molaro, P., Nonino, M., Pasian, F., Ramella, M., Vladilo, G., Centurion, M., Bonifacio, P. 1992: *The Messenger* No. **69**, p. 6.

Wallander, A. 1990: *The Messenger* No. **60**, p. 59.

Wallander, A. 1993: "Remote Control of the ESO New Technology Telescope", in Proceedings of Workshop on Remote Observing, Tucson, in press.



A Two-Colour Composite of IC 1396

The composite photo provides a good illustration of the usefulness of two-colour work in astronomy.

Two photographic plates for the Palomar/ESO Atlas of the Northern Sky (now being reproduced at ESO) of fields 146 (R) and 188 (B) were enhanced directly without any masking to reveal the fine details in the dust and gas clouds of this nebula which covers almost two complete fields. The amplified films were then copied onto Ilfochrome colour paper through a monochrome colour filtre. The overlapping area appears as a two-colour composite which makes it possible to separate directly objects of different colour. Great care had to be taken to obtain the best possible superposition of the two plates, especially as there are slight differences in the plates near the edges.

Unlike most present-day astronomical observations, this composite provides a very-wide-field image of a sky area of about 6° × 10°.

The second photo is an enlargement of an area east (left) of the centre of the larger one. There are lots of interesting details. Note, however, that some of the rectilinear shapes in the nebula are at least partly due to the reflection pattern of a very bright star seen in the upper-right part of the "red" image.

H.-H. HEYER, ESO

Another Trans-Plutonian Minor Planet: 1993 FW

O. HAINAUT and R.M. WEST, ESO

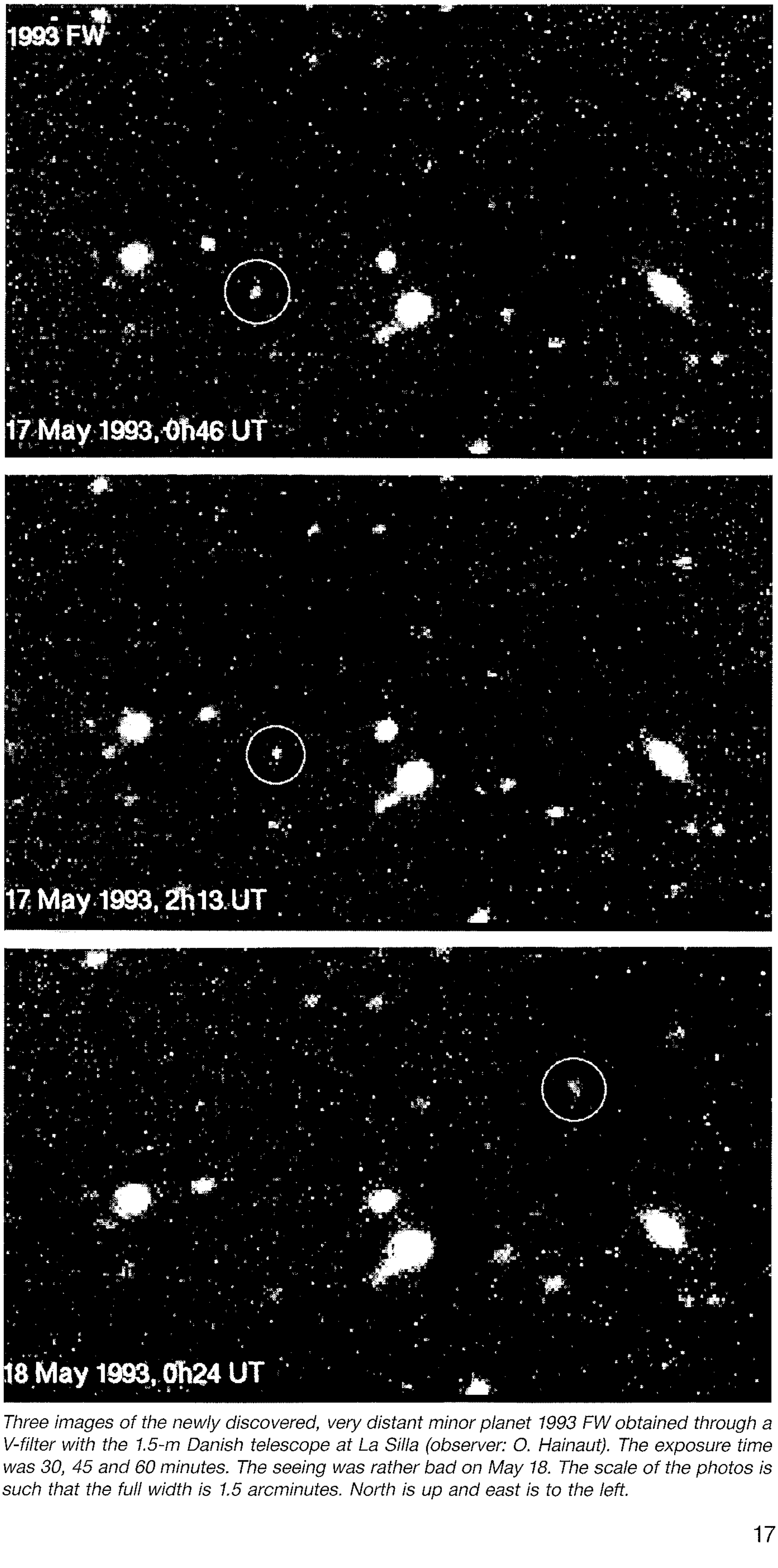
On March 28, 1993, David Jewitt and Jane Luu on Hawaii discovered a slowly-moving minor planet of magnitude 23. More observations were made the following night, confirming the unusual motion and indicating that it is located at a very large distance from the Sun, possibly even far beyond Pluto. The new object was given the preliminary designation *1993 FW* (IAU Circular 5730).

It was unfortunately not possible to obtain any further observations of this interesting object, also not during the next dark-moon period in April, and despite its slow motion, there was some concern that it might be lost again among the myriads of faint celestial objects. However, with the help of a rough, predicted location, furnished by the IAU Minor Planet Bureau in Cambridge, Mass. (USA), we were able to find and observe it again during two nights in mid-May 1993.

Here are shown three of these recent CCD frames with of 1993 FW. They were obtained with the 1.5-metre Danish telescope and allowed us to detect the faint images after careful computer-blinking of the frames. The object was about 30 arcseconds from the extrapolated position. The frames were immediately transferred via the permanent satellite link to the ESO Headquarters from where accurate positions, measured on the Optronics machine, were communicated to the Minor Planet Bureau. Here, Brian Marsden was able to compute a rough (circular) orbit with a nominal, mean semi-major axis of 42.34 AU and to show that the present heliocentric distance of 1993 FW must be between 39 and 48 AU, i.e. at the mean distance of Pluto (39.8 AU) or beyond (IAU Circular 5796).

At the time of these observations, the motion was only 1.7 arcsec/hour, corresponding to a shift of 41 arcseconds between the upper- and lower-most frames. The diameter of 1993 FW, as deduced from the brightness and distance, is probably a few hundred kilometres. This object is similar to minor planet 1992 QB1 which was discovered by Jewitt and Luu last year, see *The Messenger* No. **70**, page 33. The two objects may belong to the hypothetical Kuiper belt and it is not difficult to predict that others will be found during the next years, especially as the observing techniques are refined.

More observations are now needed to refine the orbit of 1993 FW. They will be attempted in June and possibly also in July, before it moves behind the Sun and becomes unobservable until the end of the year.



Three images of the newly discovered, very distant minor planet 1993 FW obtained through a V-filter with the 1.5-m Danish telescope at La Silla (observer: O. Hainaut). The exposure time was 30, 45 and 60 minutes. The seeing was rather bad on May 18. The scale of the photos is such that the full width is 1.5 arcminutes. North is up and east is to the left.

CCD Photometric Standards for the Southern Sky: a Status Report

A. FERRARI[1], B. M. LASKER[2], G. MASSONE[1], A. PIZZUTI[1], E. SICILIANO[2], M. G. LATTANZI[2, 1], B. BUCCIARELLI[2, 1], M. POSTMAN[2] and H. SCHWARZ[3]

[1]Osservatorio Astronomico di Torino, Italy; [2]Space Telescope Science Institute, Baltimore, MD, U.S.A.; [3]European Southern Observatory, La Silla, Chile

Summary

We report on the status of a long-term project using the 0.91-m Dutch telescope, equipped with a CCD camera, to establish faint CCD photometric sequences for the calibration of photographic sky-survey material.

1. The Programme

The long-term project *Photometric Calibrators for the Southern Sky Surveys* has been supported with ESO observations beginning with Period 47. This project is a joint effort of teams from the Osservatorio Astronomico di Torino (OATo) and the Space Telescope Science Institute (STScI), with additional support by R.S. Le Poole (University of Leiden). The main goal is to establish faint (down to about 20th mag in the B, V, and R passbands) photometric sequences with a (at least internal) precision of 0.05 mag. Analysis of CCD data gathered by the STScI team for the northern sky shows that this kind of precision is indeed possible. Transformation to the standard Kron-Cousin B, V, R system is done by obtaining short exposures of Landolt (1992) standards. Tests on the reduction procedures and on the definition of the photometric system (with respect to that of Landolt) are done by reobserving equatorial regions that are also covered by the northern hemisphere part of this programme, as well as standard fields (where faint photoelectric photometry is available) and selected southern regions coordinated with the programmes of other groups.

Once obtained, those photometric sequences will serve for accurate calibrations of contiguous all-sky digitized Schmidt plate surveys. Indeed, this material has the potential of providing the information to explore a wide range of astrophysical problems both in galactic and extragalactic astronomy. In particular, the collaboration STScI – OATo is focussed on the area of Galactic structure. Some of the topics that are being actively pursued are (a) the test of galactic models with traditional techniques as star counts and colour distributions, (b) the measure of the gradient in the galactic potential through absolute proper motions, (c) the discrimination of stellar populations via reduced proper motion diagrams such as Pop II white dwarfs.

A more detailed description of the applications in Galactic astronomy which are possible with a fully calibrated data base of digitized Schmidt plates is given in Lasker et al. (1989).

To date, we have imaged 22 % of the total number of fields (≃ 800) listed on the programme. All data taken with the old GEC # 7 chip (see below) have been reduced and transformed to the standard system. A catalogue with the basic information (coordinates of the imaged fields, filters, exposure time, limiting magnitude, reduction status) concerning all available frames is being assembled at OATo. We intend to open this database to the community upon completion. Of course, the database will be updated as new data become available. As for the availability of the frames themselves, (raw and/or calibrated) small amounts of data can be made available on a collaborative basis.

2. Imaging Properties of the CCD System

Our first run occurred right after CCD detector # 7 (GEC coated) was made available to guest observers (August 1991). Therefore, we devoted large part of the observing time to perform calibrations of the CCD imaging properties and tests of the integrated system. We found a problem of light contamination in some of the frames, which showed a somewhat non-uniform illumination of part of the chip, with a sharp knife-edge like diffraction pattern on the side of the dark (uncontaminated) portion of the chip. A. Gilliotte identified this with stray sky-light from insufficient telescope baffling; accordingly, a circular diaphragm of 100 mm clear aperture was put on the primary mirror baffle. Two 1-min frames (one V and one R) on the star field that had previously shown the highest level of contamination (there were two 8-mag stars nearby the field centre) proved that the contamination was removed. The following night, other experiments on the same test field helped to decide on the optimal size for the primary mirror baffle stop. A 114-mm and 104-mm diameter (the unstopped baffle is 134 mm clear aperture) were used. The 104-mm diaphragm gave uncontaminated light, though retaining about 8 % more light over the previous usable stop. During the most recent run (March 1993) we still experienced occasional light contamination on some exposures. Since a new CCD camera (detector # 33) was mounted at the telescope adapter at the time, the tests described above are to be repeated; then the baffle stop, still provisional at present, should be made definitive. As far as the CCD characteristics are concerned, the old chip proved to be adequate for the scientific programme, even though its sensitivity was a little poor, especially in the B band (≃ 25 % responsive quantum efficiency [RQE]). The new chip is a TEK 512 × 512 with a pixel size of 27 microns, which at the Cassegrain focus gives a scale of 0.44 arcsec per pixel. Calibrations of this new chip were still going on at the time of our last run (March 1993). Notwithstanding the sensible amount of time we had to spend in focussing the system during the night – the poor performance of the telescope in this respect has long been known –, the much higher responsive quantum efficiency (RQE) of the new chip permitted to increase the number of scientific frames per night by 30 %.

3. CCD Precision Photometry

The main issues we want to address here are the following:

- CCD linearity;
- stability of the read-out noise (R.O.N.);
- practical limiting magnitude as a function of signal-to-noise ratio, given our minimum goal of 0.05 internal magnitude accuracy at B = 20 mag;
- possible colour dependent errors when transforming to a standard photometric system.

With regard to CCD linearity, both the old chip and the new one showed to be linear at the 0.5 % level up to the saturation level of the analogue-to-digital converter.

The read-out noise of the new chip is slightly worse than that of the old one

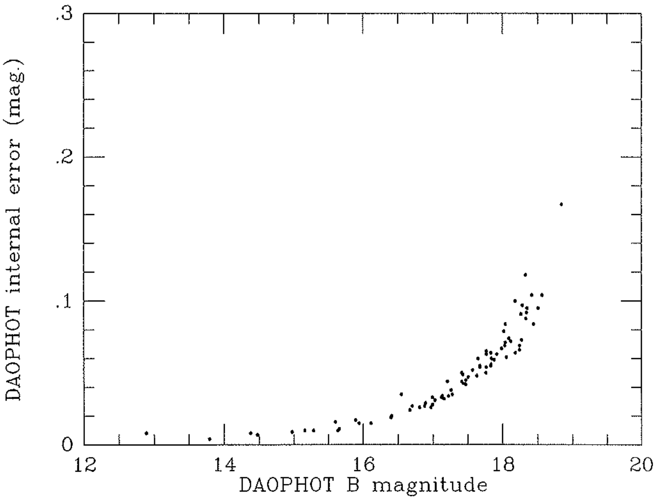


Figure 1.

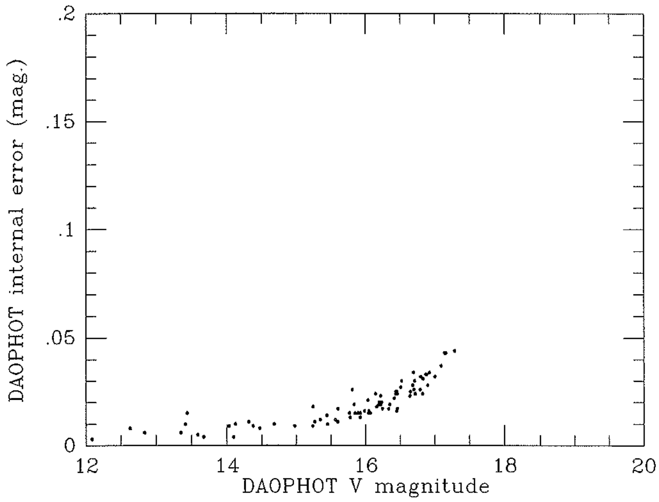


Figure 2.

(about 16.8 versus 13 electrons rms). In addition, the new chip is more noise sensitive and it needs to be shielded very carefully in order to avoid electromagnetic interference.

The material gathered with the old chip has been fully reduced at the Torino Astronomical Observatory, using the DAOPHOT package available in MIDAS.

Figures 1 and 2 show B and V magnitudes of stars versus the corresponding internal errors as obtained from DAOPHOT. The exposure times were 30 min and 20 min for the B and V filters respectively. If we apply the zero point offset from internal to standard magnitude ($\simeq + 2.46$ in B and $\simeq + 3.32$ in V) we clearly see that the basic scientific requirements are met.

The transformation to the standard magnitude system is done via observations of standard photometric stars taken from Landolt (1992). We typically observe 10 to 14 standard stars per night. Residuals after computing the night extinction coefficients and colour transformation are of the order of 0.015 mag.

In trying to minimize possible colour-dependent errors the standard stars should have a colour range as wide as possible. Landolt's standards have B–V colours ranging from -0.3 to $+2.3$. Among the standards available during each observing run, we make an effort to select those with as different colours as possible.

A full paper devoted to the comparison of our photometry with literature data and CCD photometry taken at CTIO by the STScI group as part of the STScI-OATo collaboration is in preparation. Below, we briefly report on the results derived from one of the calibration fields (in the region of the globular cluster M15). B and V photoelectric photometry down to $V \simeq 22$ is given by Sandage (1970). CCD photometry, in the same passbands, is available from Fahlman et al. (1985). CTIO data provide the only comparison in R.

We have 23 stars in common with Sandage's photometry and 15 with the work of Fahlman et al. (1985). The mean error of the comparisons $V_{ESO} - V_{Sand}$ and $V_{ESO} - V_{Fahl}$ are 0.045 mag and 0.052 mag respectively. The corresponding values for the colour comparisons $(B-V)_{ESO}-(B-V)_{Sand}$ and $(B-V)_{ESO}-(B-V)_{Fahl}$ are 0.059 mag and 0.060 mag. The mean error of the differences $(V-R)_{ESO}-(V-R)_{CTIO}$ is 0.024. From these values we have not removed the errors of the comparison photometry. There is no evident indication of an increase of the (external) error as a function of magnitude down to the limit of this comparison ($V \simeq 19.2$ and $B \simeq 19.7$). The mean value of the residuals is not always negligibly close to zero. The colour comparison to Fahlman et al. photometry yields the largest of such deviations (+ 0.051 mag). This might be an indication that some residual systematic effects are still hidden in our data, conceivably as a simple (and hopefully recoverable) function of colour or magnitude.

Such effects will be analysed in the upcoming publication (mentioned above) where we combine data from all five of our comparison fields.

4. Desiderata

In order to further improve the operation of the CCD camera at the Dutch telescope, two improvements are desirable. The first one, about to be implemented, is the replacement of the secondary mirror assembly. The existing mechanical structure holding the secondary mirror introduces uncontrolled 20-micron changes in the mirror position. Because of the telescope's long focus (f/13.75), such a movement corresponds to a 500-micron shift of the focal plane (gamma factor = 25). At the moment, the system has to be refocussed several times per night (depending on temperature change) penalizing time-efficiency.

Another desirable feature is the automatization of the dome movements. Although not essential, it would represent a further advantage, especially for a project like ours, where a huge number of fields have to be imaged, and every spare minute is important!

Acknowledgements

We wish to thank ESO for its long-term support of the programme. We also thank the technical staff at La Silla, and the Dutch staff in particular, for their help during the observing runs and their interest in the programme. The OATo participation in the programme is partially supported by the Italian Space Agency (ASI) under contracts ASI 1991 RS 88 and ASI 1992 RS 78. The STScI participation in this collaboration is supported by NASA.

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The EROS Search for Dark Halo Objects

E. AUBOURG, P. BAREYRE, S. BRÉHIN, M. GROS, M. LACHIÈZE-REY, B. LAURENT, E. LESQUOY, C. MAGNEVILLE, A. MILSZTAJN, L. MOSCOSO, F. QUEINNEC, J. RICH, M. SPIRO, L. VIGROUX and S. ZYLBERAJCH, DAPNIA, CE Saclay, Gif-sur-Yvette, France
R. ANSARI, F. CAVALIER and M. MONIEZ, Laboratoire de l'Accélérateur Linéaire, Centre d'Orsay, France
J.-P. BEAULIEU, R. FERLET, PH. GRISON and A. VIDAL-MADJAR, Institut d'Astrophysique de Paris, France
J. GUIBERT, O. MOREAU and F. TAJAHMADY, Observatoire de Paris, France
E. MAURICE and L. PRÉVÔT, Observatoire de Marseille, France
C. GRY, Laboratoire d'Astronomie Spatiale de Marseille, France

1. Introduction

It is widely believed that the flat rotation curves observed for spiral galaxies like our own indicate that such galaxies are contained in a "halo" of dark matter [1]. While the mass of the dark halos should be as much as ten times that of the visible parts of galaxies, the composition of the halos is not known. Candidates range from hypothetical weakly interacting elementary particles to dark astronomical objects like brown dwarfs or black holes. The identification of the halo constituents would have profound implications for cosmology and theories of galaxy formation.

Paczyński [2] suggested that dark astronomical objects in our Halo could be detected by monitoring the brightness of individual stars in the Large Magellanic Cloud (LMC). Because of the gravitational deflection of light, if a massive Halo object passes near the line-of-sight to an LMC star, the amount of light received from this star by the observer will be increased. The amplification is a function of the "impact parameter" r_0, i.e. the minimum distance between the undeflected line-of-sight and the massive deflector. In terms of the normalized impact parameter *u*, the amplification is

$$A(u = r_0 / R_E) = \frac{u^2 + 2}{u\sqrt{u^2+4}}$$

where R_E, the "Einstein radius", is a function of the deflector's mass M, the observer-deflector distance D_d and observer-star distance D_S:

$$R_E^2 = \frac{4GM}{c^2} D_d \ (1 - D_d/D_s) .$$

The size of the amplification is greater than 0.3 magnitude if the impact parameter is less than the Einstein radius of the deflector ($u < 1$). The probability of such an amplification, for a given star and at any given time, is simply the probability that this star lies behind a circle of area πR_E^2 centred on any deflector between us and the star. Since R_E^2 is proportional to the deflector mass while the number of deflectors in the Halo is inversely proportional to their mass, this probability depends only on the total dark matter mass along the line-of-sight and not on the individual deflector masses. This probability turns out to be of the order of the square of the galactic rotation velocity devided by the speed of light, or about 10^{-6}. A more precise estimate gives a probability of about 0.5 $\times 10^{-6}$ for amplifications greater than 0.3 magnitude. This figure was calculated assuming a spherical "isothermal" halo of total mass 4×10^{11} $M_\odot$ at distances from the Galactic centre less than the distance to the LMC. This mass would produce a flat rotation curve at the observed Galactic circular speed of 220 km s^{-1}.

Since the observer, star and deflector are in relative motion, a sizeable amplification lasts for a time of order R_E/v_T where v_T is the relative transverse velocity of the deflector. For the lensing of stars in the LMC by objects in our Halo, these relative speeds are of order 200 km s^{-1} and the most probable lensing time is roughly:

$$r = 70 \text{ days} \sqrt{\frac{M}{M_\odot}} \cdot \qquad (1)$$

(We have taken the "lensing time" to be the time during which the amplification is greater than 0.3 magnitude.) The characteristic light curve is shown in Figure 1. The distribution of lensing times for a given deflector mass is expected to resemble that shown in Figure 2.

Since τ is proportional to $\sqrt{M}$, the number of microlensing events expected for a fixed observation time is inversely proportional to $\sqrt{M}$. To observe one event with characteristic time τ, the product of the number of stars monitored and the effective observing time must be of order $10^6\tau$. This can be achieved if the Halo consists of unseen objects in the mass range one to 10^{-7} solar masses, corresponding to characteristic times of a few months to a few hours. This range of masses covers hydrogenous objects that are both too light to burn hydrogen ($M < 0.07$ $M_\odot$) and too big to have evaporated since their formation in the early Universe ($M > 10^{-7}$ $M_\odot$) [3].

To be sensitive to amplifications of order 0.3 magnitude, the photometric precision per measurement should be of order or better than 0.1 magnitude. Rejection of intrinsically variable stars can be achieved, in principle, by requiring that light curves be symmetric, achromatic and exhibit a single extremum (the amplification events should not be repeated).

