International Max-Planck research School on Astrophysics at the University of Munich

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For the second time, the International Max-Planck Research School on Astrophysics (IMPRS) is accepting applications for its PhD programme. IMPRS is a joint collaboration between the European Southern Observatory, Max-Planck-Institut für Extraterrestrische Physik (MPE), the Observatory of the Ludwig-Maximilians University of Munich (USM) and the Max-Planck-Institut für Astrophysik (MPA). Also participating as associated partners are the Astro-particle physics groups at the Technical University of Munich (TUM) and the Werner-Heisenberg-Institut for Physics (MPP).

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The closing date for applications for the programme starting in September 2002 is January 15, 2002.

Please apply by using the IMPRS application form available on-line (http://www.imprs-astro.mpg.de/admission.html).

Book Review: Reflecting Telescope Optics II, by Ray Wilson

Springer-Verlag, Corrected Second Printing, 2001, ISBN 3-540-60356-5, 554 pages, 240 illustrations, PRICE DM 159,90

Volume I appeared in 1996 and was reprinted with significant corrections in 2000. It deals with the historical development of the reflecting telescope with essentially "classical" technology from its invention up to about 1980 and gives the complete optical design and related theory of virtually all known telescope forms. An interesting addition in the reprint is the recently researched identity of Cassegrain in the Portrait Gallery of App. B.

Volume II appeared in 1999 and deals with all aspects of the technological "revolution" from about 1970–1980 onwards, which allowed the breakthrough of the absolute barriers to further progress both in size and optical quality imposed by the limitations of classical technology. A corrected reprint appeared in mid-2001.

The frontispiece added in the reprint shows one of the 8-metre ESO VLT telescopes, the first 8-metre-class telescope using modern active technology for *monolithic* mirrors; while the unchanged cover shows the two 10-metre Keck telescopes using modern active technology for *segmented* mirrors. These two technologies, in combination, seem set to dominate coming developments of super-large telescopes. Volume II deals with all practical aspects of the production and operation of such telescopes designed for use in the visual and infrared wavebands. All techniques required to build them, in particular for large telescopes, are described in considerable detail.

Chapter 1 gives a description of what is often the most demanding task in such projects, the manufacture of the surfaces of the mirrors. Many of the techniques have not changed considerably over the last years, but are nowadays much more effective owing to the use of computers. New methods like stress and ion beam polishing can be used for special applications or fine tuning, respectively.

The success of the figuring depends critically on the procedures used for the test of the optical surfaces. Computer techniques have completely revolutionised the precision, speed and convenience of test procedures. The method has to be adapted to the type of mirror. Interferometric methods are discussed in detail, also the null systems required to generate aspheric surfaces. Special attention is given to the complex test procedures for convex mirrors. Chapter 2 deals with the test and alignment of the telescope in function. After an introduction to the optical theory of misaligned two-mirror telescopes, an alignment procedure for such telescopes is described in detail. Methods for measuring the quality of telescope optics range from simple methods like the evaluation of defocused images to computer-based procedures such as Shack-Hartmann and curvature sensing.

The central Chapter 3 discusses modern telescope developments which are, in one way or the other, all aimed at overcoming the classical scaling laws for the total mass and related flexure of telescopes as functions of the diameter of the mirror. The four possibilities treated are the use of (usually hexagonal) segments, the coupling of separate telescopes, the light-weighting of the mirrors, or the use of actively controlled thin meniscus mirrors. Whereas most mirrors of large telescopes are made of lowexpansion glass ceramics, there are other possible blank materials such as, for example, metal or silicon carbide. All materials have advantages and face specific problems. A problem closely related to the type of the blank is its support.

The summary of the support theories includes basic laws of elasticity theory, the early theory of Couder and modern theories, in particular of G. Schwesinger, to whom the book is also dedicated. Both the axial and the lateral support of meniscus mirrors are treated. It is nowadays accepted that mirrors with diameters larger than approximately three metres have to be actively controlled. Since the author was the inventor of this method as applied to *monoliths* and used for the first time in the ESO NTT 3.5-m telescope, the history and basic principles are comprehensively presented.

Of equal importance is the control of the local environment, that is the avoidance of temperature inhomogeneities introduced by the telescope itself. Particularly significant is the attempt to keep the temperature of the primary mirror in equilibrium with the temperature of the ambient air. The local environment can, for example, be passively influenced by the dome design and also actively by cooling the air in the dome or certain components such as the primary mirror. Chapter 4 treats the question of how the optical quality can be assessed in one or a few figures of merit and how the specification for the overall quality can be broken down into specifications for the subsystems. The method using the so-called Central Intensity Ratio, a kind of Strehl Ratio for telescopes working in the atmosphere, was extensively applied during the manufacture of the ESO VLT.

Chapter 5 includes a summary of the fast growing area of adaptive optics, the purpose of which is to correct the aberrations introduced by the atmosphere and reach the diffraction limit of the telescope. After a comprehensive introduction to the theory of atmospheric optics based on the work of Tatarski, Fried and Roddier, the design and performance of the first adaptive optics systems are discussed.

Chapters 6 and 7 deal with topics which usually receive much less attention, namely the reflecting coatings of the mirrors, the design of the adapters, and the reduction of straylight through the use of baffles. Even the best coatings reflect at most 90% of the light over a reasonable range of wavelength, and the reflectivity degrades considerably if the mirrors are not regularly cleaned. Modern approaches as described in Chapter 6 are required to improve the situation. In modern telescopes, the adapters and rotators, which are often integrated into one unit, have to fulfil many tasks including guiding and wavefront sensing.

Finally, the short Chapter 8 stresses the importance of regular and systematic maintenance to preserve or even improve the quality reached after the commissioning of the telescope.

The book contains many more aspects and details than could be mentioned in this review. In fact, to the reviewer's knowledge it is the only monograph currently available which treats the whole range of modern optical technology of reflecting telescopes in a comprehensive way, whereby, as mentioned in the preface, interferometry between telescopes as well as solar and X-ray telescopes have been deliberately excluded as subjects which are too extensive or too specialised. (In contrast, a number of other modern treatments of the theory of Volume I exist, notably Schroeder's "Astronomical Optics"). It should be stressed that most of Volume II does not require a deep knowledge of the optical theory presented in Volume I. It should therefore also be of use to readers who are working in specialised areas or who simply want to get an overview of modern telescope technology. Special topics can easily be found with the help of the extensive name and subject indices, and thanks to the long list of references, the book is an entry point for more detailed studies.

Furthermore, amateur telescopes are getting bigger and better and are more and more computer controlled. Since many of the techniques and conclusions in this book can also be applied to these telescopes, the book should also be of interest for more ambitious amateur astronomers.

With the extensive name and subject index this volume should also be useful as a reference book.

L. NOETHE

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(1 October 2001 – 31 December 2001)

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