

measuring the quantity and quality of light and enable physical studies to be made of the brightness, temperatures and chemical nature of the stars and nebulae.

Theoretical analysis of the contribution of the stars advanced enormously in the 20th century through the development of quantum theory and other branches of physics, leading to a new discipline: astrophysics.

Astronomy now flourishes as never before: quasars and pulsars have been discovered and there are hopes that answers to problems such as the origin of the Universe, of chemical elements, of the Earth, and of life itself may be found.

The present development of Astronomy is to a large extent due to the use of modern technology, namely advanced telecommunications, electronic computers, precise timekeeping and rocketry.

This is also the case in other areas of fundamental research, the advance of which in effect many times requires the development of advanced technologies, which can partly justify the heavy investment necessary to provide the adequate facilities.

The risks involved in big science projects are not negligible, as the recent mishap with the Hubble Space Telescope well demonstrates. However, the potential rewards are enormous, since the intrinsic value of knowledge itself is invaluable and priceless.

The sight of our beautiful planet from space has made us fully aware of its smallness and fragility. Technology can in some way be defined as the means through which man manipulates the environment. This definition clearly shows that, despite its tremendous achievements, technology must be used in a way compatible with the survival of

Earth for the benefit of ourselves and the future generations. No generation has a freehold on this planet, all we have is a life tenancy, with a full repairing lease.

Science and Technology are now being seriously considered in this country at the political level. After many years of relative neglect, our scientific community is now the object of considerable attention and care. Conditions for scientific research and technological development have considerably improved in recent years, especially since Portugal's integration in the European Community in 1986.

At the turning point that Portugal is now, Science and Technology are key ingredients for our development and full participation in the construction of Europe.

International contacts are being strengthened rapidly and our scientists and engineers are involved in a sizable number of multinational R & D projects, namely in the context of the European Community Framework Programme.

The scientific communities of the different countries are certainly among the most internationalized bodies of the society, for obvious reasons. Science has always cut across barriers and frontiers and international contacts are instrumental for its development. Internationalization and mobility of scientists is therefore a cornerstone of our scientific policy.

The Portuguese Scientific Community is still relatively small – about 5000 full-time equivalent scientists – but young, competent and dynamic. This number has to be rapidly increased, both by new entry-level recruits and also by attracting senior foreign scientists.

At this stage, our infrastructures – buildings, equipment and support personnel – are still insufficient, limiting many times the efforts of our scientists

and making their life somewhat difficult. But there are some good prospects on the horizon to overcome this situation.

In the framework of the Structural Funds Reform of the EC, Portugal has submitted a Programme – emblematically named the Science Programme – designed to create new scientific infrastructures, reinforce existing ones and train new scientists. The programme, which was extremely well received by the EC Commission and approved with minor alterations, is now in the first stage of execution.

The articulation of this Programme with the new EC Framework Programme 1990/94 will certainly provide the stage for a rapid development of Portuguese Science and Technology. It is up to the scientific community to seize the opportunities available to them. The government should only create the right environment and of course adequate conditions and then step aside and in due time evaluate the results.

The private sector should be called upon to participate more actively in the R & D activities. We understand that for a small or medium enterprise, R & D is a very expensive activity. That is why University-Industry partnerships should be strongly encouraged and it pleases me to say that some encouraging examples have already flourished in this country.

In its present quest for development, Portugal can draw inspiration to the Great Maritime Discoveries of the 15th and 16th centuries, which were possible by the conjugation of four factors: (1) political will; (2) rigorous and methodic scientific knowledge; (3) enterprising spirit and the capacity of taking risks; (4) mastery of the technological systems of that time, navigation and weaponry.

The challenges which confront us nowadays require the same ingredients for an adequate response.

## Speech by Professor Teresa Lago

I believe today is indeed an important mark in the development of Astronomy in Portugal. In the present times of awareness for Science and Technology, today's events are of indisputable importance for the future of Astronomy, both in research and education.

They come in the sequence of an initiative taken by JNICT in 1987, and the subsequent proposal for a nationwide programme for the development of Astronomy/Astrophysics. JNICT's initiative was then very important for Astronomy, always forgotten or merely tolerated both by research planners

and university authorities. Astronomy was, for the very first time, considered as one of the areas that should be developed.

Of equal importance was the simultaneous survey of the situation at the Portuguese Observatories – the first done in modern times – including a full enquiry on the facilities, personnel, activity (teaching and research), programmes and projects being carried out at the three University Observatories (Porto, Coimbra and Lisboa) and at the National Observatory (Lisboa). The conclusions of this survey gave a realistic image of the

situation at the, until then, unique State- or University-financed Institutions for astronomical activity. Although this is neither the place nor the time to comment on those results, they should, even today, be given serious and urgent attention. Qualified human resources are the crucial component, otherwise all efforts are condemned to failure.

The situation of Astronomy in Portugal remains very worrisome: instead of the "European average" of 10 to 20 astronomers/1,000,000 inhabitants, we are still short by a factor of 10! And the lack of long tradition of research work in

the field has made recovery more difficult.