Following discussions in 1989 led by Charles Alcock of Livermore, two groups have initiated observation programmes to reach the required sensitivity. One group is a Livermore-Berkeley (Center for Particle Astrophysics)-Mount Stromlo-San Diego-Santa Barbara collaboration and is observing the LMC from Mount Stromlo, Australia [4]. The other group, called EROS (Expérience de Recherche d'Objets Sombres), is our own collaboration of particle physicists and astronomers, started in January 1990. We are observing the LMC from the ESO observatory in La Silla, Chile [5].

EROS consists of two programmes. The first is designed to be sensitive primarily to deflector masses in the range $10^{-4}M_\odot < M < 10^{-1}M_\odot$ corresponding to mean lensing durations in the range 1 day $< \tau <$ 30 days. It uses Schmidt plates of the LMC and permits us to monitor about ten million stars over a period of several years. (About

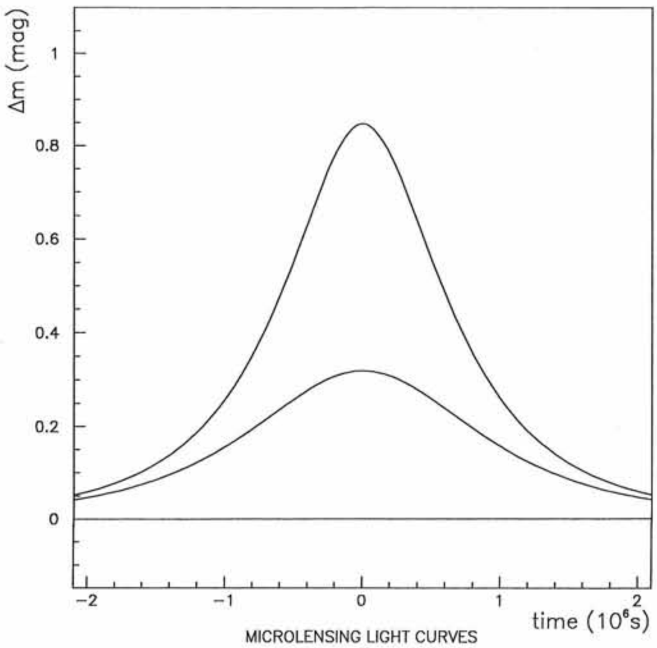


Figure 1: *The theoretical light curves for impact parameters of 0.5 R_E (upper curve) and 1.0 R_E (lower curve). The time dependence was calculated assuming a deflector of mass 10^{-2} $M_\odot$, 10 kpc from the Sun, moving with a relative transverse speed of 160 km/s.*

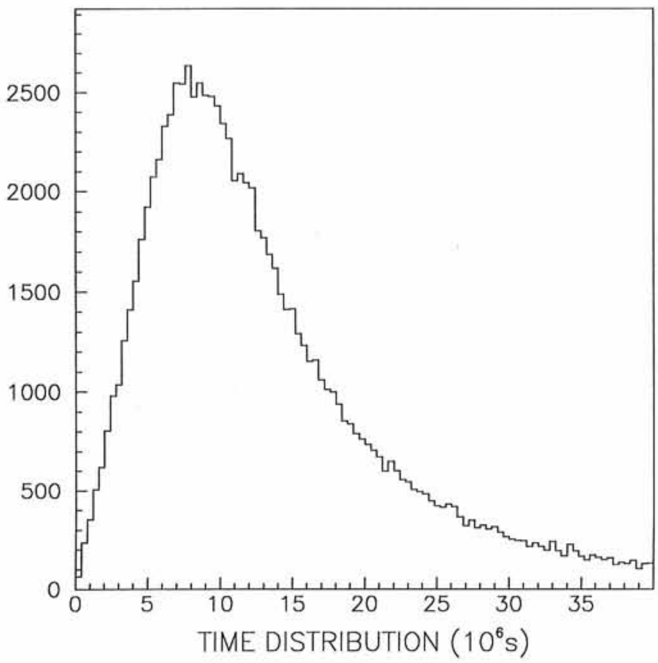


Figure 2: *Distribution of lensing times for an "isothermal" Halo composed of 1 $M_\odot$ deflectors, in units of 10^6 seconds. The lensing time is taken to be the interval during which the amplification is greater than 0.3 magnitude. For other masses, it scales with the square root of the deflector mass.*

half of these stars are bright enough to be monitored sufficiently accurately to observe variations at the 0.3 magnitude level.) The second programme is designed to be sensitive primarily to deflector masses in the range $10^{-7}M_\odot < M < 10^{-3} M_\odot$ corresponding to event durations in the range 1 hour $< \tau <$ 3 days. It uses a large CCD mosaic on a dedicated telescope to monitor about 150,000 stars every 20 minutes.

This report describes the present status of EROS and gives some preliminary results. Prospects for the future are also discussed.

2. The CCD Programme

The CCD programme started at La Silla in December 1990 with a one-month feasibility study during which we observed the LMC bar with the 40-cm GPO refracting telescope. We used a camera consisting of one 576 × 405 pixels Thomson CCD chip giving a field of 11 × 8 arcmin. A total of 63 images of one dense field of the LMC bar was taken. The strategy of using alternating blue and red filters was established.

Following this short study, we decided to replace the refracting telescope with a 40-cm reflector (f/10) mounted on the back of the GPO as shown in Figure 3. This allowed us to use wide band filters (centred at 480 nm and 670 nm) with the consequent reduction of exposure times. We also constructed a wide field CCD camera [6] with sixteen buttable 576 × 405 pixels Thomson THX 31157 CCDs (Fig. 4). The total field of this camera is about 1° × 0.5° and is oriented so as to follow the LMC bar.

Data acquisition and camera control are performed with a VME system based on a 68030 processor. The data taken during one night are stored on a

Figure 3: *The 40-cm reflector mounted on the GPO at La Silla.*

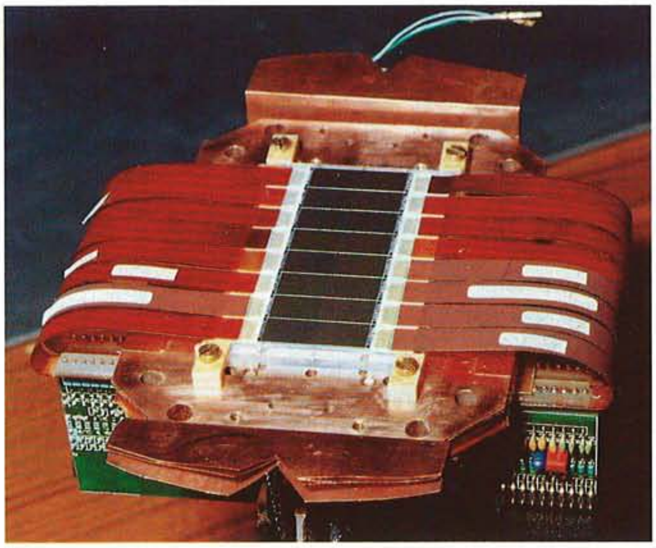


Figure 4: *The CCD mosaic.*

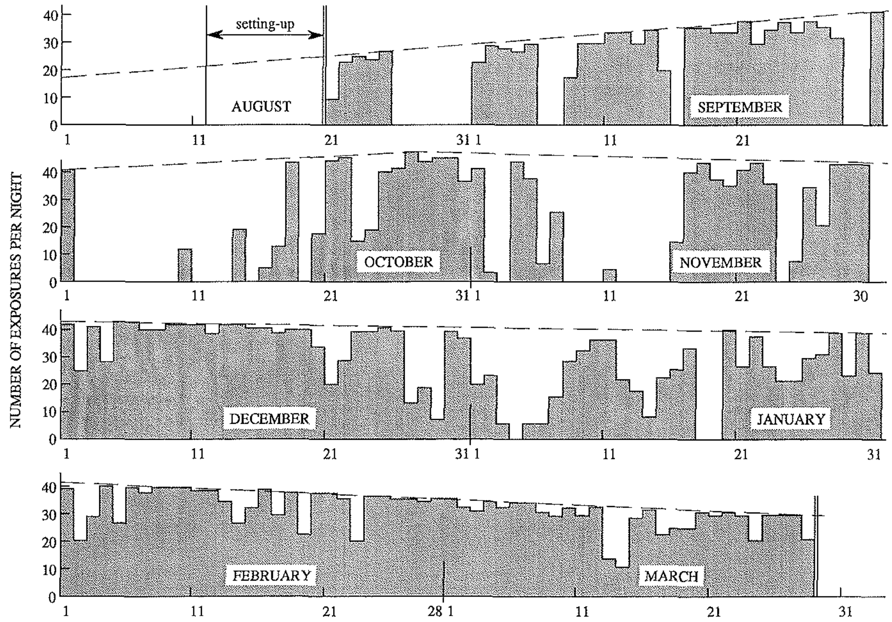


Figure 5: *Number of CCD images per night (1992–93 season).*

DAT tape. The system is also linked to a DS 5000/200 workstation for preliminary on-line analysis.

We have used this set up to observe one very populated field of the LMC from December 1991 to March 1992 and again from August 1992 to March 1993. The corners of the field are at (α = 5^h29^m, δ = – 69°28′), (α = 5^h28^m, δ = – 69°54′), (α = 5^h15^m, δ = – 69°41′), and (α = 5^h16^m, δ = – 69°15′). The procedure has been to take alternating red and blue images with 8-minute exposures for the red and 12-minute exposures for the blue. The read-out time of one exposure is 40 seconds (all the CCDs are read in parallel). As of March 1993, a total of 8,100 exposures has been taken. Figure 5 shows the number of exposures per week over the 1992–93 season. In 1993, the observing efficiency reached 70 per cent for all nights and 85 per cent for useful nights.

3. The Photographic Plate Programme

Over the period 1990–1993, a total of 308 Schmidt plates of the LMC has been taken for our programme at La Silla, Chile. Figure 6 shows the time distribution of the plates. Half the plates use a red filter (RG630) and 098-04 emulsion and half a blue filter (GG385) and IIaO emulsion. Exposure times were typically 1 hour, allowing us to monitor stars of twentieth magnitude in the red and blue. The field covers 5 × 5 degrees and is centred on (α = 5^h20^m, δ = – 68°30′).

The transparency of the plates is digitized in 10 μm (0.6 arcsec) steps by the "MAMA" (Machine Automatique à Mesurer pour l'Astronomie [7]) at the Observatoire de Paris. Digitization of one plate requires about 8 hours time on the MAMA and generates 1.6 gigabytes stored on ten 3,480 magnetic tapes. As of this writing, all but 40 plates have been digitized.

4. Data Analysis

The analysis of such a large quantity of data taken under varying conditions presents considerable programming challenges. The use of standard photometric programmes has not proved feasible because of computer time limitations. After two years of development, we are now satisfied that we have an analysis package that can treat the entity of these data in a reasonable time. We describe successively the procedure for the analysis of CCD images and Schmidt plates.

To analyse the CCD images, we first construct one reference image for each CCD and for each colour by combining 50 images taken with good atmospheric conditions. The reference image is subjected to a star finding algorithm, and a star catalogue is established, containing about 10,000 stars per CCD.

In a second step, the individual images are treated as follows. After deflatting and bias subtraction, an image is aligned with the reference image. The positions of the stars previously found on the reference image serve as input to a photometric fitting programme to determine the luminosity of each catalogue star on the new image. The photometric precision is typically 6 per cent. The image is then aligned "photometrically" with the reference image by requiring that the mean luminosity of stars in a given luminosity band be equal to the mean luminosity in the catalogue. (The small number of intrinsically variable stars in the catalogue does not affect this procedure.) Successive images then add one point to the blue or red light curve of each star in the catalogue.

The light curve of one variable star is shown in Figure 7.

The final step of the analysis is to test each light curve for the presence of a microlensing event. Because the event finding algorithms must reject random fluctuations of intrinsically stable stars due to measurement errors, it is essential to determine accurately the photometric precision for each star and for each image. This precision is a function of the star's magnitude, its environment, and the observing conditions. We determine the "nominal" precision for each star from the mean point to point variations on the light curves using only the points from 50 high quality images. For intrinsically variable stars, this procedure yields an estimated precision that is worse than the real precision. However, it accurately estimates the mean

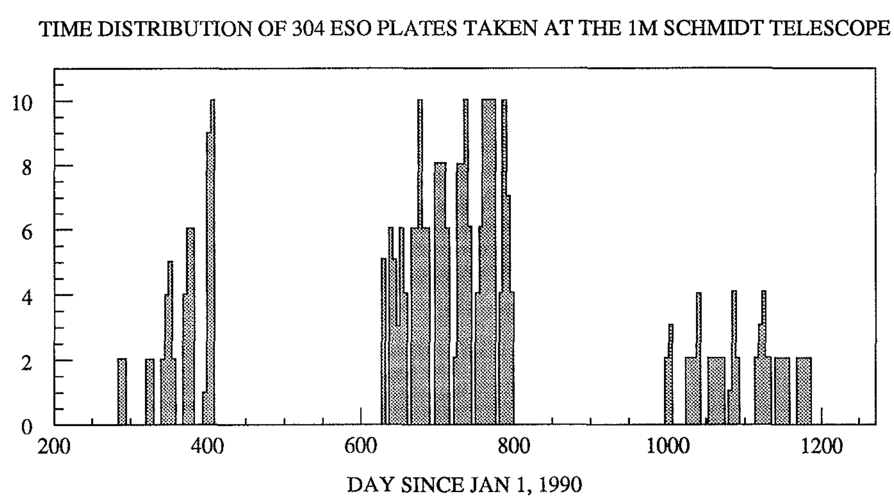


Figure 6: *Number of Schmidt plates per five days (1990 to 1993).*

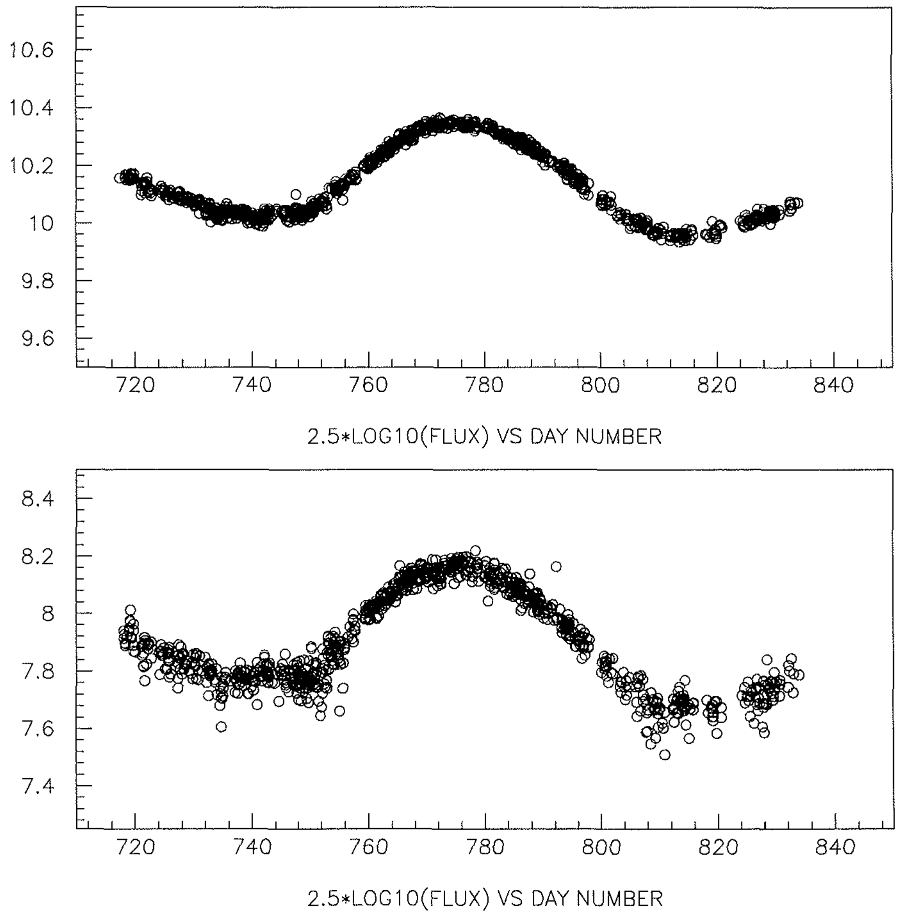


Figure 7: *A variable star observed with the CCD system in the 1991–92 season. The red (up) and blue (down) light curves contain about one thousand measurements each. Days are counted since January 1, 1990.*

precision for stable stars. A given point on the light curve is then assigned an uncertainty equal to the star's nominal precision multiplied by a factor that takes into account the quality of the image.

Once the resolution for each star and image is determined, algorithms can be applied to the light curves to search for microlensing candidates. The algorithm should accept light curves exhibiting one *and only one* amplification that is greater than that expected from measurement errors. Additionally, the amplifications in the two colours should be equal within errors and the temporal development of the amplification consistent with the expected curve. After application of the algorithm to the set of light curves, the number of events accepted by the algorithm can then be compared with the number expected if the Halo is comprised of astronomical objects of a given mass distribution. This number must be estimated via a Monte Carlo simulation of the observation sequence and detector resolution. The number will depend on the distribution of deflector masses and, to a lesser extent, on the spatial distribution of deflectors in the Halo.

We have investigated several possible algorithms for identifying microlensing events from the observed red and blue light curves. Basically we scan the two light curves for sequences of consecutive points that exhibit a mean luminosity sufficiently superior to that of the reference image. Candidates are chosen if they exhibit one and only one such sequence. These candidates are then examined in detail to verify that their light curves are compatible with the characteristics expected for microlensings.

As of this writing, the entire analysis chain has been applied to the 1991–92 data for two CCDs; this corresponds to five per cent of the total data. We have found *no candidates* that satisfy all criteria. For this quantity of analysed data, *we expect about 0.5 candidates* if the Halo is comprised of dark objects in the range 10^{-7} to 10^{-4} solar masses. This number of events is nearly independent of deflector mass in this range because the rising detection efficiency is compensated by the falling total number of microlensing events.

At the current analysis rate, we expect to treat all presently available data within a year. This will result in about ten candidates if the Halo objects are indeed in the above mass range.

The analysis of the Schmidt plates proceeds through basically the same steps as in the CCD programme. The plates are divided into 784 1-cm^2 blocks (10^6 pixels per block) that are treated separately. A reference image for each block and for each colour is constructed by combining ten images. A catalogue of about 10,000 stars on an average is constructed in each block, which then serves as input to the photometric reconstruction programmes for individual images. The mean stellar luminosity corresponds to 19th magnitude.

The mean photometric precision determined from the point-to-point variations on the light curves is about 15 per cent for the 50% brightest stars. The linearity of the photometric algorithms is confirmed using photometric sequences taken by us with the Danish 1.5-m telescope in fields scattered throughout the LMC.

The light curve from one variable star is shown in Figure 8. The light curve from a simulated microlensing event is shown in Figure 9.

The photometric analysis for the present data will require 3,000 cpu hours on a large IBM computer. As of this writing, ten per cent of the total field has been treated for the 1990–91 and 1991–92 data. At the current rate, the totality of the available data can be treated in about a year's time.

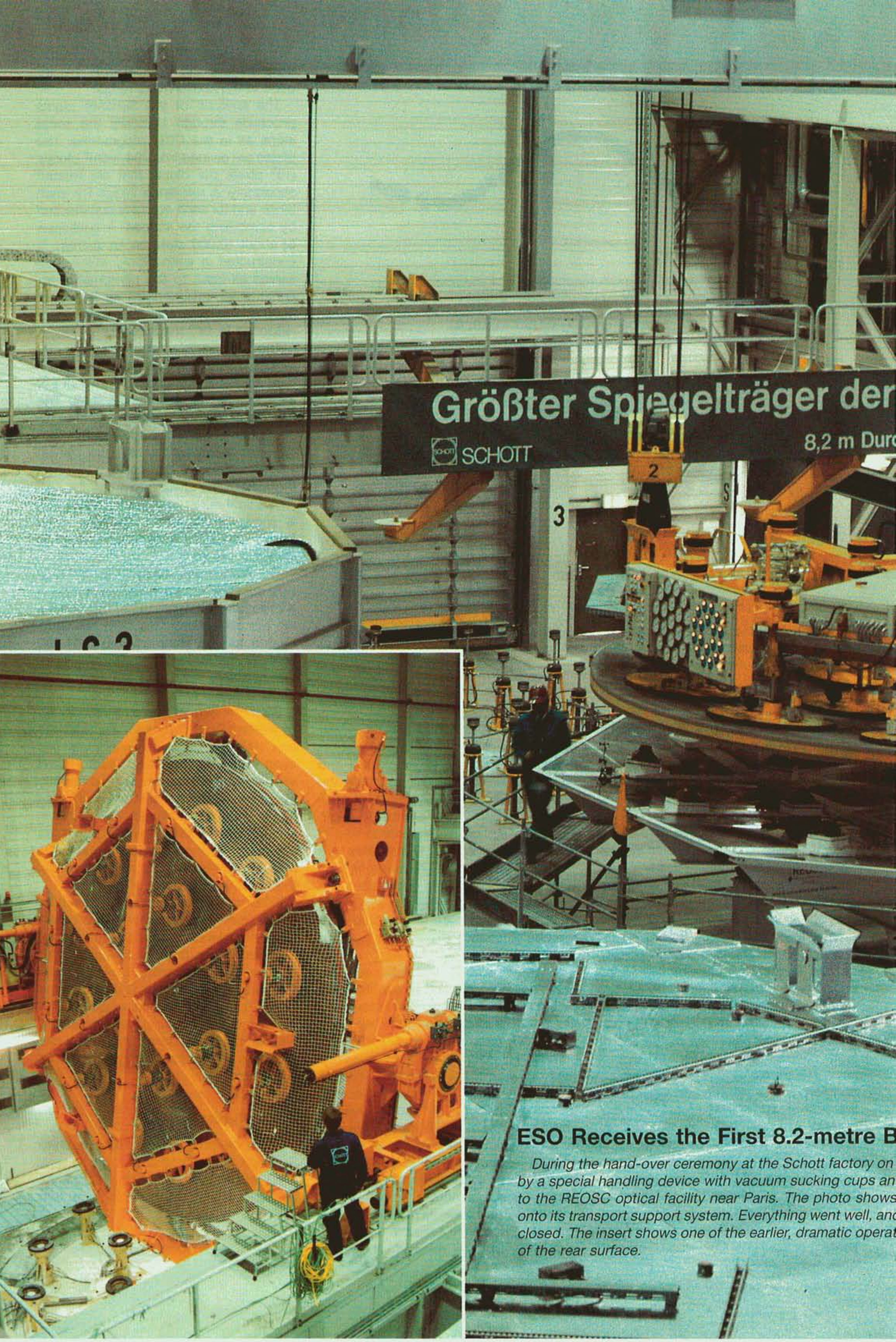
Selection algorithms have been tuned by treating three blocks for the 1990–91 and 1991–92 data. (No candidate has been found, for 0.07 expected). Based on this analysis, we expect to identify about twenty microlensing events when all the data are analysed, if the Halo is indeed comprised of objects of masses betweeen 10^{-4} and one solar mass. We also expect to identify more than ten thousand variable stars.

In conclusion we remark that we now know, from the absence of any candidate microlensing event in the data analysed so far, that the background of variable stars simulating a microlensing is small, both for the CCD data and the Schmidt plates. It is even small enough that each microlensing candidate that we may find can be scrutinized at the raw data level, and submitted to other algorithms.

