Introduction

The progress of science depends on the technological development of its instrumentation. This is particularly true for the astronomical sciences where the study of remote objects requires sophisticated and costly detection techniques. In this book I shall analyze some of the large European astronomical projects, both on the ground and in space, their development during the last two decades, and their prospects in the future. While scientific progress is intimately related to technology development, both are contingent on professionals and funding, and I shall consider the situation with regard to both of these.

This book is addressed to a varied audience: scientists who wish to see what is happening outside their own domain, students who look for fruitful areas of thesis research, functionaries who need some background for decision making, amateur astronomers interested in knowing what is going on in the profession, and also to an educated public that wants to get the flavor of what is behind the newspaper articles reporting scientific results and to know how European activities compare to what is being done elsewhere. The more detailed description of the development of the VLT, ESO's Very Large Telescope, illustrates how a large technological project gets underway and after some pitfalls reaches completion.

In the first half of the twentieth century observational astronomy was *ipso facto* astronomy done from the ground in the visible part of the spectrum. While in the USA ever larger telescopes were being built, in Europe developments were much more modest, partly owing to unsuitable meteorological conditions, but even more because private donors on the scale of an Andrew Carnegie did not exist here. In the early fifties some proposals were made to construct a large European telescope at a suitable location. Political and financial conditions for science were much improving, and in 1964 ESO, the European Southern Observatory, was founded by half a dozen countries as an intergovernmental organization; in the meantime most countries in Western Europe have become members. In writing this book, I have placed ESO at the beginning because of its increasing role in several areas of European astronomy.

The early evolution of ESO has been well described by Adriaan Blaauw in his book "ESO's Early History"[1)], so I shall give only a brief recapitulation and then sketch the origin of the VLT, which has brought Europe to the forefront of contemporary optical astronomy. Following a brief overview of the

development of the astronomical sciences, subsequent chapters of the book deal with the origin, development, construction and siting of the VLT, its interrelation with the Hubble Space Telescope and with possible successors of these instruments.

Also during the fifties radio astronomy became a major contributor to scientific progress. The European radio community has made many advances – in part by tying national facilities into a network, the EVN (European VLBI Network). The French-German-Spanish IRAM has been successful in radio astronomy at millimeter wavelengths. ESO entered this field with SEST, the Swedish-ESO Sub millimeter Telescope. ESO is the European partner in ALMA – the Atacama Large Millimeter Array, the major Europe-Japan-US venture in submm astronomy.

With the advent of the space age other parts of the spectrum became observable. Thus, infrared, ultraviolet, X- and gamma-ray observations allowed entirely new objects to be discovered and studied. Moreover, possibilities opened up for *in situ* exploration of the solar system. At about the same time as ESO, the precursors of the European Space Agency ESA came into being. The ESA has constructed large facilities for space research. Again I shall be brief on early ESA history, since it is described by Roger Bonnet and Vittorio Manno in their excellent short book "International Cooperation in Space: the example of the European Space Agency"[2)], while early worldwide space science developments are comprehensively covered in "The Century of Space Science" edited by Johan A.M. Bleeker, Johannes Geiss and Martin C.E. Huber[3)]. Subsequently, I deal with recent and future European scientific projects in space. Most of these have been developed in the ESA context, but also some national projects have had an important role. ESA and ESO are increasingly cooperating: The European Coordinating Facility for the Space Telescope is one example; joint studies in interferometry another. The latter may be essential in one of the most exciting astronomical subjects: the search for earth like planets and life. Also archiving the enormous data flows is a common interest of ESA and ESO.

A more sociological discussion of European astronomy follows. How many astronomers are there in the different countries and how much is spent on astronomy? The end product of the astronomical activity consists of publications, and the productivity of the different communities is evaluated. The final chapter deals with the future and the difficult selection of expensive projects in a relatively less favorable economic and political environment, but ending on a positive note: the past achievements augur well for the future in which the countries now entering the EU should also play their part.

The present book deals with European achievements and prospects which do not seem to have been described previously in a coherent way. Others have described their achievements elsewhere. Of course, comparisons are made with what other nations – in particular Japan, Russia and the US – are doing. Also cooperative projects with these countries play an

important role. But is is important to realize that Europe has the full capacity to an autonomous role in science. Sometimes the necessary self-confidence seemed to be lacking among Europeans who measured their own success by how they are regarded across the Atlantic. The press services are not very helpful in this respect; even European results appear to become more respectable after a round trip across the ocean. Cooperation is a very good thing with mutual benefits. But such cooperation can only be profitable if it is based on equality, self-confidence and mutual respect. Europe has the capacity to autonomously plan its scientific future and does not have to try to fit into plans made elsewhere. It only has to strengthen its will to do so.

Two caveats should still be made. In this book I discuss mainly the larger astronomical projects. Many smaller ones are also important, but including these would require a much more voluminous tome. Secondly, when I discuss collaboration, it refers to institutional collaboration. Individuals participate in an infinite number of collaborations with fellow scientists in their researches without regard to nationality or to political factors. This contributes much to the liveliness of the field and may also be beneficial in the creation of a more harmonious world.