The situation has substantially improved over the last two years. Some investment has been made. However, any programme for the development in Astronomy must necessarily include simultaneous components, risking to compromise the objectives aimed at, would any of them be neglected. These components are

(i) the education of a new generation of astronomers, both at University level and at doctoral level. At the doctoral level this should preferably take place abroad or through international collaborative projects, until a "critical mass" is achieved; this implies a steady number of grants for some period of time,

(ii) the support of a small number of infrastructures, providing the necessary facilities for research and education, and the support to those fields where competitive work is already being done, in order to avoid dispersion of the available resources,

(iii) the establishment of a small

number of temporary positions, both at the technical support level and post-doctoral level (national and/or foreign) so that research teams can be provided with acceptable working conditions; at a more advanced phase an adequate number of permanent research positions for Astronomy should also be considered,

(iv) finally the access to adequate observing facilities for Portuguese astronomers and postgraduate students.

The signature of this agreement with ESO is an event of great importance for the development of the astronomical research in Portugal. Not only does it fulfil some of our needs – the access to adequate observing facilities – but it also allows the collaboration and, at some level, participation with ESO at an exciting time – the time in which a very large telescope of a new generation and the important related instrumentation are being developed at ESO.

I believe this agreement constitutes the undeniable proof that the decision makers in Science and Technology in Portugal finally give to Astronomy the

credit it fully deserves and receives in other countries in Europe. I take this ceremony as a real commitment for a continuous and serious effort to develop Astronomy in Portugal. A commitment to provide conditions that allow the Portuguese astronomy to grow to levels comparable to the European ones over a period of time of 5 to 10 years.

I want to thank the Secretary of State for Science and Technology for his decisive support and involvement at the crucial stages of the negotiations with ESO. And to express to the ESO Director General my gratitude for his comprehension and understanding, that has been so important for the conclusion of such an advantageous agreement for us. I feel that Prof. van der Laan's attitude during the whole process was closer to the fellow astronomer and well beyond the negotiator's job.

Of course, years of low profile take time and an enormous effort to be replaced. Mentalities probably take even longer to change. But as an astronomer I must say this is a time of optimism and strong hopes for a brighter future.

## A Short Summary of Astronomy at "Centro de Astrofísica da Universidade do Porto"

*M. T. LAGO, Astrophysical Centre, University of Porto, Portugal*

In 1988 JNICT (the national research council) took the decision to finance the first research centre in Astrophysics in Portugal, the "Centro de Astrofísica" at the University of Porto.

Although in activity since 1988 the Centro was officially created in May 1989 as a financially autonomous association within the University and is housed since October 1989 at the new building of the University Computer Centre.

As personnel it involves

- 2 University staff (Ph.D. in Astronomy, 1979, 1982),
- 8 Ph.D. Students (1 M.Sc. in Applied Statistics, 1988; 2 M.Sc. in Astronomy, 1989, 1990; 1 M.Sc. in Astronomical Technology, 1989; 3 D.E.A. in "Astrophysique et Techniques Spatiales", 1989, 1990; 1 "Licenciado" in Surveying Engineering, Univ. Porto, 1984) and
- 2 temporary staff (1 "Licenciado" in Physics/Applied Mathematics [Astronomy, University of Porto, 1989] in charge of the computer management and assistance to users, general administrative activities and

part-time research, and 1 secretary/librarian).

It also involves several undergraduate students of Astronomy (terminal year).

Because of the particular situation of Astronomy in Portugal, we believe that any programme aimed at the development of Astronomy must necessarily include five simultaneous components. There would be a risk of compromising the objectives if any of them would be neglected; the "Centro de Astrofísica" therefore includes all of these components in its objectives:

1. The education of a new generation of astronomers – the shortage of adequately trained and active prospective supervisors in Astronomy in Portugal implies that, at this initial stage, the majority of the doctorates must be prepared abroad, and those to be prepared at home also need to benefit from a close and continuous collaboration with scientists from well-known foreign institutions; therefore the Centro has been trying to guarantee a continuous and equilibrated scheme of grants as well as the necessary contacts.

At the same time, the Centro provides

conditions for its visitors to collaborate in the undergraduate teaching and to involve the terminal year students in its projects. Therefore the Centro's support for education comes,

– *at university level*: through support to the only undergraduate degree in the country aimed at the education of the new astronomers, at the School of Sciences of the University of Porto; this interdisciplinary degree was set up in 1984 and is jointly offered by the Physics and Applied Mathematics Departments. It has a four-year plan of studies, a *numerus clausus* of 15 students per year and is structured in course units of which 37% are in Physics, 32% in Mathematics, 25% in Astronomy and 6% either in Chemistry, Geology, Mathematics or Physics. The initial three years providing basic training in Mathematics and Physics, except for an introductory course (first year) intended as an overview of modern Astronomy and aiming at keeping alive the student's enthusiasm. The 3rd year offers a general Astronomy course and finally the 4th year includes 5 options from an annual list of various topics in As-