5. The Future

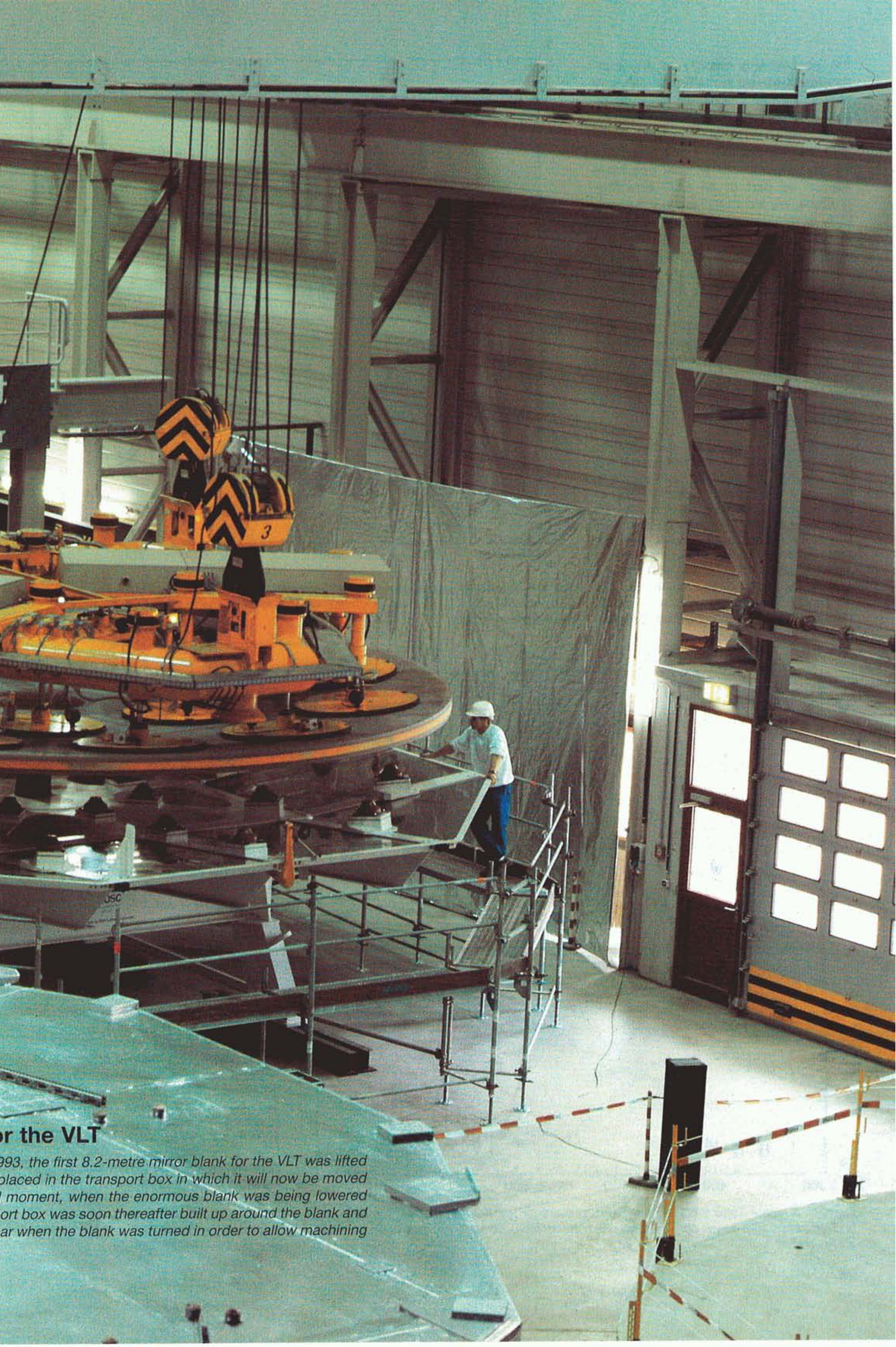
We have proposed to continue the Schmidt plate programme for a few years at the rhythm of about 50 plates per season. This will allow us to confirm

(continued on page 26)



ESO Receives the First 8.2-metre B

During the hand-over ceremony at the Schott factory on by a special handling device with vacuum sucking cups an to the REOSC optical facility near Paris. The photo shows onto its transport support system. Everything went well, and closed. The insert shows one of the earlier, dramatic operat of the rear surface.



or the VLT

993, the first 8.2-metre mirror blank for the VLT was lifted placed in the transport box in which it will now be moved l moment, when the enormous blank was being lowered ort box was soon thereafter built up around the blank and ar when the blank was turned in order to allow machining the post-lensing stability of any candidates observed in the first three years and to further search for lensings on very long time scales.

We plan to continue the observations with the present CCD camera and the 40-cm telescope for at least one more season as part of an ESO Key Programme. We are investigating the possibility of replacing the present telescope in 1995 with a 1-metre-class telescope equipped with a larger CCD camera. For the long term, some of us are involved in the LITE proposal [8] to build a wide-field 2-metre telescope for the Paranal site. Searches for microlensings with such a telescope are expected to result in ten times more candidates than the present system.

Acknowledgements

We are very grateful to Ph. Véron, Director of the Observatoire de Haute-Provence, and to the staff of OHP, especially J.-P. Berger, R. Burnage, J.C. Delclite, D. Kohler, R. Magnan and A. Richaud: their contribution to the tests and preparation of the CCD experiment was invaluable. We thank A. Baranne from the Observatoire de Marseille, and Ph. Lavocat, J. de Trogoff and the technical staff from the DAPNIA for their important contributions in the construction of the set-up. We thank R. Chesnel and P. Toupet for help with the plate digitization. We thank S. D'Odorico and H. van der Laan of ESO for encouragement and advice. We thank D. Hofstadt, the technical support groups of ESO at La Silla for the CCD observations and the whole Schmidt operations group. We have benefitted from discussions with C. Alcock, G. Barrand, D. Bennett, A. Bijaoui, P. Felenbok, B. Fort, K. Griest, Y. Mellier, B. Sadoulet, C. Stubbs, A. Terzan and M. Virchaux.

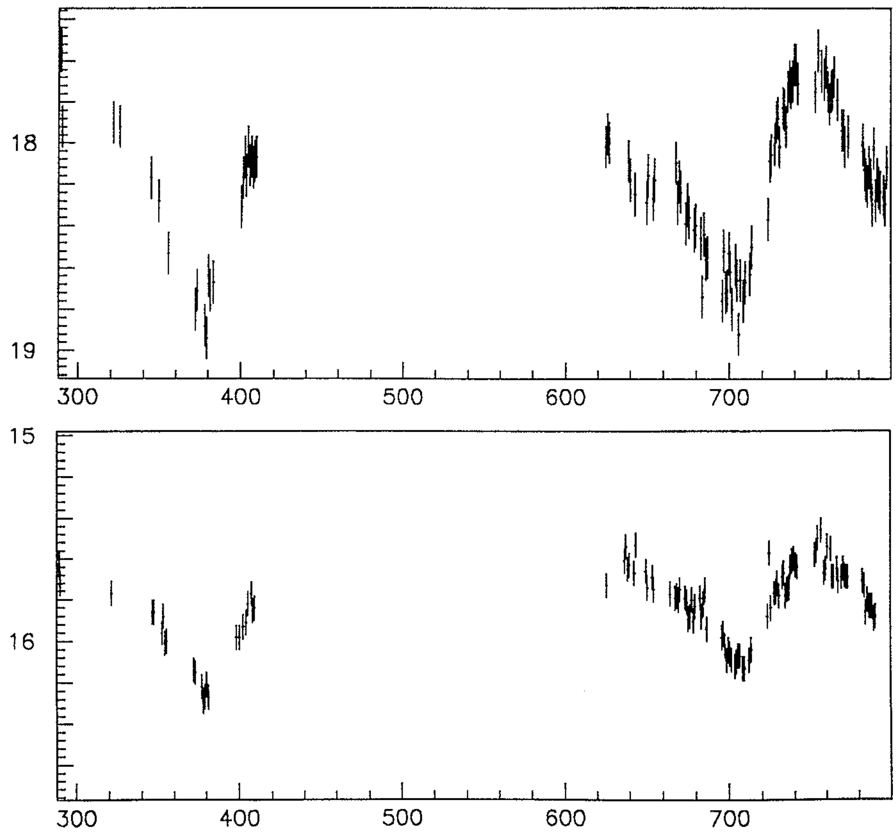


Figure 8: *A variable star found on the Schmidt plates using the 1990–92 data. The blue (up) and red (down) light curves contain about one hundred measurements each. Days are counted since January 1, 1990.*

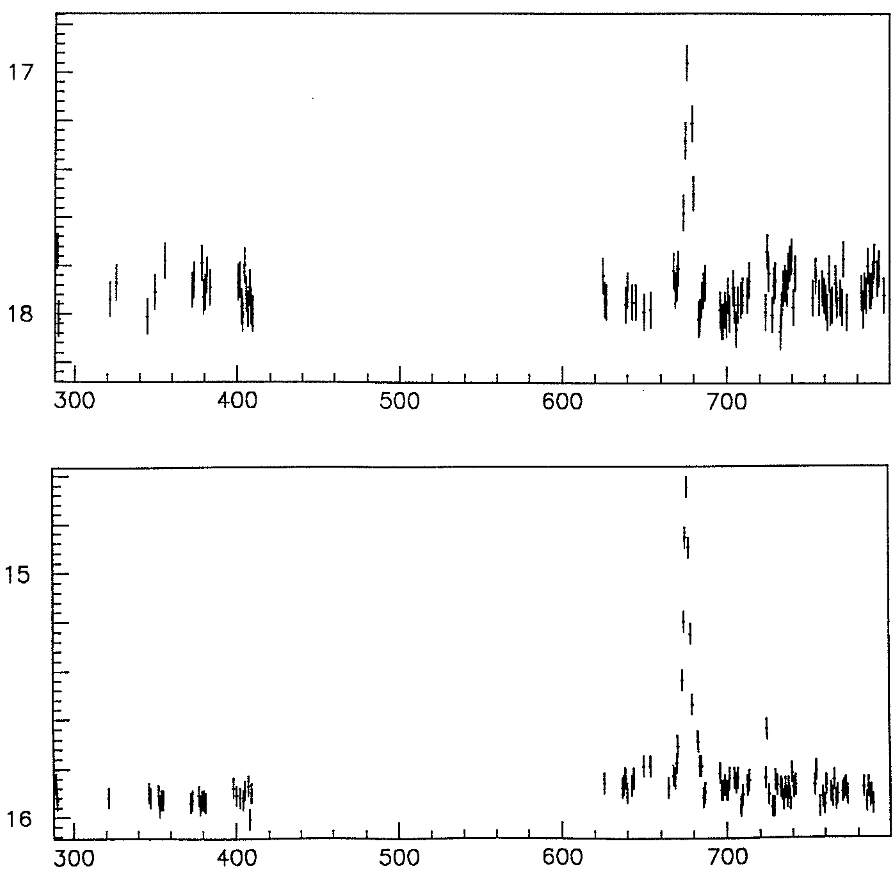


Figure 9: *A Monte-Carlo simulated microlensing event for the 1990–92 period. The blue (up) and red (down) light curves contain about one hundred measurements each. Days are counted since January 1, 1990.*

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E. Aubourg, Ph. D. thesis (1992), Saclay preprint DAPNIA/SPP 92–22;
L. Moscoso and M. Spiro, *Nucl. Phys. B (Proc. Suppl.)* **28A** (1992) 267;
R. Ansari, talk given at the IVth Rencontres de Blois, Orsay preprint LAL 92–46;
L. Moscoso, talk given at the XVth International Conference on Neutrino Physics and Astrophysics (Neutrino 1992), Saclay preprint DAPNIA/SPP 92–27.

[6] E. Aubourg et al., in preparation.
[7] J. Berger et al., *Astron. Astrophys. Suppl. Ser.* **87** (1991) 389; J. Guibert and O. Moreau, *The Messenger* **64** (1991) 69.
[8] L. Vigroux et al., IAU *Working Group on Wide-Field Imaging Newsletter* **3** (Royal Observatory, Edinburgh, February 1993); L. Vigroux et al., *The Messenger* **71** (March 1993) 44.

First Optical Identification of an Extragalactic Pulsar

The recent identification of the optical image of a pulsar in the Large Magellanic Cloud is a fine illustration of astronomy as a high-tech international science. It is the first extragalactic pulsar to be so identified and only the third radio pulsar, after those in the Crab and Vela nebulae in the Milky Way, for which this has been possible.

The conclusive observations were made in early 1993 by astronomers from Ireland, Denmark and ESO[1] with TRIFFID[2], a new, powerful instrument of their own design, used together with the ESO MAMA[3] detector system and attached to the 3.5-metre New Technology Telescope (NTT) at the ESO La Silla observatory in Chile. Earlier observations by Italian astronomers with the same telescope were crucial for the success of this research project.

A Spinning Neutron Star in the Large Magellanic Cloud

The Large Magellanic Cloud (LMC), a satellite galaxy to the Milky Way galaxy in which we live, is one of the most studied objects in the sky. In addition to several millions of stars it also contains a great number of nebulae of gas and dust. Some of these have been found to be the remains of gigantic supernova explosions in the past when heavy stars in the LMC became unstable and blew up. The most recent happened as late as in February 1987, when Supernova 1987A became the first naked-eye supernova in 400 years.

One of these nebulae has a circular shape with a diameter of about 6 arcseconds; it is believed to be the remnants of the penultimate LMC supernova which exploded some 760 ± 50 years ago; this age is deduced from the expansion rate of the nebula. In 1984, a group of American astronomers studied the data from the Einstein X-ray satellite observatory and found that pulsed X-rays are emitted from the direction of this nebula. The measured pulsation frequency is unusually high and has now been refined to 19.838 Hz (pulses per second).

This is explained by the presence of a pulsar somewhere inside the nebula, that is an extremely compact neutron star which weighs as much as the Sun, but has a diameter of 10–15 kilometres only. It was created by enormous pressures during the supernova explosion. The observed pulses indicate that it is now spinning around its axis once every 0.05 seconds. The nebula in which it is imbedded contains the rest of the material that was thrown out during the explosion.

The new object received the designation PSR 0540-693 (the numbers indicate its approximate position in the sky). Because of its many similarities with the Crab pulsar and nebula, it has also been nicknamed the Crab Twin.

Due to the large distance to the LMC, of the order of 160,000 light-years, it has not been possible, until recently, to measure the very faint radio emission from this pulsar with southern radio telescopes. The X-ray observations only fix the pulsar position within a circle with a diameter of about 4 arcseconds (the "X-ray error circle"), and since detailed radio observations cannot be made of this faint radio source, it is impossible to determine the position of PSR 0540-693 with sufficient accuracy to permit identification of its optical image. Variations of the optical emission with the above X-ray frequency were measured in the mid-1980's from the general area of the nebula, but the image sharpness achievable with the astronomical telescopes available at the time did not allow the detection of a star-like object inside the relatively bright nebula.

Narrowing Down the Choice

This was the situation in early 1992 when a group of Italian astronomers[4] obtained images of the field around PSR 0540-693 with the ESO NTT.

Thanks to excellent weather conditions, the remarkable optical quality of the NTT and the fine performance of the ESO SUSI high-resolution CCD camera, they were able to record the most detailed images ever made of this region. Although the comparatively strong light from the nebula tends to "wash out" any details within its confines, they detected for the first time the presence of two star-like objects inside the nebula. Both were much fainter than the nebula itself; they are located in the south-west area of the nebula (near the edge of the X-ray error circle) and are separated by about 1.3 arcseconds. (See the photo on page 28).

Because all of the exposures necessarily lasted much longer than the 0.05 second pulse interval, these observations did not permit to decide if any of the two had a variable light intensity and might therefore be the pulsar. Still, when the Italian astronomers published their new results[5], they remarked that the northernmost of the two objects was more likely to be the pulsar; this image was somewhat more star-like (sharper) than the other one and a jet-like symmetrical structure appeared to be exactly centered on it.

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[1] The group consists of Andy Shaerer, Mike Redfern and Peter O'Kane from the University College Galway (Ireland), Holger Pedersen from the Copenhagen University Observatory (Denmark) and Martin Cullum from ESO.

[2] TRIFFID = TRansputer Instrument For Fast Image Deconvolution. This image sharpening camera was built by the University College Galway in collaboration with the Dunsink Observatory of the Dublin Institute for Advanced Studies (DIAS). The construction of TRIFFID and the observational programme which lead to the identification of the pulsar were funded by EOLAS, the Irish Science & Technology Agency.

[3] MAMA = Multi-Anode Microchannel Array.

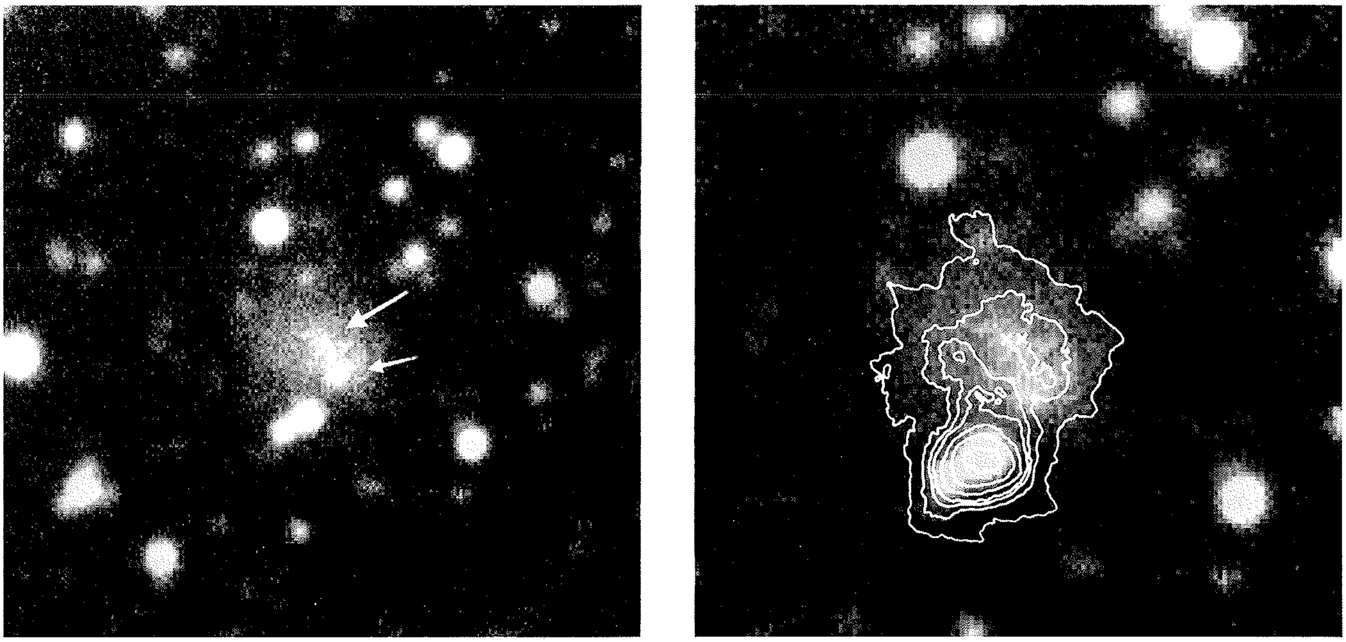
[4] This group consisted of Patrizia Caraveo, Giovanni Bignami, Sandro Mereghetti from the Istituto di Fisica Cosmica del CNR and Marco Mombelli from the Dipartimento di Fisica, Università degli Studi, Milan, Italy.

[5] In *The Messenger* (No. **68**, page 30; 1992) and the *Astrophysical Journal* (Vol. **395**, page L103; 1992).

New ESO Publications

SCIENTIFIC REPORT No. 12: "Second Catalogue of Stars Measured in the Long-Term Photometry of Variables Project (1986–1990).

OPERATING MANUAL No. 17: "Remote Control of the 3.5 m New Technology Telescope at the European Southern Observatory – User Guide."



This composite photo shows the optical image of the first extragalactic pulsar to be so identified. It is situated in a small nebula in the Large Magellanic Cloud, a satellite galaxy to our Milky Way. This nebula is the remnant of a supernova explosion which took place about 760 years ago and also created a rapidly spinning neutron star which is now observed as a pulsar.

On the left photo is shown the CCD image obtained by Patrizia Caraveo and collaborators in 1992; it is a two-minute exposure through a V-filter with the ESO New Technology Telescope (NTT). Two star-like objects are seen in the nebula; they are indicated with arrows. The northernmost (upper) one is more centrally placed in the nebula and was presumed to be the image of the pulsar.

This has now been confirmed by Andy Shearer and collaborators on the basis of observations with the new TRIFFID/MAMA instrument at the NTT in January 1993. In the right picture, the observed isophotes have been superposed on the 1992 photo. The two crosses indicate the positions from where the strongest 19.838 Hz optical signal was independently detected on two different nights. It is obvious that they are very close to the central object and that this is the pulsar, not the more southernly one.

The pixel size is 0.13 arcseconds. North is up and east is to the left.

Catching Individual Photons

The observations which have now led to the unambiguous identification of the pulsar image were performed during 3 nights in January 1993 at the ESO NTT by the Irish/Danish/ESO group. Their new instrument, TRIFFID, together with the ESO MAMA detector, has the ability to record individual photons as they arrive at the telescope. The observational data consist of the exact position and time of arrival of each photon that comes from the sky field towards which the telescope is pointed. Common CCD images "add" together the photons during the exposure and therefore only permit to measure positions. It is exactly the information about the photon arrival times recorded by TRIFFID/MAMA[6] which is of crucial importance for the identification of objects with rapidly varying light intensity.

To the astronomers' great dismay, the weather was not very good during the observations. The atmospheric turbulence was rather high and the recorded images were not as sharp as they had hoped for. As planned, the astronomers spent most of their time at the telescope recording the photons from the most recent LMC supernova, SN 1987A. They did not detect the elusive pulsar in that object, but were nevertheless able to set very stringent limits on its brightness.

In order to test their new equipment they carefully observed the Crab pulsar and also PSR 0540-693. The latter was observed about 90 minutes during two nights. But while the observations lasted only a short while, the subsequent data analysis at University College Galway[7] turned out to be very time-consuming.

The technique consisted of analysing the arrival times of photons in different parts of the field. To begin with, all photons detected in each square of a coarse area grid were put together and a time series analysis was performed to see if any of the squares displayed any periodicities. Already at this stage, and despite the very few photons and the statistical nature of light, the 19.838 Hz frequency could be clearly detected in the general area of the nebula. By successively diminishing the grid size, it was found that this photon periodicity was most significant in one small area with a diameter of less than 1 arcsecond. The positional centre of the corresponding photons could be determined with an accuracy of about 0.4 arcsecond.

The independent data obtained on two observing nights showed a positional coincidence better than 0.2 arcseconds and also corresponded within this uncertainty with the position of the northernmost object in the Italian astronomers' picture. The perfect coincidence, in position as well as in the pulse frequency, is the basis for the definitive identification of the pulsar's optical image. After more than three months of hard work the group was able to make the important announcement about their discovery on Circular 5786 of the International Astronomical Union on May 10, 1993.

The magnitude of the optical image of PSR 0540-693 is about 22.5 and its relative faintness is illustrated by the fact that only about 2 photons per second were detected from it during the NTT observations.

[6] For its normal function of producing high-resolution images, TRIFFID also uses the RAL-PCD photon counting camera, produced by the Space Science Group at Rutherford-Appleton Laboratory UK.

[7] Ray Butler and Chris O'Byrne, PhD students at Galway, were involved in the development and recording and processing systems for TRIFFID and Torsten Rowold, visiting student at Galway, performed much of the data analysis.

Why is the Identification of the Pulsar so Important?

Being only the third radio pulsar for which the optical image has been found, PSR 0540-693 now belongs to a most selected and interesting group of objects. It is now possible to concentrate future observations to the corresponding optical object and to better exclude the disturbing background light from the surrounding nebula. There is no doubt that it will be very thoroughly studied by large optical telescopes during the coming years and the groups have already applied for additional observing time at ESO as well as with the Hubble Space Telescope.

When the direction to the pulsar is known with the highest achievable precision, it is possible to take correctly into account all the various effects introduced by the Earth's uneven motion and thereby to combine observations of individual pulses accurately over long periods. This will allow to properly measure the progressive lengthening of the pulsar period, the exact value of which is of key importance for understanding the pulsar mechanism. Of the 550 pulsars presently known, this measurement has only been made for the two youngest ones, the pulsar in the Crab Nebula and PSR 1509-58. The age of PSR 0540-693, as deduced from the lengthening of its rotation period, is not yet well determined, but it is likely to be the third youngest known.

In this connection, note also the recent identification by the Italian group of the nearby, but radio-quiet pulsar, Geminga, see *The Messenger* **No.** 70, p. 30.

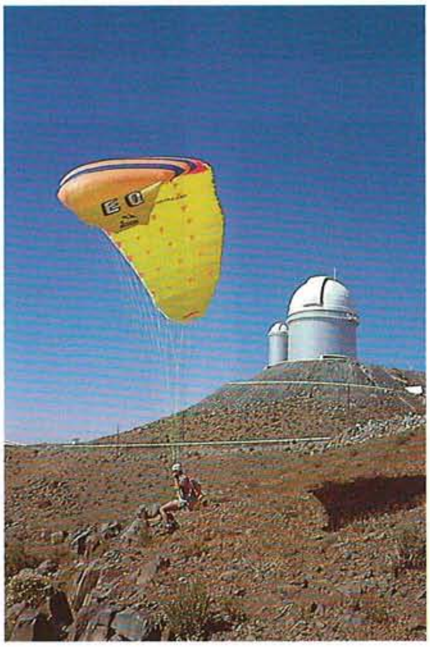
From ESO Press Release 4/93, June 3, 1993.

"El Cóndor Loco" Tests the La Silla Winds!

After many long and exciting nights at La Silla during my time as "French cooperant" in 1992–93, I enjoyed a few times the thrill of testing in a very special way the wind patterns around that mountain.

Everybody knows of course how important it is to study the local atmospheric conditions around observatories in connection with the seeing investigations, etc. Astronomers all around the world are doing so, and when you can combine the "useful" with the pleasent, why not? True, I must admit that I could not avoid a certain feeling that this particular method of aerodynamic investigation may not have been entirely permitted at La Silla, but if you have ever tried to imitate the peaceful and majestic condors of the Andes, then it is very difficult not to attempt it.

This picture was taken by Marc Moniez and is for me an unforgettable souvenir of this good old time. Hoovering around the mountain, I experienced the beautiful site of the ESO observatory as no astronomer has ever before (and probably also after) me.



Beware! I absolutely do not recommend other potential astronomical paraglider pilots to follow me unless they have a very thorough experience indeed. The airflow conditions around La Silla, as it turns out, are not ideal for such flying; this is also common knowledge among the poor photographers who, hanging dangerously in open doors of one-engine planes, have obtained photos of the observatory in impossible angles. I did come back from Chile with some (fortunately minor) holes in my gossamer wings, punctuated by a stray cactus at the time of a rough landing.

If they follow my advice, they should rather go to "Cerro Grande" above the La Serena bay where they will encounter good conditions for dynamic flight in non-turbulent conditions ensured by the wind from the sea. Or for long summer flights, go to "Batuco", some 20 kilometres north of Santiago. You can also easily fly at the various ski resorts above Santiago, and the very best is the "Cerro Providencia" flight, 2,500 metres above the Chilean capital – an experience, I promise, that you will never forget!

A todos los que se acuerdan todavía del "cóndor loco".

B. ALTIERI, ESA/ESTEC, Noordwijk, The Netherlands

TRIFFID Imaging of 47 Tuc on the NTT

M. REDFERN[1], A. SHEARER[1], P. O'KANE[1], M. CULLUM[2], C. O'BYRNE[1], R. BUTLER[1], B. JORDAN[3]

[1] Department of Physics, University College Galway, Ireland; [2] European Southern Observatory, Garching, Germany; [3] Dublin Institute for Advanced Studies, Dublin, Ireland

The four images shown here illustrate the observational possibilities with TRIFFID, the TRansputer Instrument For Fast Image Deconvolution which was used to identify the optical image of the pulsar PSR 0540-693 in the LMC, cf. page 27 in this *Messenger* issue.

The processing of these frames is still quite preliminary – various techniques are proving promising and are being incorporated into a single flexible process. The amount of processing is quite horrendous. Image files contain pixel addresses and times for every single photon – a maximally uncompressed

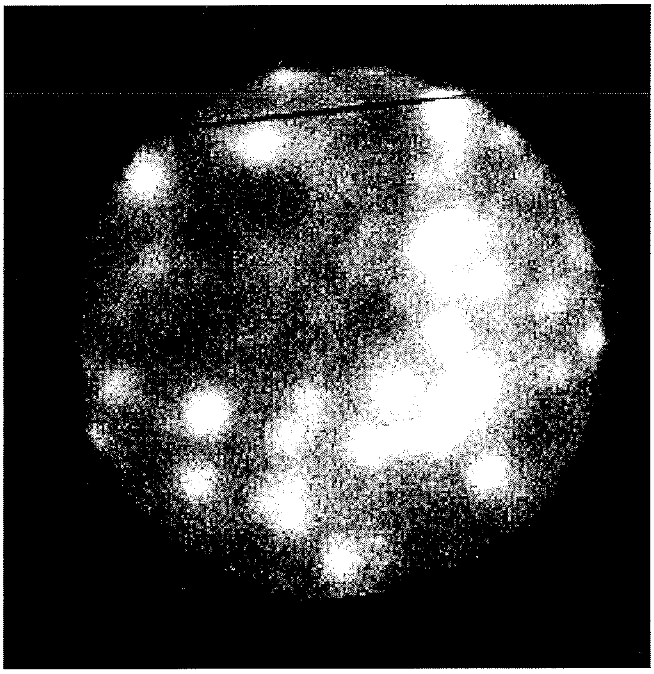


Figure 1.

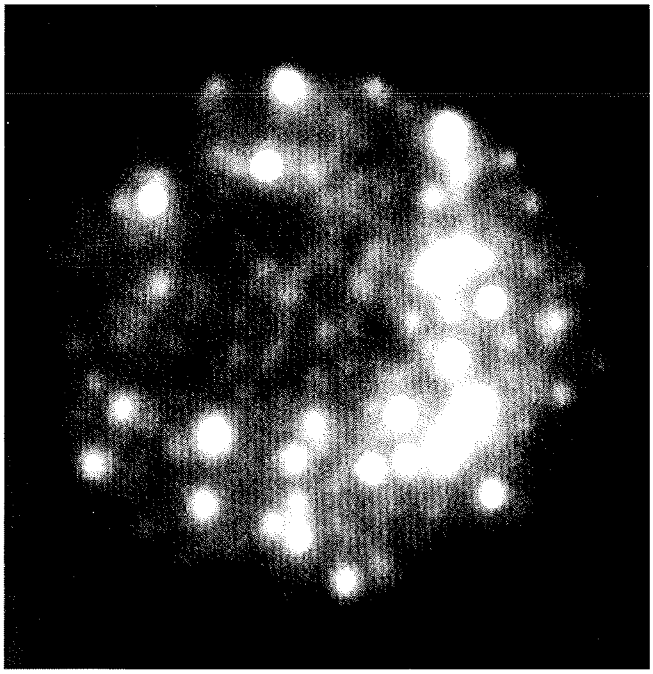


Figure 2.

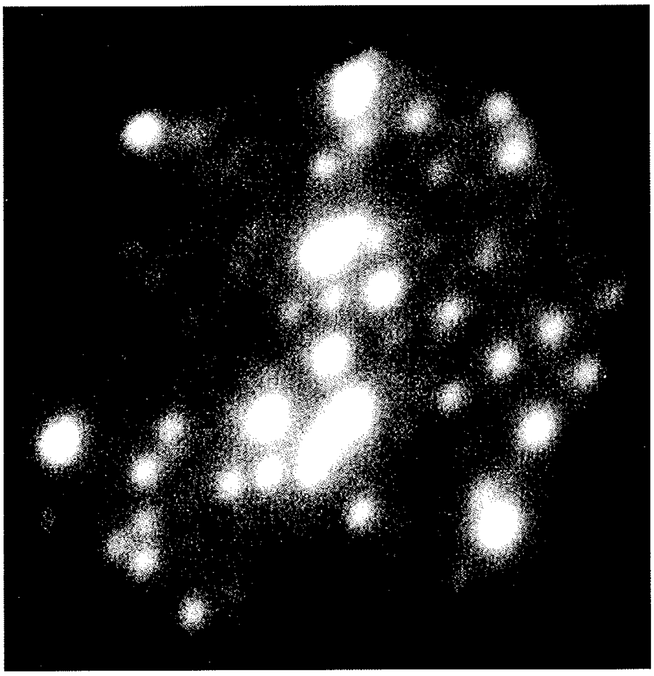


Figure 3.

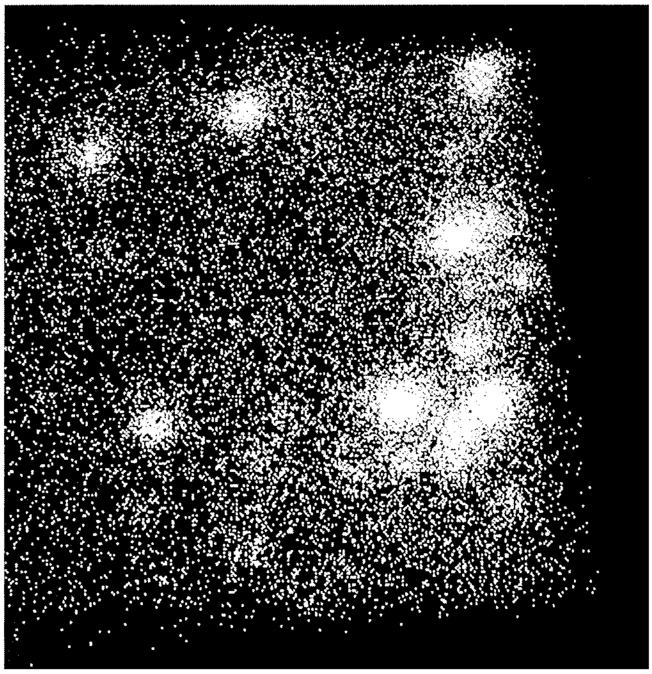


Figure 4.

format. There are altogether about 25 Gbytes of such numbers to process. Fortunately we have recently been able to increase our in-house processing power considerably and we now have 3 HP9000 series workstations (710, 720, 735) boosted by Transputer and TMS320C40 DSP networks.

Here are some details about the individual images:

Figure 1: MAMA images of the optical centre of 47 Tuc taken with TRIFFID on the NTT August 22, 1992. The optical scale was 0.″087 per pixel. There were no filters so the predominant response was blue (from the photocathode response). The seeing was actually rather poor after a very stormy period. The raw image has a half width of >1.″0. The zenith distance was > 50° – the raw image is 5 minutes integrated and de-rotated only. At this time it was not possible (for software reasons) to use the NTT de-rotator platform so software de-rotation was necessary – this has now been fixed. The magnitude of the brightest star in the field is ~15. The data are from one sub-pupil only of 0.57 m diameter, which is matched to the (rather poor) seeing. Note the missing row of pixels, which is due to one of the anode strips becoming internally disconnected.

Figure 2: 30 minutes of the same dataset integrated, de-rotated and sharpened by shift-and-add only (no frame selection). The image width has improved to 0.″6, which is close to the theoretical limit of improvement of a factor 2. Note that the missing row of pixels has vanished. This is due to the fact that in the missing row the photons are piled up in the adjacent row – the process of shifting smooths out the pile-up. Image motion was determined from the weighted centroid position of a "composite star" formed by the co-addition of the brightest 10 stars in the field and integrated with a variable time-weighting determined by the seeing rather than using a slab integration. The time

weighting is performed by creating a (Weiner) temporal filter matched to the correlation properties of the atmosphere on a particular occasion. In this way one can achieve the highest possible number of reference photons (avoiding purely statistical fluctuation in centroid position) without integrating into the image genuine atmospheric movement. In the case of a bright reference the effective integration time can be reduced. The star profiles of the sharpened image have rather sharp cores indicating that a further stage of improvement can be expected from image selection – we would also expect that there will be a further improvement when the centroid is determined by reference to the brightest region in the composite reference, a method which we have previously demonstrated with MAMA data (of M15, using the 4.2-m WHT). In a number of cases groups have stars that have become resolved in the sharpened image compared to the raw image – which would have been considered to be of good resolution until recently.

Figure 3: TRIFFID has the ability to perform image sharpening in two colours simultaneously. The MAMA is used on a straight-through optical path to perform blue imaging and to give information about image motion and width. The same information is applied to the side-arm detector, which is in this case the RAL-PCD, imaging in the red. The RAL-PCD is an image intensifier plus CCD real-time centroiding photon-counting camera. A narrow strip of the photocathode (50 by 500 pixels) is read out every 7 milliseconds, which produces 200 by 2,000 pixels after centroiding in an array of Transputers. The image scale is 1.7 times larger than the MAMA. The image is the result of derotation and sharpening using the MAMA centroid – the resultant resolution is 0".7, comparable with that of the MAMA. The field looks quite different from the blue image.

Figure 4: The side-arm image sharpening does not have the same requirement for large numbers of reference photons which plagues most high-resolution imaging techniques – since the sharpening information is transferred from the straight-through arm. In fact, the Hα image displays the best final resolution at 0".5 – the maximum gain allowed in theory. One purpose of narrow band imaging in the crowded centre fields of globular clusters, for example, is to look for activity which might be indicative of the presence of a cataclysmic variable star.

These images were achieved in conditions of only moderate seeing. In better seeing we have demonstrated that the process improves faster than the relative improvement in seeing. In better seeing the pupil sizes can be increased (this sort of image sharpening optimally uses pupils which are 3.5–4 times the diameter of the diffraction-limited telescope which would reproduce the seeing-limited image width), thereby increasing count rates, thereby changing the optimization between Weiner filter width and atmospheric correlation time.

This work has been partly supported by EOLAS – The Irish Science & Technology Agency – and by the University College Galway Development Fund.

Wolf-Rayet Stars Beyond 1 Mpc: Why We Want to Find Them and How to Do It

G. TESTOR, Observatoire de Paris, Section de Meudon, DAEC, France
H. SCHILD, Dept. of Physics and Astronomy, University College London, UK

1. Why

Wolf-Rayet stars are luminous objects with broad and conspicuous emission lines. In principle they can be observed out to large distances. Over many years of intensive search and with contributions from many workers, a practically complete catalogue of the WR population in the Magellanic Clouds has been obtained. In other local group galaxies similar searches were conducted and individual WR stars have been identified in most of them.

Here we report about our efforts to extend this search beyond the local group into the Sculptor group of galaxies. We selected NGC 300 as a suitable member of this group because its inclination to the line of sight is relatively small. Its distance modulus of 26 mag corresponds to 1.5 Mpc thus giving a scale of 7 pc per arcsec and allowing under good seeing conditions to resolve areas of about 6 pc. In spite of the low spatial resolution we expect that most of the WR stars can be observed individually, i.e. uncontaminated by other WR stars. If we take the spatial distribution of WR stars in the LMC as a guideline, we see that about half of them are located in large OB associations (15 pc to 150 pc) (Breysacher, 1988) and almost all of the others are widely scattered in the galaxy (Pitault, 1983). Only a few per cent are found in dense structures like the tight clusters (≤ 5 pc) in the 30 Doradus area (Moffat 1987, Schild and Testor 1992). Such 30 Dor-like concentrations of massive stars are extremely bright and can be observed to distances even far beyond the Sculptor group. Broad WR emission features have indeed been found in many giant H II regions and H II galaxies (see eg. Arnault et al. and references therein). From these objects we can however only obtain synthetic information about the population of the massive stars as a whole. If possible, it is preferable to trace WR stars individually and consequently to study them in various environments because:

- The frequency and subtype distribution of WR stars in a galaxy provides fundamental clues in relation to stellar evolution theory. Metallicity effects are currently thought to dominate most aspects of a WR population (see e.g. Azzopardi et al. 1988, Arnault et al. 1989). The size of the convective core of a massive star together with mass loss processes which remove the outer hydrogen rich layers determine the predicted number of WR stars and the WN/WC ratio at various metallicities (Maeder 1991).
- Deep spectroscopic observations of WR stars in M33 have established the existence of unusually narrow-lined early WC stars, a type of WR star which was not previously known to exist. The relation between subtype and line width found for galactic WC stars does not hold for these stars. The breakdown of this relationship is unlikely to be a pure metallicity effect and remains unexplained.
- WR stars are highly evolved objects

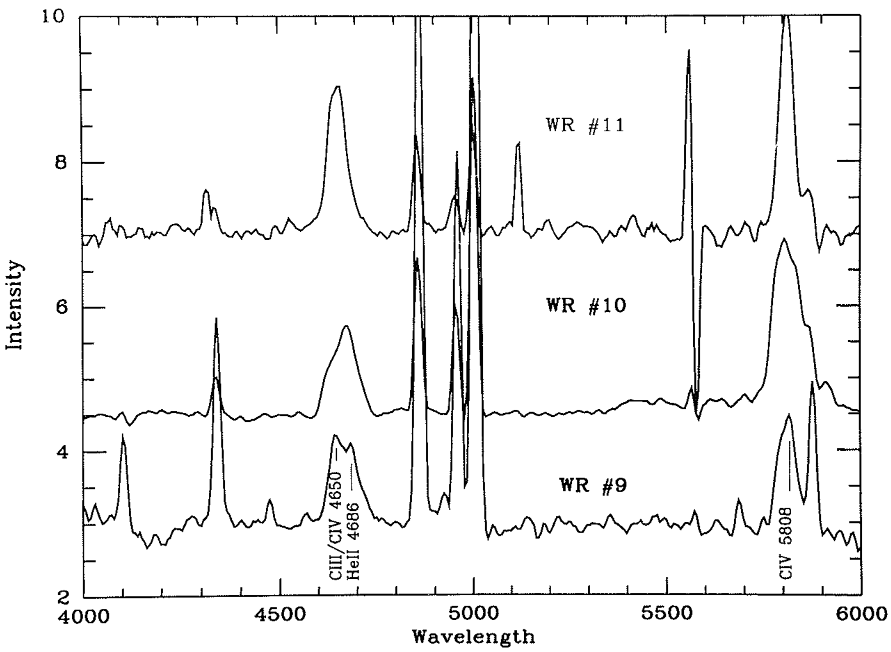


Figure 1: *Normalized spectra of WR stars number 9, 10 and 11.*

and are rapidly approaching the end of their stellar lifetime. Whether they explode as a (faint?) supernova or collapse into a black hole is unknown. Theory is unlikely to provide unambiguous answers. It is therefore important to increase the number of known WR stars to a maximum in order to increase the chances for such an event to be observable. It is incidentally an intriguing thought that the light travel time from NGC300 is much longer than the remaining lifetime of the WR stars in this galaxy and therefore these stars no longer exist today.

2. How

We decided to look into the possibilities of exploring the WR population in NGC300 with present-day ESO instrumentation. EFOSC with its high efficiency and versatility was the obvious choice. Two narrow-band filters, one centred on the strong WR emission lines between λ4650 and λ4690 Å and the other in the adjacent continuum were mounted in the filter wheel. Promising candidates could immediately be confirmed (or otherwise) by switching into spectroscopic mode. We obtained the first trial images during the night of 31 December 1989. Most surprisingly, it was possible to recognize three WR candidates already visually by just comparing the two images. Spectroscopic observations immediately confirmed the WR nature of these stars (Schild and Testor 1991). Subsequent analysis of the images with DAOPHOT revealed more candidate WR stars. We were allocated 3 nights in October/November 1991 to continue the search but the observations were hampered by bad weather and bad seeing conditions. Nevertheless we were able to obtain spectra for a handful of our candidates and confirm them as WR stars (Schild and Testor 1992).

Now we report further recent progress: Three new WR candidate stars were found and one of them was confirmed spectroscopically. We also give spectral types for the remaining WR stars No. 9 and 10 without spectra in Schild and Testor (1992). These slit spectra were obtained during the night of 31 December 1992 with the ESO 3.6-m telescope and EFOSC. We used the B300 grating giving a wavelength coverage from 3700 to 7000 Å and a resolution of 15 Å with a slit of 2″. The observations were recorded with a 520 × 570 pixel Tektronix CCD (ESO # 26). The pixel size of 27 μm projects to 0.61″ on the sky. The seeing was good (FWHM = 1″).

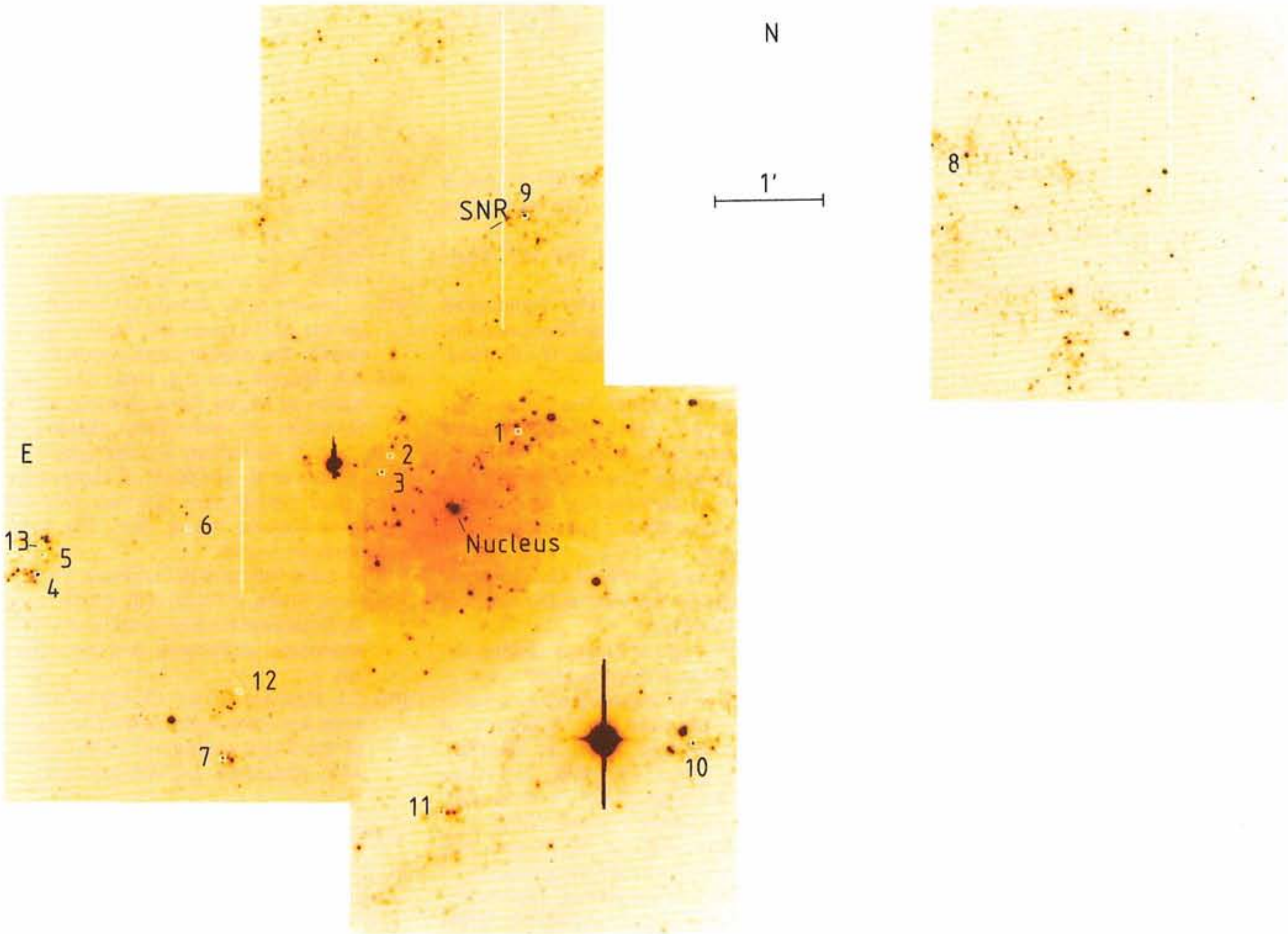
The spectra of the WR stars No. 9, 10 and 11 are shown in Figure 1. Star 9 is the brightest source (stellar or tight cluster) in a giant stellar association of about 100 pc diameter. We previously found a WR excess of 0.6 magnitude in the narrow-band filter images for this star. This is consistent with the spectrum which seems to be of composite WN + WC type. Figure 3 shows the spectrum of WR 9 (top) in the range λ5600 to λ6800 Å. The broad CIV λ5808 emission line is clearly visible. A supernova remnant located 8 arcsec east of star 9 was observed serendipitously (Fig. 3, bottom). The slit passed over the edge of the remnant but the high velocity dispersion in the Hα line (600 km/sec) still is well recognizable. The supernova remnant coincides with the HII region No. 79 of Deharveng et al. (1988).

WR 10 is also located in a giant cluster. It has a large WR excess (Schild and Testor 1992) and accordingly, the spectrum shows strong CIV λ4650/HeII λ4686 and CIV λ5808 emission lines. We classify the object as WC4. Two arcmin south-east of No. 10, we found a further star with a strong WR excess: WR 11. It is located in the HII region numbered 90 by Deharveng et al. (1988). The spectrum shows strong CIV λ4650 and CIV λ5808 emission and we classify it as WC4–5. Two further stars with a large excess and very likely WR stars are: No. 12 in the HII region 118 (Deharveng et al. 1988) and No. 13 lying just north of WR star 5. These stars are at present only WR candidates and require spectral confirmation.

Table 1: *List of presently known WR stars in NGC300. Most WR stars are located in HII emission regions and the corresponding numbers of Deharveng et al. (1988) and the integrated Hα fluxes (in 10^{-16} erg s^{-1} cm^{-2}) are listed. The deprojected distance from the galactic centre ϱ* is given in arcmin.

WR	Type	HII region	Hα intensity	ϱ
WR1	WC4–6	76b	1162	0.87
WR2	WNE	98	290	1.09
WR3	WC4–5			
WR4$^{\alpha}$	WN3–6	137a	8214	3.91
WR5$^{\alpha}$	WC4–5	137b	5393	3.90
WR6	WC4–6	—		2.54
WR7$^{\alpha}$	WN7	119b	2074	3.33
WR8	WNE			5.47
WR9$^{\alpha}$	WC+WN	77	4397	3.45
WR10$^{\alpha}$	WC4	53b	3300	3.86
WR11$^{\alpha}$	WC5	90	1200	3.57
WR12		118a	4978	2.82
WR13$^{\alpha}$		137b	8214	3.91

$^{\alpha}$ indicates that the Wolf-Rayet star is a member of a giant stellar association.



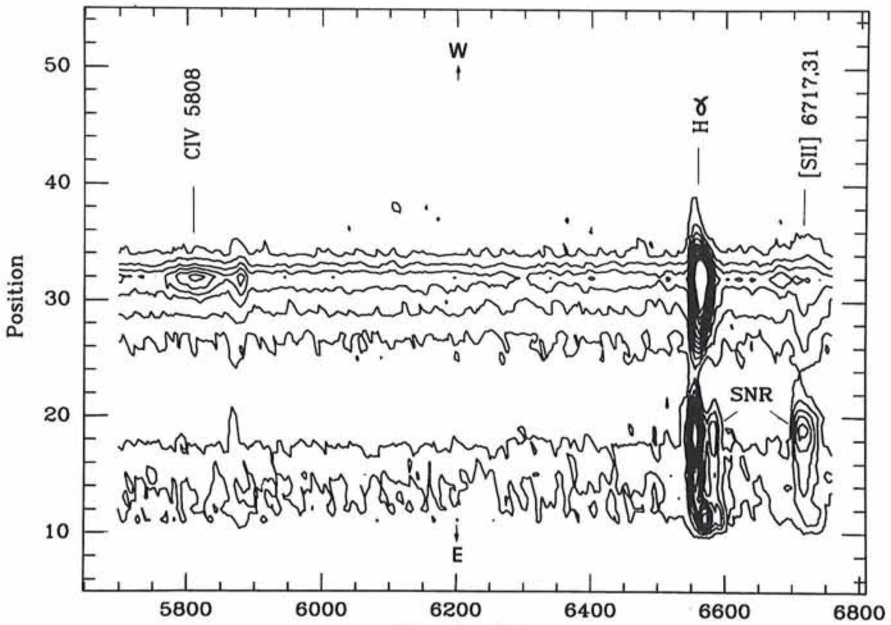


Figure 2: *Mosaic view of the parts of NGC300 which have been surveyed. The images were taken through an interference filter in the light of the WR emission feature between λ4650 to λ4690 Å. The position of the 13 WR stars listed in Table 1 are marked. The location of the serendipitously discovered supernova remnant near WR 9 is also shown. The images of the two brightest stars are heavily saturated and show vertical stripes.*

Figure 3: *Spectrum of WR 9 (top westwards) and a supernova remnant (bottom eastwards) in the range λ5600 to λ6800 Å. Note the CIV λ5808 emission feature in the spectrum of the WR star and the velocity dispersion of about 600 km/sec, the strong [NII] λ6584 and [SII] λ6717,31 emission lines in the SNR spectrum.*

In Figure 2 we present a view of the parts of NGC300 which we have imaged so far. The positions of the 11 confirmed WR stars and the 2 candidates are marked. We note that a majority of WR stars were found at galactocentric distances betweeen 3 and 4 arcmin (Table 1). This indicates that, like in other galaxies, recent formation of massive stars predominantly occurred in a ring-like structure. In Table 1 we list spectral types and data about the stellar and nebular environment of these WR stars. The spectra of many of them are of early WC type but this may be an observational selection effect because this type of WR star has particularly strong emission lines at λ4650.

Future observations will undoubtedly turn up more WR stars in NGC300. We plan to continue our search and will in a first step observe spectroscopically more of our candidate WR stars. So far all of our candidates have turned out to be WR stars because we selected first those with a large WR excess. We expect that we will however soon reach the threshold where the excesses are not very significant anymore. The continuum magnitudes of the WR stars are typically 20–21 mags and there are probably many more which are fainter. Although present day instrumentation clearly allows individual WR stars to be observed at distances beyond 1 Mpc, we find that we use it close to its limitations. In the longer term it will be necessary to use larger telescopes such as the VLT in order to complete the survey.

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NEW ESO PREPRINTS

(March–May 1993)

Scientific Preprints

909. T.R. Bedding et al.: MAPPIT: Optical Interferometry with Non-Redundant Masks.
T.R. Bedding et al.: The VLT Interferometer.
Papers presented at IAU Symposium 158, "Very High Angular Resolution Imaging", Sydney, Australia, 11–15 January 1993.
910. G. Setti and L. Woltjer: The Gamma-Ray Background. *Astrophysical Journal Supplement.* Special issue of the Integral Workshop on "The Multi-Wavelength Approach to Gamma-Ray Astronomy", 2–5 February, 1993, Les Diablerets, Switzerland.
911. G. Meylan and C. Pryor: Observational Constraints on the Internal Dynamics of Globular Clusters.
P. Dubath et al.: Is There a Central Velocity Dispersion Cusp in M15?
To appear in the proceedings of a workshop in "Structure and Dynamics of Globular Clusters", held in Berkeley, California, July 15–17, 1992, to honour the 65th birthday of Ivan R. King. ASP Conference Series, in press (1993).
912. A. Sandage and G.A. Tammann: The Hubble Diagram in V for Supernovae of Type Ia and the Value of H_0 Therefrom.
913. P. Padovani and F. Matteuccl: Stellar Mass Loss in Ellipticals and the Fuelling of Active Galactic Nuclei. *The Astrophysical Journal.*
914. E. Oliva: The O I-Lyβ Fluorescence Revisited and its Implications on the Clumping of Hydrogen, O/H Mixing and the Pre-SN Oxygen Abundance in SN 1987A. *Astronomy and Astrophysics.*
915. L. Binette et al.: Effects of Internal Dust on the NLR Lyman and Balmer Decrements. *The Astrophysical Journal.*
916. P.A. Mazzali and L.B. Lucy: The Application of Monte Carlo Methods to the Synthesis of Early-Time Supernovae Spectra. *Astronomy and Astrophysics.*
917. J. Martí et al.: HH 80-81: A Highly Collimated Herbig-Haro Complex Powered by a Massive Young Star. *The Astrophysical Journal.*
918. M. Della Valle and H. Duerbeck: Study of Nova Shells. I: V1229 AQL (1970) Nebular Expansion Parallax and Luminosity at Maximum. *Astronomy and Astrophysics.*
919. I.J. Danziger et al.: Optical Spectroscopy and Photometry of the Companion of the Bright Millisecond Pulsar J0437-4715. *Astronomy and Astrophysics.*

Technical Preprint

51. B. Lopez and M. Sarazin: The ESO Atmospheric Temporal Coherence Monitor Dedicated to High Angular Resolution Imaging. *Astronomy and Astrophysics.*

Mapping the Large-Scale Structure with the ESO Multi-Slit Spectrographs

V. DE LAPPARENT, C. BELLANGER, S. ARNOUTS, Institut d'Astrophysique de Paris, France
G. MATHEZ, and Y. MELLIER, Observatoire Midi-Pyrénées et de Toulouse, France
A. MAZURE, Université des Sciences et Techniques du Languedoc, France

Preliminary Remarks

During the past decade, our understanding of the large-scale galaxy distribution has evolved drastically through the steady acquisition of redshifts of galaxies. The major optical redshift surveys of the nearby distribution ($B \leq 14.5-15.5$) are being performed using partly-dedicated telescopes of small diameter (1.5 m) or significant fractions of observing time in general facilities (see for example references [1], [2]. In these surveys, the projected density of objects is of the order of one per square degree, requiring the acquisition of the spectra one by one.

Mapping the galaxy distribution out to larger distances – and thus to fainter limiting magnitudes – requires the use of intermediate and large-size telescopes. The decrease in flux is largely compensated by the increasing projected density of galaxies, yielding a high rate of data acquisition in terms of number of redshifts per night. Multi-fiber spectrographs on 2.5 to 3.5-m telescopes allow to obtain simultaneously spectra of tens of galaxies in fields of the order of the square degree out to limiting magnitudes in the range $B = 18-20$. In these configurations, more than 100 spectra can be obtained per observing night [3], [4].

Whereas optical fibers offer a convenient way to cover fields of the order of one square degree, multi-slit spectrographs guarantee both efficiency in transmission and quality of the sky-subtraction for spectra of galaxies with limiting magnitudes $B = 22$ or fainter. The ever increasing projected density of objects allows to still benefit from the multiplex gain over the small area of a typical CCD. However, the loss in flux implies longer exposure times, and acquisition of a significant sample of objects at these magnitudes requires a large amount of observing nights on a 4-m-class telescope.

The quest for samples of galaxies which continuously increase in number of objects and/or effective distance originates from the charateristics of the galaxy distribution. Until recently, each

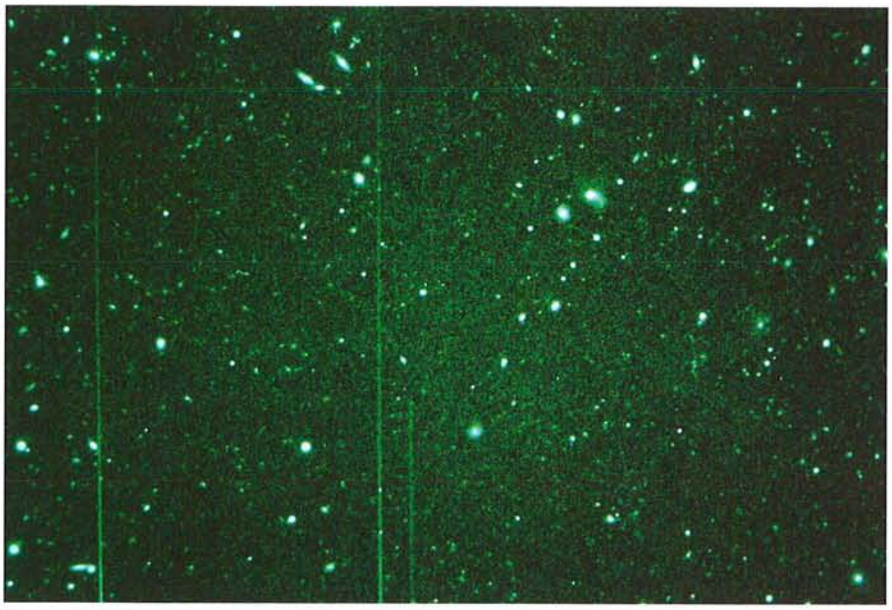

Figure 1: *A 5 × 7.5 arcmin region of a 20-minute NTT exposure with the R filter. The vertical spikes are caused by saturated stars. This field is rich in galaxies and future redshift measurements might show that it contains a cluster.*

increase in sample size has lead to the discovery of new and larger structures in the distribution. A striking picture of the galaxy distribution was suggested by the Center for Astrophysics redshift survey: galaxies appear to be distributed within dense walls delineating vast regions with diameters between 20 and 50 h^{-1} Mpc (with a Hubble constant H_0 = 100 h km s^{-1} Mpc^{-1}) devoid of bright galaxies [5], [6]. This description is in agreement with other wide-angle surveys [2], [7].

Because the depth of the nearby catalogues is ~ 100 h^{-1} Mpc, the largest size for the structures is poorly defined. It is shown that the size of the largest voids in the galaxy distribution is tightly constrained by the isotropy of the microwave background radiation within the standard theoretical model for the formation of large-scale structure [8]. Two on-going surveys (the Las Campanas Deep Redshift Survey using multi-fiber spectroscopy at the DuPont telescope [4]; and the Münter Redshift Survey Project using objective prism techniques at the UK Schmidt telescope [9]) probe the distribution at larger distances. These surveys suggest that the largest voids have diameters smaller than ~ 100 h^{-1} Mpc and that we might have reached the scale where the universe becomes homogeneous. The apparent periodicities on scales of ~ 128 h^{-1} Mpc in deep and narrow pencil-beam probes [10] can also be reconciled with this result when sampling effects and galaxy clustering are taken into account [11], [12].

In order to address the issue of the typical and largest size for the voids in the galaxy distribution, we have started a photometric and redshift survey of ~ 700 faint galaxies to $R \leq 20.5$ (corresponding to $z \lesssim 0.6$) over a region of ~ 0.4 deg^2. This on-going survey is performed in the context of an ESO Key Programme [13]. It was started at the 3.6-m with EFOSC [14] and has been continuing at the NTT with EMMI [15] since the availability of the multi-object spectroscopic (MOS) mode [16]. Although these instruments are mostly used for measuring redshifts in dense environment like clusters of galaxies, it is possible to take advantage of their multiplex capability over fields of average galaxy density when a limiting magnitude of R ~ 20.5 is reached.

Acquisition of Data

One great advantage of EMMI and EFOSC for our programme is the possibility to obtain both the photometric and spectroscopic data with the same instrument. This makes the observation schedule very flexible, and in particular it allows adjustment to variable weather conditions: when the conditions are photometric with good seeing, priority is given to direct imaging; when the weather degrades, we can switch to spectroscopy by simply rotating the aperture wheel which positions a previously punched mask into the optical path.

The photometry for the survey is obtained by a mosaic of CCD frames regularly offset by ~ 9/10 of the CCD size, thus providing many overlaps for subsequent checks of the photometry. Typical exposure times are 20 min in R, 25 min in V, and 30 min in B. Due to the steep decrease in quantum efficiency of the CCD's around 4500 Å, the B images are shallower than the R and V images. The obtained images are nevertheless significantly deeper than the limit of the spectroscopic survey (for example the R images reach magnitude ~ 24). Therefore, we shall be able to examine the counts of the fainter galaxies and compare the results among the three bands B, V, and R. Figure 1 shows an R image of one of the NTT frames. In Figure 2, an

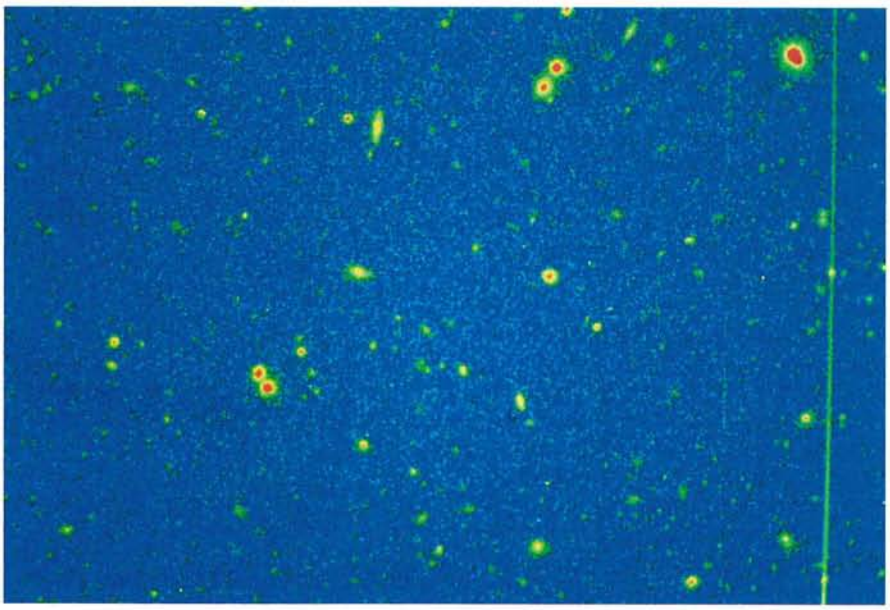

Figure 2: *False-colour enlargement of an NTT exposure with the R filter, showing a 2.5 × 3.7 arcmin region of a frame. The brightest galaxies in this image are in the magnitude range 19–21. The faintest galaxies have magnitudes ~ 23–24. For the latter objects we will not have spectra, but we shall be able to calculate their number counts as a function of magnitude.*

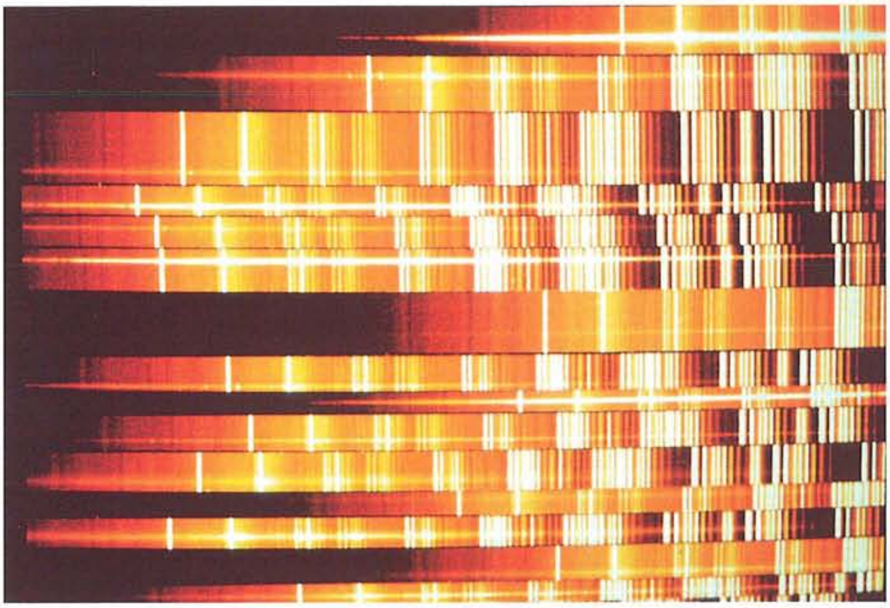

Figure 3: *Part of a 7.5 × 7.5 arcmin EMMI-MOS exposure of 1.5 hour (a 5 × 7.5 arcmin region is shown). Cosmic events have been removed and the frame has been divided by a spectroscopic flat-field exposure. The average slit lengths vary between ~ 10 and 30 arcmin. The dispersion is 230 Å/mm, and with the slit width of 1.3 arcsec, the resulting resolution is ~ 10 Å FWHM. Wavelength increases to the right. The numerous OH emission lines of the earth atmosphere are visible in the red part of the spectra.*

enlarged portion of another frame shows the typical galaxies for which we obtain MOS spectra. Because the large number of nights granted for the survey must be spread over many observing runs, the imaging data of a given run can be reduced in preparation of the subsequent observations, yielding finding charts of the galaxies with R ≤ 20.5 to be observed spectroscopically.

The aperture masks are obtained by taking a few minute-long direct images of the fields. When a field was previously observed with the same instrument and CCD as the spectroscopic exposures to be taken, the flat-fielded direct image is brought to the telescope, and can allow to prepare a mask before the first observing night. At the NTT, the software for object selection and slit positioning is performed within a MIDAS context using a graphical user interface [17]. This package includes an automatic search for the objects using INVENTORY, and an optimization of the resulting aperture mask given chosen parameters like slit lenght, limiting magnitude, etc. A manual mode allows to position slits at will, and in our case where we already have lists of objects, it is the most frequently used. Our main concern, given a list of objects, is to adapt the slit length to the brightness of the objects, following the principle that the sky spectrum and its profile along the slit should be better determined for the fainter objects. Once the table corresponding to the positioned slits is ready, it is sent to EMMI within which the mask is punched.

On EFOSC, an IHAP programme runs a more primitive version of the slit positioning software, with less flexibility and poorer optimization of the mask. In contrast, the punching is done in the control room at the PUnching MAchine (PUMA). With EFOSC, the slits are punched with a row of circular holes offset from each other by a small fraction of the hole diameter. This leads to residual chips of metal and/or paint along the slits which cause significant variations in the slit transmission. This problem can be significantly alleviated by an additional punching of the masks with an offset of ½ the initial offset between the punched holes. Moreover, manual rubbing of the slits with a sharp head under a magnifying lens proved to be extremely efficient in removing the large residual chips.

Great attention is directed towards the correction of slit non-uniformities because they can significantly deteriorate the quality of the sky-subtraction and thus the signal-to-noise ratio of the resulting spectra, especially for faint and extended objects. With EMMI, the rectangular punching head corresponding to slitlets of 1.3 × 8 arcsec yields much cleaner slits than with EFOSC. With both instruments, the residual variations in slit transmission are removed by flat-field exposures using internal lamps or an illuminated screen in the dome. With both instruments, we found that flat-field exposures with a similar illumination (in spectral range and in flux) as our science exposures yield slit transmissions which are more uniform after flat-fielding than with highly exposed flat-fields.

Given the usable MOS fields with EFOSC (3.5 × 4.7 arcmin for an imaging

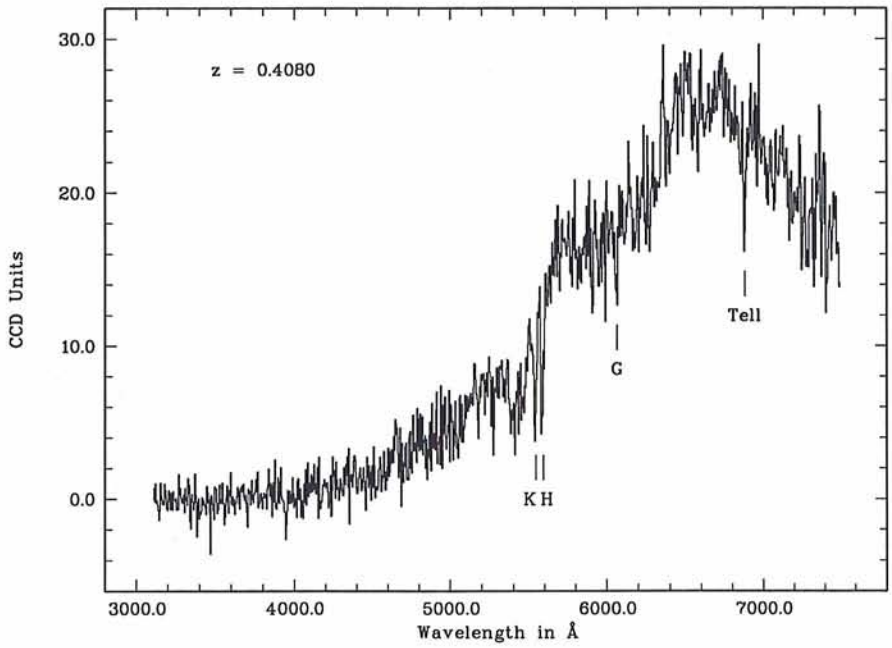

Figure 4: *Typical absorption spectrum of a galaxy near the limiting magnitude of the survey. The redshift of the object is indicated and its uncertainty is 0.0003. The prominent H (3968.5 Å) and K (3933.7 Å) lines of Ca II and the G molecular band (4304.4 Å) of CH are indicated. A large part of the contribution to the cross-correlation peak originates from these lines. Note that the numerous emission lines of OH redward of 6300 Å are well removed from the spectrum. The strong residual line due to the band of O_2 telluric absorption near 6900 Å is indicated.*

field of 3.7 × 5.7 arcmin) and EMMI (5 × 7 arcmin for an imaging field of 7.5 × 7.5 arcmin), respectively ~ 10 and ~ 20 spectra are obtained simultaneously. Typically, each mask is exposed between 1 and 1.5 hour, depending on the weather conditions. Figure 3 shows a 1.5-hour exposure after removal of the cosmic events and flat-fielding. The Ca II H and K lines can be clearly seen in the brighter objects. Several other objects exhibit emission lines ([OII] at 3727 Å; or Hβ at 4861 Å and [OIII] at 5006 Å).

Nearly-Automatic Reduction

For the data reduction, we are using the portable version of MIDAS installed on SUN workstations. Both the direct imaging and the MOS data are reduced using nearly-automatic procedures which were designed specifically for this programme. They guarantee that the data are reduced in a homogeneous and repeatable way over the entire sample.

For reducing the deep images which provide the photometric catalogue of the survey, we are using a systematic sequence of procedures. To best detect the faintest objects, we are making "super-flat-fields" obtained by median filtering over the images of the fields obtained in the same filter during a given run. After photometric calibration, the star-galaxy separation and the measurement of magnitudes are done using the INVENTORY context of MIDAS (with some changes to match the needs of faint galaxy photometry [18]).

The reliability of the star-galaxy separation and of the photometry is in the process of being tested using simulated images. The synthetic fields contain both stars and galaxies with a set of adjustable parameters to model the nature, relative proportions, and properties of the objects, as well as the observational effects such as seeing, sampling due to the finite pixel size, etc. These simulations are crucial for testing the ability of any star-galaxy separation algorithm at faint magnitudes, and for adjusting the input parameters. An important final adjustment of the photometric catalogue will be obtained by a least-square fit of the magnitudes of the objects located in the overlaps of the CCD images. This adjustment of the zero-point of the magnitude scale will guarantee an internally homogeneous photometry and correct for the possible variations which might have occurred due to the long time interval over which the programme will have been performed as well as the instrument changes.

As far as the spectroscopy is concerned, we spent the first years of the programme designing a nearly automatic MIDAS procedure for the reduction of the MOS frames and for testing it extensively on our data. The procedure was specifically optimized for low signal-to-noise slit-spectra of extended objects. The major steps are: cosmic events removal by comparison of multiple exposures; flat-fielding to correct for pixel-to-pixel variations, variations in the slits transmission, and fringes; long-slit wavelength calibration in the context LONG of MIDAS; sky subtraction by a wavelength-dependent fit of the sky flux along the slit and by interpolation at the position of the object; optimal extraction of objects by profile weighting; cross-correlation of the resulting spectra with galaxy templates for redshift measurement and error estimation; flux calibration using spectrophotometric standards.

In the MOS reduction procedure, the interventions from the astronomers are reduced to a minimum: indicate the desired edges of the slits for extraction of the individual spectra by mouse clicking; define the columns of sky to be used in the sky-fitting procedure by mouse clicking; choose the logarithmic scale in the rebinning of the spectra in preparation for the cross-correlation; check visually the result of the cross-correlation and reject the obtained redshift when the confidence level is mistakenly large but no spectral feature can be recognized. These interventions turn out to provide useful degrees of freedom during the reduction. For example when several objects are within the same slit, a fully automatic algorithm for recognition of the slit edges would fail to separate the two objects.

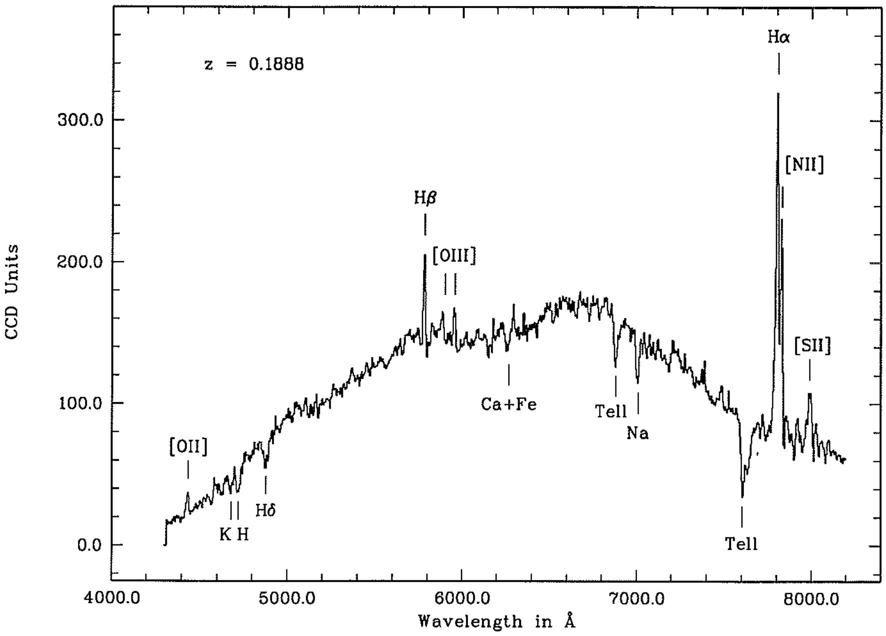

Figure 5: *Spectrum of a galaxy containing both absorption and emission features. The redshift of the object is indicated and its uncertainty is 0.0003. This redshift is obtained by weighted mean of the cross-correlation redshift with the emission redshift derived by gaussian fits to the emission lines. Many objects in the survey have a similar spectrum. For the higher redshift galaxies, only the [O II] 3727 Å and sometimes the Hβ 4851 Å and [O III] 4958.9 Å and 5006 Å are within the observed wavelength range. The strong telluric bands of absorption lines of O_2 near 6900 Å and 7600 Å are indicated.*

It was time consuming to design this general MOS reduction procedure and to match its performances to the requirements set by the data. Nevertheless, given that the procedure contains ~ 7,000 lines of MIDAS commands, it definitely was worth the investment! It makes the spectroscopic reduction an easy and fast task which has now been performed routinely for over a year. A significant fraction of the commands are dedicated to the house-keeping: defining names for all the intermediate files created and kept on tape; saving into the appropriate files all the parameters used by the various MIDAS commands in order to trace back the history of each spectrum, etc. In connection with this, we are experiencing that when dealing with large data sets, classifying and keeping track of the information represent a heavy and tedious, but extremely important part of the work!

Comments on First Results and Prospects

A significant fraction of the redshifts for the sample have now been measured. All the spectra obtained until now have been reduced. Nearly 400 objects

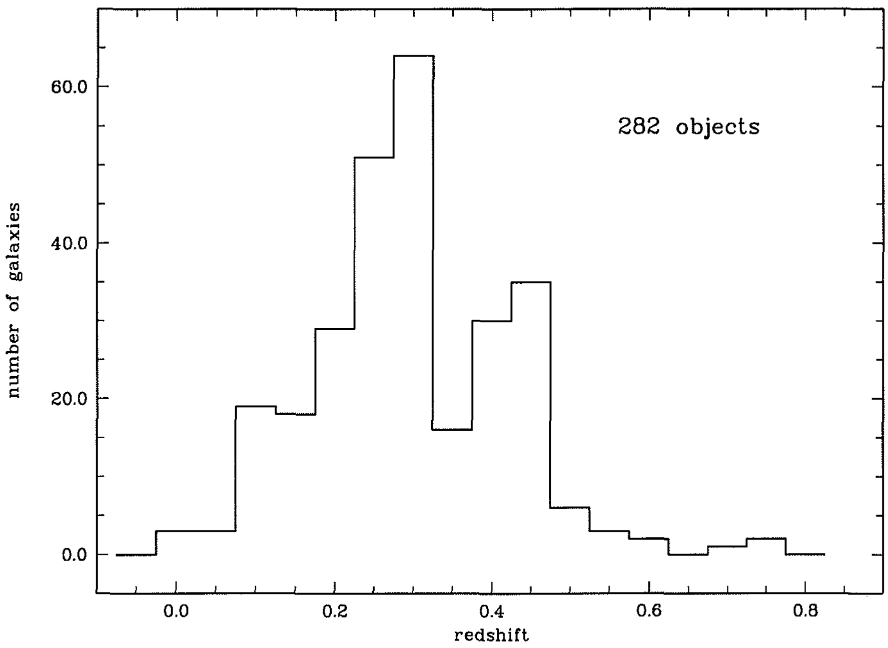

Figure 6: *Redshift distribution of the partial data already obtained. The data are binned in redshift intervals of 0.05. This diagram illustrates that the survey is most sensitive in the redshift range 0.1–0.5. The inhomogeneities are partly due to incompleteness.*

have reliable redshifts. A part of them corresponds to secondary regions which are observed when our main fields are too low on the horizon. Another fraction of the objects is fainter than our R limiting magnitude: when space is left on a mask we put additional slits on fainter galaxies. Figure 4 shows an absorption-line spectrum typical of the galaxies in the survey (the majority of them being near the limiting magnitude). For such objects the cross-correlation technique yields a highly significant correlation peak.

Figure 5 shows a spectrum having high signal-to-noise and many narrow emission lines. In the already obtained data, a large fraction of spectra, ~ 50 %, exhibit emission lines (mostly [O II] at 3727 Å, due to the redshifted spectral range). Detailed studies are necessary, including examination of possible selection effects, to understand whether it corresponds to an increased frequency of bursts of star formation within the redshift range covered by the survey. More generally, the spectra together with the B V R photometry of the objects in the survey will provide a homogeneous database for studying recent galaxy evolution at $z \sim 0.1-0.5$, where the survey is most sensitive. The data will be used to study the variations of the properties of galaxies (spectral features, colours, morphology, etc.) with the environment (local galaxy density, location within the large-scale structure...) as a function of redshift.

A histogram of 282 reliable redshift measurements is shown in Figure 6. As expected from the chosen limiting magnitude, the peak of the distribution is located near $z \sim 0.3$. While some of the inhomogeneities are due to incomplete sampling, some are real and correspond to regions of dense galaxy environment. Examination of the large-scale clustering of the galaxies must be done from redshift versus coordinates diagrams. Because the data are spread over a large number of CCD fields, global mapping of the data requires the measurement of the coordinates of the objects. The regions of the ESO photographic plates containing our survey are in the process of being digitized at the MAMA ("Measuring Machine" of the Observatoire de Paris). This will allow precise astrometry for our fields using the existing software of the facility. By comparison of the images of the digitized plates with our CCD frames and by using existing MIDAS commands on secondary astrometric standards, we shall be able to derive the coordinate transformation equations for each of our CCD fields.

Meanwhile, relative coordinates have been calculated using the known offsets between the various CCD frames. These coordinates allow a preliminary examination of the 3-D distribution of galaxies in the survey. Maps of the redshift of the galaxies versus the right-ascension (the long dimension of the survey) show the remarkable alternation of dense structures with voids whose diameters are comparable with those detected in the shallower redshift surveys [19]. These partial data can be used to examine the statistical tools for characterizing the large-scale clustering in deep pencil-beam probes. Completing the survey to its full extent in right ascension is however indispensable for understanding the nature of the intercepted peaks of galaxy density and for comparing with the structures in the nearby surveys. Yet, the partial data which have been already obtained demonstrate that EFOSC, and more so EMMI with its larger field and better efficiency, are well suited for mapping the large-scale structure out to redshifts of 0.6.

We are grateful to ESO for the numerous nights of observing time allocated to this programme. We also wish to thank the staff members at La Silla who greatly contribute to the success of our observing runs.

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New Bright Double Quasar Discovered

GRAVITATIONAL LENS OR PHYSICAL BINARY?

D. REIMERS, L. WISOTZKI and TH. KÖHLER

Hamburger Sternwarte, Universität Hamburg, Germany

Spectroscopic observations of bright quasar candidates with the ESO 3.6-m telescope have led to the serendipitous discovery of a close pair of bright quasars with a separation of 3 arcsec. Recent observations of the pair with the ESO New Technology Telescope on La Silla in remote control from Garching on May 11/12 confirm the discovery. The new double QSO may be particularly suited to probe absorbing gas clouds in the early universe.

A Bright Quasar Survey

Bright quasars which can be observed in detail across the whole electromagnetic spectrum are rare objects in the sky. The only way to find such objects is a wide-angle survey of large parts of the sky. Within the ESO Key Programme "A wide angle objective prism survey for bright quasars (P.I. D. Reimers), a group of European astronomers from Hamburg, Liège and ESO (Garching), uses since 1990 the ESO 1.2-m Schmidt telescope on La Silla equipped with an objective prism in front of the main mirror. Each deep 75-min Schmidt exposure thus yields 20,000 to 30,000 low-resolution prism spectra on a 30 × 30 cm Kodak IIIa-J photographic plate. The plates are fully digitized in Hamburg with a fast measuring machine, and quasar candidates are selected by computer using automated quasar search routines. Quasar candidates are then spectroscopically observed on La Silla with the 1.5-m and 3.6-m telescopes in order to obtain redshifts and details that are not visible on the Schmidt plates.

The Hamburg-ESO Bright QSO survey has up to now produced more than 200 bright (V < 17.5) quasars in 70 Schmidt fields.

A New Double QSO

Spectroscopic observations of quasar candidates in March 1993 led to the serendipitous discovery of a bright quasar pair. With a separation of 3 arsec the double nature of the object was not recognized on the Schmidt plate. However, the long slit of the spectrograph of EFOSC (ESO Faint Object Spectrograph and Camera) on the 3.6-m telescope "by chance" included the second component. It was only during data reduction at home that it was recognized that the fainter second (B) component has an identical spectrum with component A, strong evidence for image splitting due to a gravitational lense which is typically a massive galaxy in the light path between the quasar and us.

The serendipitously taken spectrum of the fainter B component, however, was too noisy for an unambiguous interpretation.

Observations of the Pair with the ESO NTT – Evidence for Microlensing?

To fully confirm the nature of the object, called HE 1104–1805 AB, we used the ESO NTT telescope equipped with EMMI in the remote control mode via satellite link from Garching in the night May 11/12 to confirm the discovery with better spectroscopic and photometric data.

The facts are now: HE 1104–1805 AB form a pair with a separation of 3.0 arcsec with nearly identical spectra and identical redshifts 2.303. Component A has a visual magnitude V = 16.2, B has 18.0 However, there appear to be small distinct differences between the two spectra. The continuum of component A rises steeper to the blue than that of B, and *all* emission lines (Lyα, C IV, Si IV, C III) are systematically weaker relative to the continuum in A, while, if normalized to, e.g., the C IV profile, the line strengths and in particular their profiles are identical in both components. The systematic differences between the components in both the continuum and the lines are exactly what would be expected if component A is amplified by microlensing due to stars, and the source size is different for the line and continuum forming regions. This hypothesis can be easily tested in the future since the difference between A and

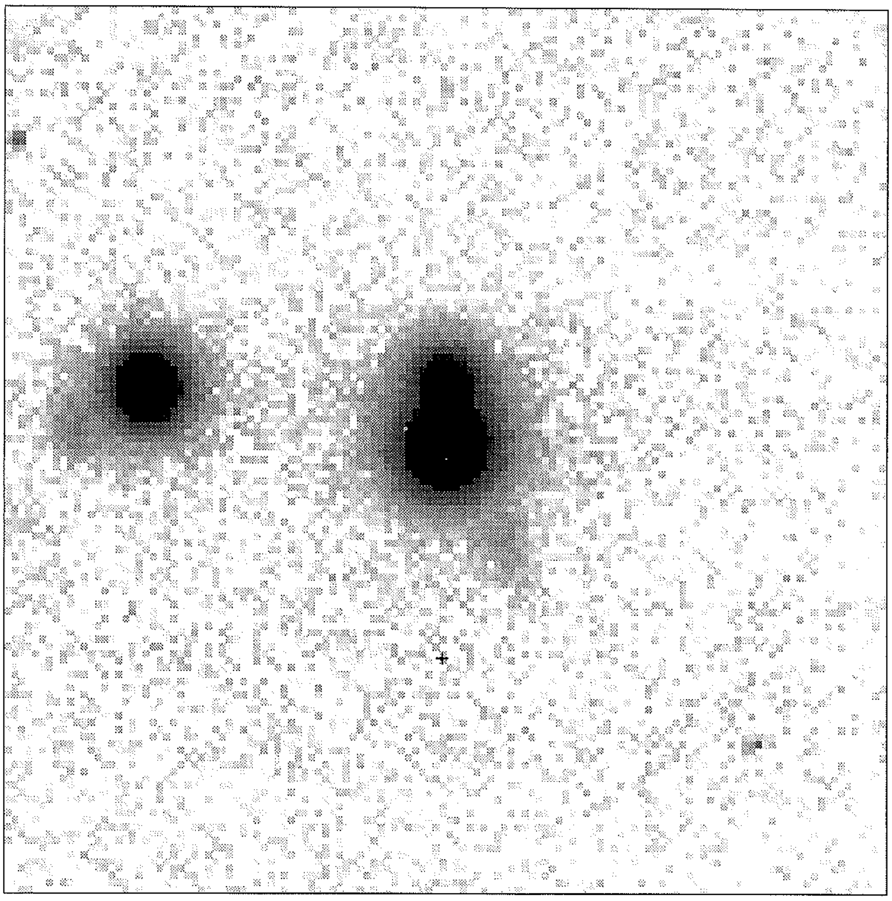

Figure 1: *NTT R image of HE 1104-1805. Composite of three 200-sec exposures. Seeing was 1."8. The faint object south-west (below and right of the bright pair) is a 21^m galaxy.*

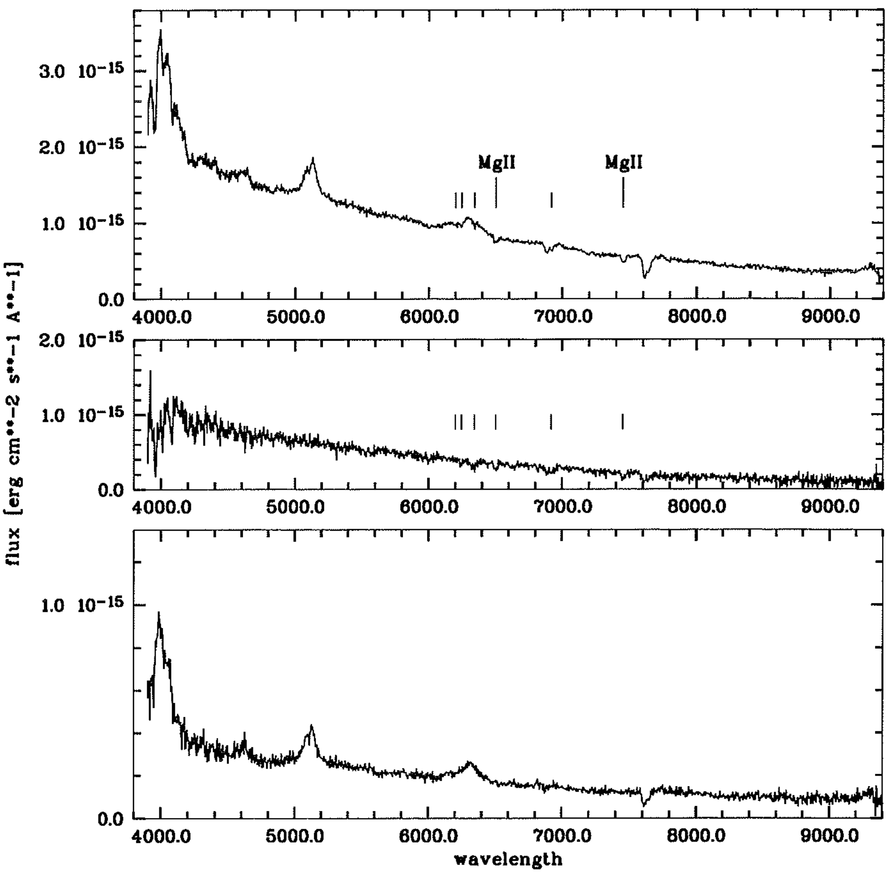

Figure 2: *Spectra of HE 1104-1805 A (upper) and B (lower) taken with NTT and EMMI (red arm, 246 Å/mm grism, 5″ slit width). Exposure time was 600 sec. Resolution is FWHM ≈ 18 Å. The middle "spectrum" is f_{ML} = fλ(A) − 2.8 fλ(B), the hypothetical component in A due to microlensing. Strong absorption features seen only in A are marked.*

B as observed in May 1993 should have disappeared on a time scale of at most years if due to microlensing. If not, HE 1104-1805 A–B is a genuine QSO pair and not two images of the same object.

If it should turn out to be a gravitational lens object, HE 1104-1805 is particularly promising for monitoring of the time delay between the two images which provides a completely independent means to determine the distance scale of the universe or the Hubble constant H_0. This technique had been proposed in 1964 by Sjur Refsdal, 15 years before the first double-image QSO was discovered. The new double, if a lensed object, and if variable, has a predicted "time delay" between the light curves of the two images of several months only, so that the time delay could be measured within one season. However, the first deep images taken with EMMI in the red do not yet show a lens galaxy.

Absorbing Clouds in the Far Universe Along the Line of Sight

There is another distinct difference between the spectra of the two components which has never be seen before in quasar pairs. Component A has a strong absorption line system due to an intervening cloud at redshift z = 1.66 seen in the Mg II doublet, five strong Fe II UV resonance lines, C IV and, as seen in the UV with IUE, a Lyman edge in the UV at 2450 Å as well as damped Lyα and Lyβ at 3230 Å and 2730 Å respectively. The Mg II and Fe II absorption is not present in component B, while the C IV doublet is present in B too. Since the observed separation of 3 arcsec projected to z = 1.66 corresponds to a length of about 20 kiloparsecs, this gives the first clear size estimate for a damped Lyα system. The redshift z = 1.66 system might be related to the lens galaxy, since the type of absorption line system seen only in component A is typically produced by disks of galaxies, while the C IV absorption is related to galactic halos.

It will be exciting to observe the new double quasar with the Hubble Space Telescope in the UV and at high spectral resolution in the optical. With HST, absorption lines of the elements C, N and O from the extreme ultraviolet (EUV) are shifted into the satellite UV above 120 nm and enable quantitative abundance studies in absorbing gas clouds around still young galaxies.

Observations with the IUE satellite (International Ultraviolet Explorer), scheduled immediately after discovery on April 29 as a target of opportunity, have confirmed that the object is UV-bright, as had been hoped, and make it an excellent target for the HST.

The new double quasar has also been found to be X-ray loud in the ROSAT All Sky Survey, and it would be important to decide whether the X rays are from the quasar itself or due to an intervening cluster that may be in part responsible for the gravitational lense effect. Target-of-opportunity time to observe the object with the ROSAT PSPC has already been granted.

What Is This?

One of the most important, but perhaps least visible features of the production of a photographic sky atlas is the *quality control.* It ensures that the photographic copies, as far as technically and humanly possible, contain the same information as the original plates. In practical terms, this implies careful sensitometry at the copying and processing machines, and also a thorough visual control of the resulting copy films and plates.

Sky Atlasses have been produced at ESO during the past 20 years and a lot of experience has been gained in the meantime, also what concerns the quality control. The photographers involved know that while it is impossible to achieve a complete transfer of information from the original plate to the copy, for instance of the highest densities, it is very important that the copying process does not "add" artificial "objects" which may be mistaken as real astronomical objects.

It is therefore part of the quality control to check for "plate faults" on the copies which may look like real objects, but which are absent on the originals and are therefore artifacts. Fortunately, modern emulsions are rather clean, and normally few such cases occur.

It was during such a visual control of the Palomar Schmidt infrared plate of northern field 232 for the Palomar/ESO Atlas of the Northern Sky that ESO photographer Gisela Strigl noticed two unusual objects. Both looked like large black spots and seemed strange indeed. However, when she checked with

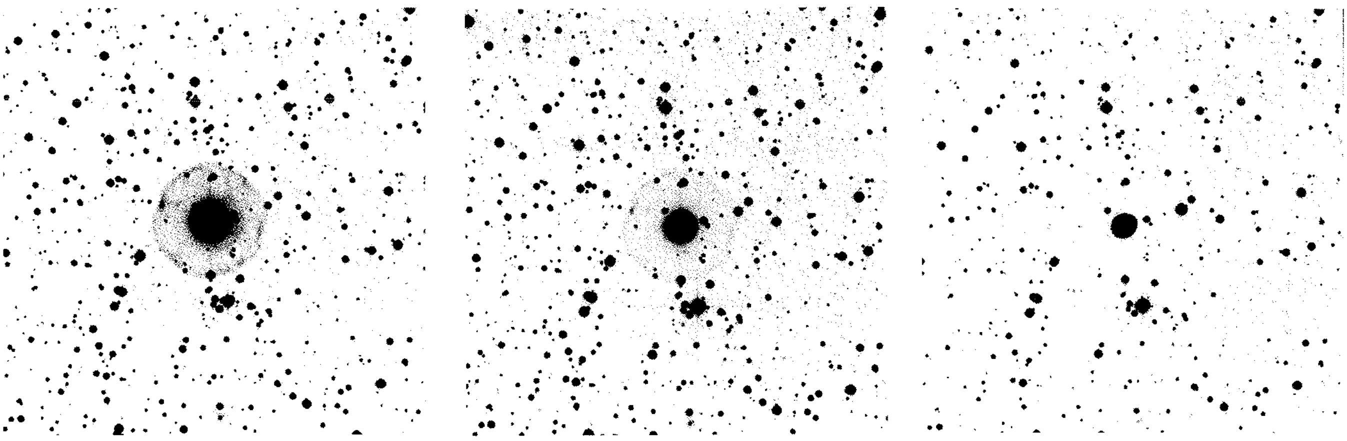

Figure 1: *(a) Blue image (IIIa-J emulsion) on the Palomar/ESO Atlas of planetary nebula NGC 6826 (PK 083+12.1). (b) Corresponding red image (IIIa-F). (c) Infrared image (IV-N).*

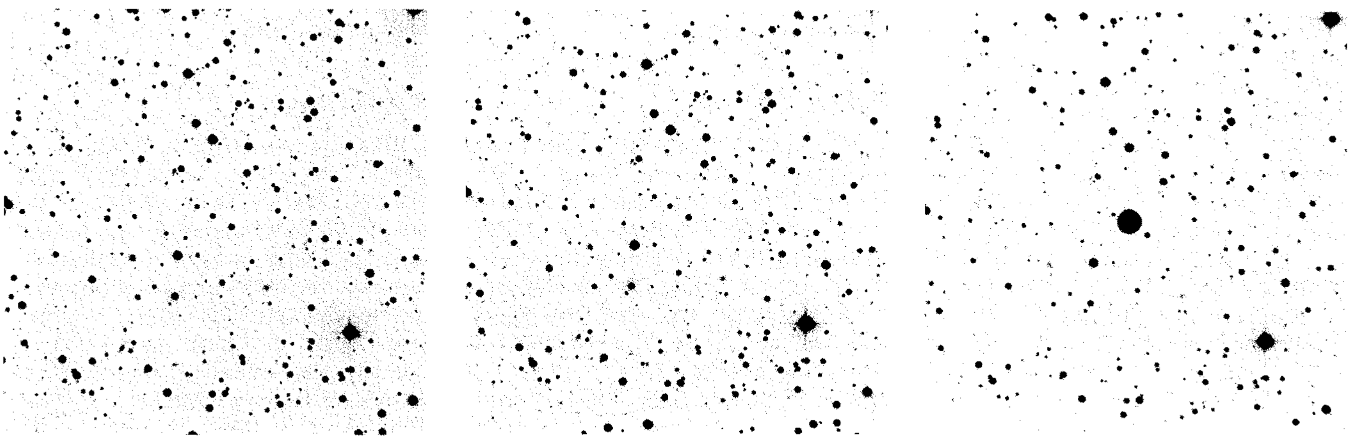

Figure 2: *As Figure 1, now showing mysterious object near R.A. = 19 13; Decl. = 49 20 (2000.0) in blue (a), red (b) and infrared (c) light.*

the original plate, both were there, so they were at least not due to the copying process. Just to be sure, she then had a quick look at the corresponding blue and red Atlas plates and quickly discovered that one of them belonged to a planetary nebula. A check in the available catalogues identified this object as NGC 6826 (PK 083+12.1). While the outer, filamentary nebula is well visible of the blue and red plates (Figs. 1a and 1b), only the central part can be seen on the infrared plate (Fig. 1c).

But what about the other object? Although it looks very similar to NGC 6826 (albeit somewhat fainter) on the infrared plate (Fig. 2c), at this position there is only a faint star on the two other plates (Figs. 2a and 2b)! How can such a faint object be so bright in the infrared? Here it should be remembered, that the photographic IR waveband covers the 7000–9000 Å interval, i.e. it is quite close to the red band.

A check in the computer catalogues at ESO did not provide any identification with a known object. In particular, there is no IRAS source listed in this direction.

So what is it? A plate fault on the infrared plate or a real object with a very strange spectrum? Or did it experience a most unusual outburst when the infrared plate was obtained? We do not know.

Just in case one of the *Messenger* readers would like to have another look to solve this riddle, here is the approximate position: R.A. = 19 13 01; Decl. = +49 19.5 (2000.0). *R.M. WEST, ESO*

STAFF MOVEMENTS

Arrivals

Europe

HESS, Matthias (D), Mechanical Engineer
JANSEN, Ronald (NL), Accounting Assistant
OCH, Susanne (D), Student
PELLEGRINI, Silvia (I), Fellow
THEODORE, Bertrand (F), Coopérant
VAN DER WERF, Paul, Fellow

Chile

CAPPELLARO, Enrico (I), Associate
LEHMANN, Thomas (D), Student
SWINNEN, Eric (B), Senior Technical Engineer

Departures

Europe

JØRGENSEN, Bruno (DK), Clerk (General Services)
YOUNG, Andrew (USA), Guest Professor

Chile

DE JONGE, Peter (NL), Construction Site Manager
EKMAN, Sture (S), Electro-Mechanical Engineer
VAN WINCKEL, Hans (B), Student

Transfers

From Europe to Chile

FAUCHERRE, Michel (F), Optical Engineer

Dynamics of the Pavo-Indus and Grus Clouds of Galaxies

P. FOUQUÉ[1,2], D. PROUST[1], H. QUINTANA[2] and R. RAMIREZ[2]

[1]*Observatoire de Paris-Meudon, France;* [2]*Pontificia Universidad Católica, Grupo de Astrofísica, Santiago, Chile*

1. Introduction

One of the outstanding problems in astrophysics concerns the missing mass of the Universe: 90 % of the mass of the Universe appears to be invisible. Several arguments show that luminous mass cannot give account of dynamical effects. One of these is the high mass-to-luminosity ratio usually found in groups and clusters of galaxies.

These ratios are computed assuming that groups of galaxies are virialized entities. The actual mass of not yet virialized bound aggregates of galaxies is probably of the same order of magnitude as the mass calculated assuming that the group is virialized, but the precise ratio is unpredictable. Evidence that groups of galaxies, and at least some clusters, have not yet reached a virialized status, is growing. The time to reach virialization is larger than the age of the Universe, for many observed systems. Moreover, many clusters of galaxies show subcondensations, which might be accreted small groups not yet well mixed with the remaining galaxies of the cluster. These results force us to look more closely for truly virialized aggregates, in order to see whether these contain missing mass or not.

In order to search for such entities, we recently compiled a catalogue of groups of galaxies within 80 Mpc (H_o=75 km $s^{-1}Mpc^{-1}$) Fouqué et al. 1992) using a revised hierarchical algorithm described in Gourgoulhon et al. (1992). Our whole sky catalogue used a sample limited to a diameter of 100 arcsec, roughly corresponding to a limiting magnitude of 14. A group is recognized as such only if it contains at least three members. Therefore, groups at moderate distances were missed due to the limited depth of the whole sample.

2. The Sample

We decided to investigate selected regions by using deeper samples. The present work deals with one of such regions, where de Vaucouleurs (1975) identified two clouds of galaxies, namely Pavo-Indus and Grus. These clouds belong to the connection between the Indus Supercluster and our Local Supercluster.

Within very defined limits in these clouds, we selected from the PGC catalogue of galaxies (Paturel et al. 1989a, 1989b) all objects with a listed magnitude brighter than 15. After correction for extinction effects, the limiting magnitude becomes 14.5. Moreover, we added to the sample a few galaxies fainter than our limit, but with a known recession velocity. The total samples for the Pavo-Indus and Grus regions are 142 and 136, respectively; 58 galaxies have no known redshift.

3. Observations

The spectroscopic observations were conducted at La Silla (Chile) in September 1991 at the 1.52-m telescope, equipped with the Boller an Chivens spectrograph at its Cassegrain focus. A 600 lines/mm grating, blazed at 4500 Å in the first order, was used. The dispersion was 127 Å/mm. The detector was an excellent 1024×1024 Thomson 1K coated CCD, with a pixel size of 19 μm. The slit width was set at 2 arcsec, giving a projected slit-width of 2 pixels, and a resolution of 4.7 Å. The spectral coverage was 4250 Å to 6710 Å. Before each science exposure, a calibration with a He-Ar lamp was made. Well-exposed radial-velocity standard stars and well-known galaxies were also observed as templates in the cross-correlation procedure in order to derive the radial velocity.

The spectral reduction was carried out using the IHAP image processing software at ESO-Garching, and the recession velocities were derived from a cross-correlation procedure developed at Paris Observatory, within the frame of the MIDAS context. Figure 1 shows a histogram of the velocities for the 266 galaxies measured.

4. The Results

Although our sample is deeper by about 1 mag than the all-sky sample used in Fouqué et al. (1992), only 8 among 58 newly measured galaxies are found to belong to the Pavo-Indus-Grus groups. The remaining ones belong to the background. The limiting recession velocity, up to which our results are credible corresponds to V_{lim}=8,600 km s^{-1} for our limiting magnitude 15 (Gourgoulhon et al. 1992). A group at that distance needs three such galaxies to be detected. As there is no galaxy in our sample with recession velocities between 7,060 and 7,849 km s^{-1} (see Fig. 1), we prefer setting the limit at 7,500 km s^{-1}, corresponding to 100 Mpc. Another hole in the distribution of recession velocities exists be-

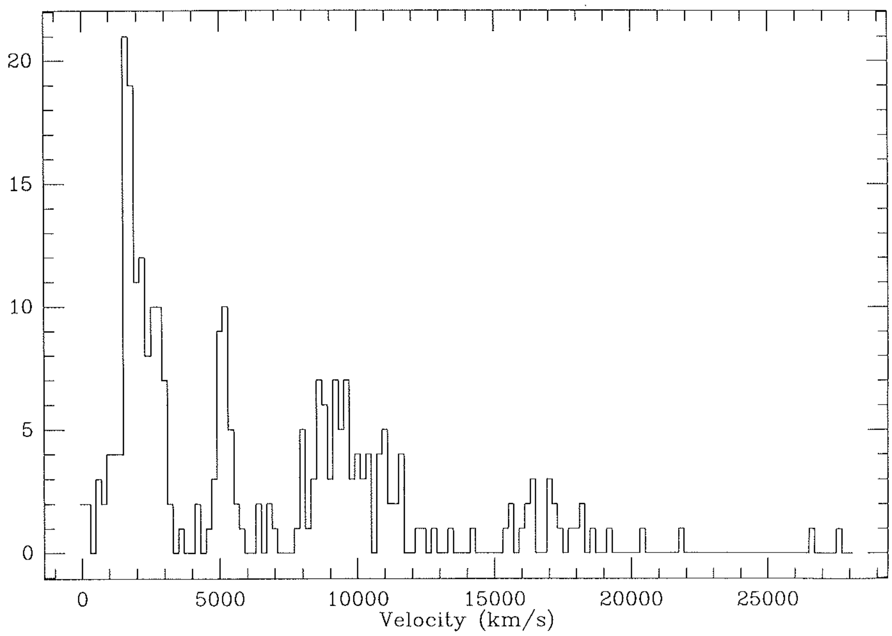

Figure 1: *Histogram of heliocentric velocities of the 266 measured galaxies. Holes around 3,500 and 7,500 km s^{-1} are noticeable.*

Table 1: *M/L ratio for the 6 most populated groups (see text)*

Group name	N	σ_V	$\left(\frac{M_V^w}{L}\right)_{obs}$	$\left\langle\frac{M_{sim}}{M_{obs}}\right\rangle$	σ	M_P/M_V^{uw}	M_A/M_V^{uw}	M_M/M_V^{uw}
NGC 7582	11	121^{+40}_{-21}	5– 15	6.84	3.42	2.29	1.60	0.89
NGC 7213	9	144^{+61}_{-36}	35–158	1.69	1.07	3.05	2.56	2.09
NGC 7060	6	157^{+90}_{-38}	37–205	0.90	0.26	1.80	1.26	1.40
IC 1459	11	120^{+40}_{-22}	53–167	1.18	0.44	1.63	0.83	1.07
NGC 7079	9	98^{+42}_{-26}	58–284	0.82	0.26	1.42	1.14	1.35
NGC 7424	7	175^{+84}_{-34}	214–892	1.31	0.55	1.64	1.45	1.70

tween 3,196 and 3,629 km s^{-1}. We are therefore rather confident of the completeness of our list of groups up to 3,500 km s^{-1}.

Using the same hierarchical algorithm as in Gourgoulhon et al. (1992), we find 18 groups, containing 95 galaxies among the 160 with $V < 7{,}500$ km s^{-1} (59%). 18 other galaxies belong to pairs, and 19 are isolated members of associations (regions where the density level is five times less than for groups). This leaves 28 apparently isolated galaxies. In fact, two of them probably belong to the Local Group and the Sculptor Group, and 13 of them have a recession velocity larger than 3,500 km s^{-1}.

Most of the detected groups were already known. Two new associations are evidenced below 3,500 km s^{-1}. Only one association is detected between 3,500 an 7,500 km s^{-1}, which contains four groups. The median line-of-sight luminosity-weighted velocity dispersion is 90 km s^{-1}, part of which is due to the measurement uncertainty. The median virial radius is 0.53 Mpc. The median mass-to-blue luminosity ratio is 75 $M_\odot/L_\odot$. The median crossing time is 2.0×10^9 yr, showing that our aggregates are gravitationally bound entities and not spurious concentrations.

Figure 2 shows the projected distribution of the galaxies in our sample. Group members are identified by special symbols. Figure 3 shows an iso-number density plot of the 122 galaxies with recession velocities smaller than 3,500 km s^{-1}; the four most luminous groups are evidenced.

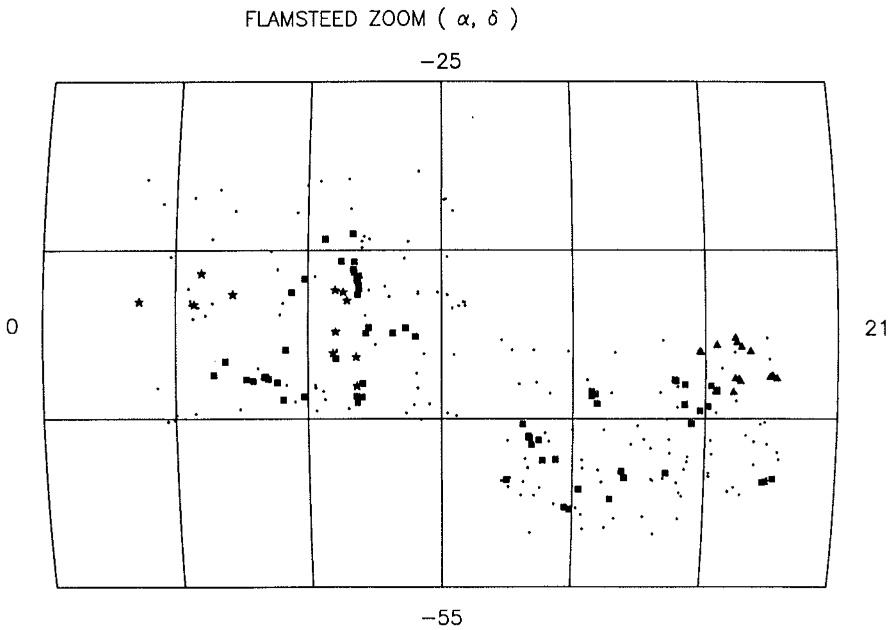

Figure 2: *Projected distribution of the 278 galaxies, in a sinusoidal (Flamsteed) projection. Filled symbols represent members of the 18 groups (stars if $V < 1{,}500$ s^{-1}, squares if $1{,}500 < V < 3{,}500$ km s^{-1}, and triangles if $3{,}500 < V < 7500$ km s^{-1}). Dots represent galaxies not assigned to groups, or galaxies with $V > 7{,}500$ km s^{-1}.*

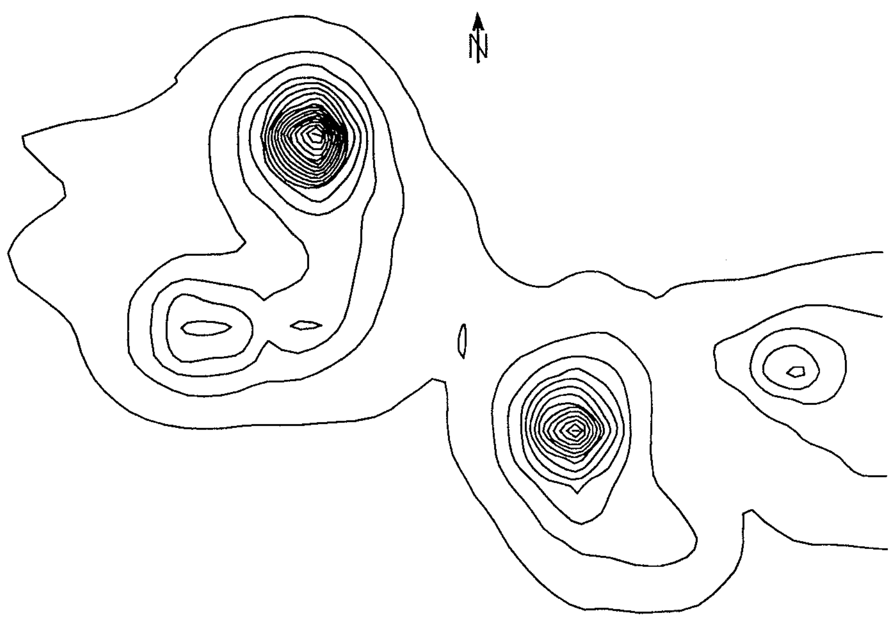

Figure 3: *Iso-number density plot of galaxies with recession velocities smaller than 3,500 km s^{-1}. North is up and east at left. The lowest contour corresponds to 1 galaxy per Mpc^2, and an interval corresponds to 1 galaxy per Mpc^2. The peak is at 18 galaxies per Mpc^2.*

5. Discussion

Our main goal, when we embarked upon this survey, was to understand the large dispersion observed in the M/L ratios of the groups in our all-sky survey, and to determine if certain parameters can help to understand this dispersion. Our present deeper survey has not reduced the dispersion, with M/L values varying between 9 and 442 $M_\odot/L_\odot$. If we now restrict the discussion to groups with at least 5 galaxies, to reduce effects of projection factors and poor statistics, we get 6 groups, which we will compare in more detail.

The uncertainty of our M/L estimate depends upon both mass and luminosity errors. As our estimate of L involves correcting factors for incompleteness, it is difficult to estimate an error bar. We therefore concentrate our effort on mass determination, in three directions: we first correct the dispersion velocity for measurement uncertainties, using the precepts of Danese et al. (1980). The result is given in columns 3 and 4 of Table 1.

Then, we make a simulation keeping fixed the positions on the sky of the galaxies in a group, but mixing their velocities and their luminosities, choosing at random 1,000 possibilities among the ($N!^2$) combinations, and computing a new M/L ratio. We than compare it to the observed M/L, and compute the ratio of both numbers. The mean value of the 1,000 trials and their rms dispersion are given in columns 5 and 6 of Table 1. An average value significantly different from one implies that the observed configuration is rather particular. This is the case of the NGC 7582 group, which has the lowest observed M/L ratio. On the other hand, the highest M/L ratio, observed in the NGC 7424 group, is confirmed by our simulation. In fact, the mean ratio M_{sim}/M_{obs} is a measure of the ratio unweighted over weighted estimators of the virial mass.

Finally, we compute the Heisler et al. (1985) estimators of mass, and compare them to the virial mass. The projected mass is computed assuming isotropic orbits and equal masses. The ratios of projected mass, average mass and median mass over unweighted virial mass are given in columns 7, 8 and 9 of Table 1.

6. Conclusions

Several conclusions can be drawn from the results of Table 1, being aware that our statistical basis is very limited.

The low observed M/L ratio of the NGC 7582 group appears to be due to a particular configuration of the galaxies. The unweighted virial mass to luminosity ratio is well within the range of other groups.

The high values of the ratios M_P/M_V^{uw}, M_A/M_V^{uw} and M_M/M_V^{uw} of the NGC 7213 group are probably due to the violation of one underlying hypothesis made to compute these masses, namely that the galaxies in the group have equal masses. Remember that for a group dominated by a massive central member, the projected mass estimator is divided by two.

The ratio M_P/M_V^{uw} appears to be larger than the two other ratios, M_A/M_V^{uw} and M_M/M_V^{uw} : the mean value for projected masses is about 2, while it is about 1.5 for average and median masses. This possibly corresponds to an intermediate situation between equal masses and dominant central galaxy (see previous point). An average coefficient between these two extreme cases would give M_P values lower by a multiplicative factor 0.75, and this would put the three ratios at the same level. However, this common level still corresponds to masses 50% higher than the unweighted virial mass.

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Phase-A Study Launched for the 10/20-μm Camera/ Spectrometer for ESO's VLT

On March 9, 1993 the kick-off meeting for the Phase-A study for the Mid-Infrared Imager/Spectrometer was held at ESO Headquarters. The instrument to be studied will be mounted at the Cassegrain focus of the VLT unit telescope No. 2. It is planned to have this instrument manufactured outside ESO. Shortly summarized, the instrument should provide for direct imaging with various filters and long-slit spectroscopy with $\frac{\lambda}{\Delta\lambda} \approx 300$, 8,000 and 30,000–50,000 for the 10-μm atmospheric window and some limited access to the 20-μm atmospheric window.

This kick-off meeting was preceded by a study phase inside ESO to define the overall scope of the project and to lay out a potential embodiment of such an instrument[1]. In 1992 ESO sent out a preliminary inquiry to 30 institutions in ESO member states in order to identify and select institutes interested and competent to design and manufacture such an instrument including installation and commissioning at the VLT observatory. As a result, ESO selected DAPNIA/CE-Saclay from France as contractor heading a consortium for a phase-A study. A contract was negotiated and signed in March 1993. The consortium is headed by P.O. Lagage. Partners for the study are SRON, Groningen (T. de Graauw), the Kapteyn Sterrenwacht, Roden (J.W. Pel) both from the Netherlands and the IAS-Orsay, France (R. Gispert).

It is the objective of this study to provide for:

- a preliminary design of the optics, cryogenics, vacuum system and electronics for a system which could fulfil ESO's basic requirements,
- a critical review of the detector situation,
- a performance estimate including the effects of the Earth's atmosphere,
- a predesign of any calibration/test facilities required,
- a detailed cost estimate,
- a description of the scientific objectives the scientists involved in the study expect to address with the instrument in their guaranteed observing time (which they will receive as a compensation for their effort).

In addition the consortium can study alternative technical concepts and scientific operation modes to the extent they deem appropriate.

It is planned that the study will be finished after 18 months. ESO intends thereafter to negotiate a contract with DAPNIA/CE-Saclay for the actual manufacture, installation and commissioning of that instrument.

H. U. KÄUFL, ESO

[1] The result of these internal studies is described in greater detail in H.U. Käufl & B. Delabre, 1992, "Design of a 10/20-μm Camera/Spectrometer for ESO's VLT" in Proc. ESO Conference on Progress in Telescope and Instrumentation Technologies, p. 597, ed. M.-H. Ulrich.

Astronomical Literature Publicly Accessible On-Line: a Short Status Report

F. MURTAGH and H.-M. ADORF, ST-ECF, ESO

Computers are changing the way scientists are searching for bibliographical information. The rapid growth of wide-area networks in the past few years, most notably the Internet, is being followed by a rapid increase in the number and kinds of services offered via these networks. More and more information sources are becoming available which are of immediate interest to astronomers.

Here, we aim to list where and how one can avail of the astronomical literature on-line, and some other related services, from your desk. Many of the details are specific to an ESO Unix user.

1. Astronomical Literature On-Line

- *Abstracts of Major Journals*

A large source of abstracts of articles in major journals derives from the STELAR (Study of Electronic Literature for Astronomical Research) project, part of the Astrophysical Data Facility at Goddard Space Flight Center. Eight journals of interest to the astronomical community are covered: ApJ, ApJS, AJ, PASP, A&A, A&AS, MNRAS, and JGR. The abstracts are supplied by the NASA Scientific and Technical Information System (STI) bibliographic retrieval system, which covers aeronautics, space and relevant scientific disciplines. The abstracts are specially prepared for the RECON system, which is used by STELAR. Thus the abstracts differ from the original author-supplied abstracts or those produced for the Astronomy and Astrophysics Abstracts series. Abstracts from about 1965 through March 1993 are available. Early entries may have only bibliographic details and not an abstract.

One can access these abstracts via WAIS (Wide Area Information Servers). WAIS is easy to use since it allows queries to be formulated in natural language and returns matching abstracts with a relevance ranking score. Any abstract found during the search can be fed back to have WAIS search for similar abstracts. A useful feature of WAIS is that it allows a query to be sent to more than one server simultaneously. Results retrieved are merged and sorted with respect to the relevance score.

To access these abstracts via WAIS, use the source file `abstracts.src`. In case this is not accessible system-wide, copy the `abstracts.src.` file from address `hypatia.gsfc.nasa.gov`, directory `/wais-sources`, by anonymous ftp (or see section 3 below).

- *ADS Abstract Service: Astronomical Abstracts*

NASA's Astrophysical Data System (ADS) offers another sophisticated user interface to the NASA STI (cf. above) bibliographic database. Boolean querying and feedback are supported. Following the release of ADS, however, a few weeks ago, it transpired that access to this particular bibliographic retrieval part of ADS was not allowed to non-US users.

- *Conferences and Meetings*

Electronically submitted abstracts for American Astronomical Society meetings (June 92, January 93, June 93) are available for free-text querying through WAIS. Relevant source files, with extension `.src`, are available from `hypatia.gsfc.nasa.gov`, directory `/wais-sources`, by anonymous ftp (or see section 3 below).

- *Preprint Lists*

- Space Telescope Science Institute (STScI) preprint abstracts are available through Gopher. They are also accessible through WAIS. Gopher may also be used to access the STScI Library catalogue. Use the command `xgopher stsci.edu`.
- The NRAO (National Radio Astronomy Observatory) list of preprints received in Charlottesville library from 1986 onwards contained about 13,000 records in early May 1993. Titles, authors, and citation information are available. The exact reference to the published article is added, when the paper is published. This database is updated biweekly. In WAIS, the source to use is `nrao-raps.src`. If it is necessary to obtain the source file, `nrao-raps.src`, try the ST-ECF anonymous ftp area cited in section 3 below.

- *Tables of Contents*

- ApJ, ApJS, AJ, PASP On-Line Index. The Center for Astrophysics, Cambridge, provides on-line access to the contents of these journals. Coverage is from January 1988 to June 1993 (at the time of writing, end of May 1993). Access is obtained via telnet to `cfaN.harvard.edu`, where N = 3, 4, 5, 7, or 8. To review titles of papers login as user `apjaj`.
- PASP abstracts and tables of contents are available via anonymous ftp to `stsci.edu` in directory `pasp`; or via Gopher using the command `xgopher stsci. edu`.

- *Commercial Bibliographic Services*

The Information Retrieval System (IRS) of the European Space Agency at Frascati, south of Rome, houses a range of scientific and engineering databases. These include COMPENDEX, INSPEC, PASCAL, NASA/STI, and others, a number of which cover physics and astronomy. Such bibliographic databases are temporarily accessible free of charge through ESIS (European Space Information System). Telnet to: *esis.esrin.esa.it* (192.106.252.127). Follow the menu items: *User Shell, Databases* and *Quest.*

- *Preprint Collections*

- LANL: an automated bulletin board for preprints is available at Los Alamos National Laboratory. Many subdisciplines of physics are covered. According to *Science* (26 February 1993, p. 1246) the number of users of this system is now more than 8,000. To get information on its use, send the word `HELP` in the Subject field of a message to `hepth@xxx.lanl.gov`. Information on subscribing, accessing, etc. will be automatically returned. Access by anonymous ftp is also possible. As an indication of the size of this repository, in the April 1993 subdirectory, there are 165 papers, and there are more than this in the March 1993 subdirectory.
- SISSA (International School for Advanced Studies), Trieste, Italy. Topics which might be preferentially sought for, via this server, include cosmology, and theoretical and particle astrophysics. According to the administrators of this server, in February 1993 there were around 800 users. Mail the one word, `help` to address `astro-ph@babbage.sissa.it`.
- CERN: The European Centre for Nuclear Research (Geneva) supports a preprint server. Included are all CERN

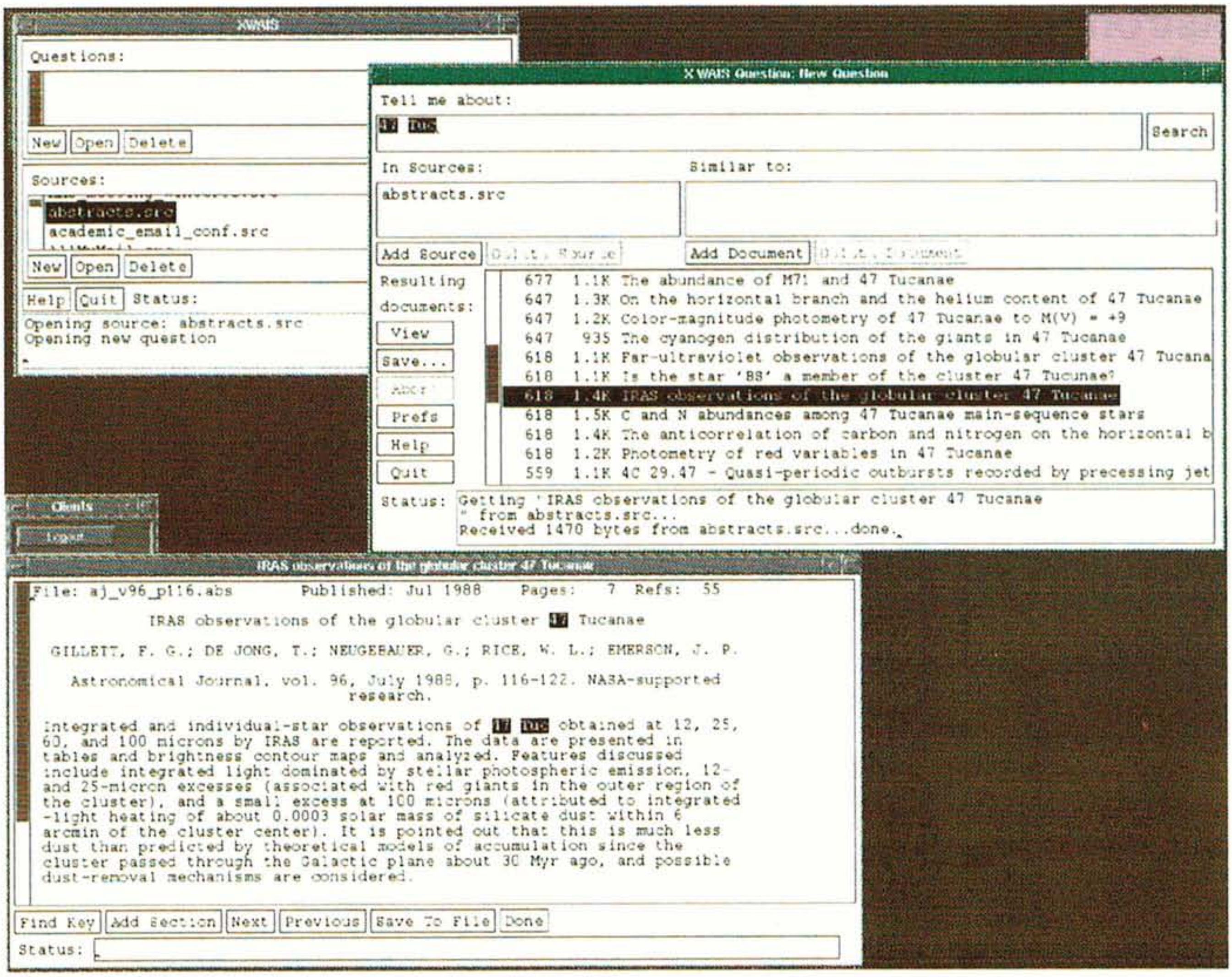

Figure 1: *A number of WAIS windows. The top left one is obtained first. Initiating a new* question *gives the top right window. A* source *is selected using the* Add Source *button. Then a free-text query is input (here: "47 Tuc"). Documents retrieved are ranked by relevance. By clicking on* View, *the document text (here, an abstract) can be obtained (bottom window).*

preprints, those of Los Alamos National Laboratory, and various other documents. In 1992, 3,000 full documents were received electronically and included in this system. Via anonymous ftp, use address asis 01. cern.ch.Directory preprints provides access to hundreds of subdirectories, each associated with one or a few institutes. An X Windows based access mechanism is also supported (but the slowness of this access mechanism at ESO discourages its use).

2. Some Other Information Sources of Interest

● *HST Information (Various)*

Various types of information can be accessed at the STScI by Gopher using the command xgopher stsci.edu. Included here are planned HST observations and the long-term observing timeline.

● *Chilean weather reports through Gopher*

Weather forecasts for Chile, in Spanish. Use command xgopher to the address tortel.dcc.uchile.cl (or 146.83.4.40) and choose the menu items: *Servicios Miscelaneos*, then *Pronosticos Meteorologicos*, and then *Informe Diario Direccion Meteorologica de Chile*.

3. Available Tools and Their Use

The tools used to gain access to these information services are increasingly widely used. Here is a short description of some of them. All are freely available, and in many cases are available for platforms other than Unix also.

● The command xwais makes a WAIS window pop up. WAIS allows you access to other sites which have set up full-text indexed files, in such a way that you specify keywords of your own choosing in order to locate files of interest. WAIS also can provide the file itself. With WAIS, click on new question, which gives another screen. Then choose a source, e.g. astronomical abstracts.src. Confirm this with ok, and this source appears in the active sources slot. Then enter your selection of index terms in the upper entry slot.

WAIS works by having all relevant address and access information in "source files" with extension .src. If relevant files have not been set up system-wide, you can easily set them up in your own directory. Create a subdirectory called wais-sources, and place them there. A number of useful .src files are available for you to copy from: anonymous ftp to ecf.hq.eso.org, directory pub/swlib/various-wais-sources.

● The command xgopher powers up Gopher. This is a tool which greatly facilitates the use of telnet and ftp, firstly by succinctly showing you what is available in remote directories, and secondly by facilitating access. It allows travelling from one Gopher site to another. It front-ends files and tools of all kinds, including a range of ways to track down correspondents' network addresses.

- The command `xarchie` gives access to archie, a directory of software and other files available by anonymous ftp. Archie automatically polls anonymous ftp sites, and collects directory listings. With some idea of the possible name of the software or data item sought, archie is a valuable first stage in locating potential sites. Archie is perhaps of most interest for the user trying to trace a particular software package.

4. Conclusion

In this note we have concentrated on freely-available services, accessible at all times of the day or night. Tools such as WAIS and Gopher enormously facilitate access to stores of bibliographic and other data. Such "wide area network resource discovery tools" have caught the imagination of research workers in many different fields in the past year or two. An ever-increasing amount of relevant and important information is becoming available via one's workstation on one's desk. These are valuable tools which can aid in one's research, – in finding relevant references, in tracking down exact citations, or in open-ended information browsing.

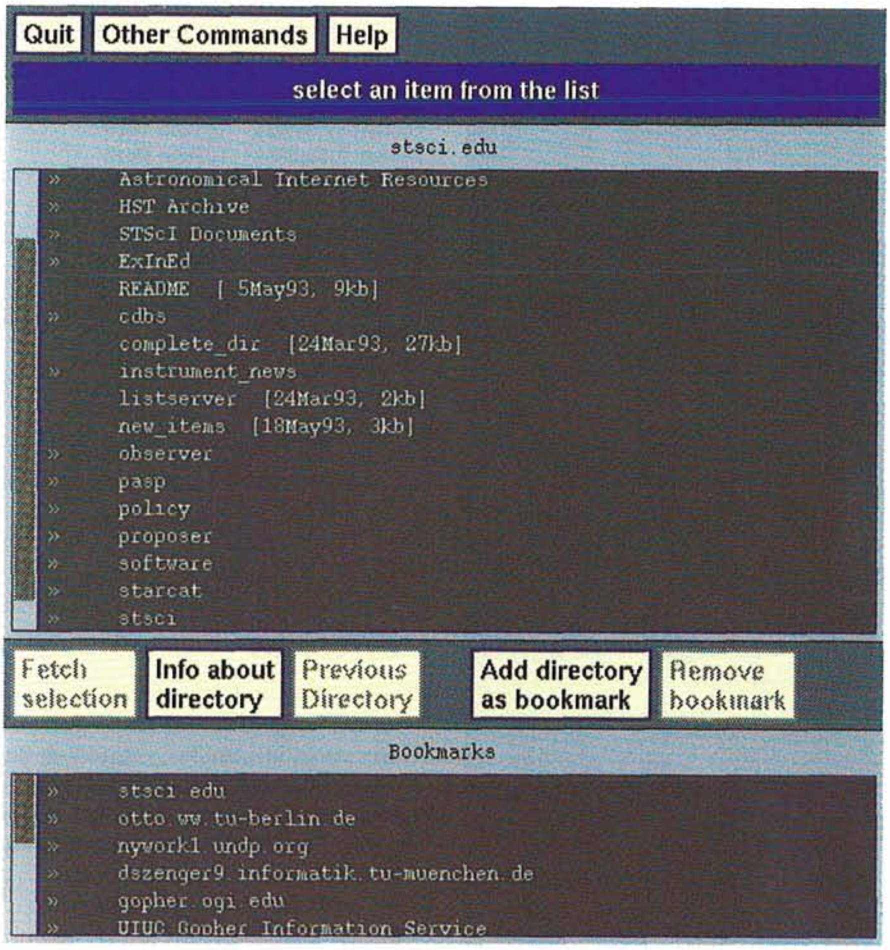

Figure 2: *A Gopher window, showing the STScI Gopher service. This is a convenient window-based way to navigate remote directories, and – further – to navigate between publicly-accessible sites.*

Written-Off Items Available at ESO Garching

The following electronic parts, in good condition for further use, have been written off at ESO, Garching, and are immediately available for donation to Scientific Institutes provided that:

- a formal request is presented to ESO, Contracts and Procurement (Mr. F. Palma, Tel.: 0049-89-32006-205, Fax: 0049-89-3207327), until August 31, 1993;
- the Institute takes charge with own means of picking up the equipment in the place, state and condition where the item is located; alternatively, the Institute can request delivery from ESO to a given destination at no warranty, bearing, however, the costs of removal, packing and transport.

Assignments will be done

- in order of presentation of a formal request up to exhausting items;
- giving priority to Institutes in the ESO Member States;
- giving preference to Institutes located in other countries, for which no export licence from Germany is necessary.

F. PALMA, ESO

Manufacturer	Description	Part Number	S/N	Year of manufact.
Digital Equipment	VAX Mainframe with Mass- and Unibus	8600-40MB	860284094	1986
Digital Equipment	VAX Mainframe with Mass- and Unibus	8600-40MB	860284095	1986
Digital Equipment	Cluster Cont.	HSC50AB	CX50520	1986
Digital Equipment	Disk	RA81-CD	KB06577	1984
Digital Equipment	Disk	RA81-CD	KB08192	1984
Digital Equipment	Disk	RA81-AD	KB08967	1984
Digital Equipment	DiskRA81 (x3)	H9CAB-B	KB01974	1986
Digital Equipment	Disk	H9CAB-B	KB01939	1986
Digital Equipment	Printer	LA120-DA	PN097615	1982
Digital Equipment	Printer	LA120-DA	PN34544	1982
Digital Equipment	Printer	LA12-DB	PN56150	1984
EMC2	16MB for VAX8600	2×16MB		1988

(continued on page 48)

Manufacturer	Description	Part Number	S/N	Year of manufact.
System Industries	Tape Drive	SI1953	4265	1983
System Industries	Tape Drive	SI1953	4264	1983
System Industries	Tape Drive	SI1953	4219	1983
System Industries	Tape Drive	SI1953	4256	1983
System Industries	Tape Drive	9261	8522	1983
System Industries	Tape Drive	9261	991	1983
System Industries	Disk Cache	9900	4686	1988
System Industries	Perform. Monitor	99050	123200220	1988
Winback	VHS Backup	Gigastore	15	1988
DeAnza	Processor	IP8500		1981
DeAnza	Color Monitor	C-3910		1981
DeAnza	Color Monitor	C-3910		1981
DeAnza	Color Monitor	C-3910		1981
Texas Instruments	Explorer	System Mod. "I"	2249426	1987

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ESO, the European Southern Observatory, was created in 1962 to . . . establish and operate an astronomical observatory in the southern hemisphere, equipped with powerful instruments, with the aim of furthering and organizing collaboration in astronomy . . . It is supported by eight countries: Belgium, Denmark, France, Germany, Italy, the Netherlands, Sweden and Switzerland. It operates the La Silla observatory in the Atacama desert, 600 km north of Santiago de Chile, at 2,400 m altitude, where fourteen optical telescopes with diameters up to 3.6 m and a 15-m submillimetre radio telescope (SEST) are now in operation. The 3.5-m New Technology Telescope (NTT) became operational in 1990, and a giant telescope (VLT=Very Large Telescope), consisting of four 8-m telescopes (equivalent aperture = 16 m) is under construction. It will be erected on Paranal, a 2,600 m high mountain in northern Chile, approximately 130 km south of the city of Antofagasta. Eight hundred scientists make proposals each year for the use of the telescopes at La Silla. The ESO Headquarters are located in Garching, near Munich, Germany. It is the scientific-technical and administrative centre of ESO where technical development programmes are carried out to provide the La Silla observatory with the most advanced instruments. There are also extensive facilities which enable the scientists to analyze their data. In Europe ESO employs about 150 international Staff members, Fellows and Associates; at La Silla about 40 and, in addition, 150 local Staff members.

The ESO MESSENGER is published four times a year: normally in March, June, September and December. ESO also publishes Conference Proceedings, Preprints, Technical Notes and other material connected to its activities. Press Releases inform the media about particular events. For further information, contact the ESO Information Service at the following address:

EUROPEAN
SOUTHERN OBSERVATORY
Karl-Schwarzschild-Str. 2
D-85748 Garching bei München
Germany
Tel. (089) 32006-0
Telex 5-28282-0 eo d
Telefax: (089) 3202362
ips@eso.org (internet)
ESOMC0::IPS (decnet)

The ESO Messenger:
Editor: Richard M. West
Technical editor: Kurt Kjär

Printed by Universitäts-Druckerei
Dr. C. Wolf & Sohn
Heidemannstraße 166
80939 München 45
Germany

ISSN 0722-6691