Observing with the VLTI
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Foreword

Astronomical interferometry was first imagined by Hippolyte Fizeau in 1868. He proposed to observe stars through two apertures to obtain interferences that would give an information on the spatial intensity distribution of the source. The resulting resolving power linearly increases with the distance between the apertures and therefore the interference fringes vanish for stars with a diameter proportional to the reciprocal of the baseline of the interferometer. This idea opened the way to a better understanding of most of celestial sources then only known as point-like objects. This technique after being first tested by Édouard Stéphan in 1874, proved to be efficient when Albert A. Michelson first measured the Jupiter satellites, binary stars orbits and the first diameter of a star other than our Sun, Betelgeuse in 1921. Stellar diameters were measured by the Michelson group during the first half of the twentieth century with two flat mirror-apertures fixed on a beam on top of a telescope mount. This technique gave access to a limited baseline hence to a limited spatial resolution. More resolution required longer baselines and the use of separate telescopes. This challenge was overpassed by Antoine Labeyrie in 1975 when the diameter of Vega with a 16 meter baseline interferometer was measured. Interferometry entered into a new era.

Since these pioneering times, astronomical interferometry has developed and a large variety of instruments have been built in Europe, in the United States and in Australia. These instruments are called stellar interferometers since they essentially measure the morphology of stars, the orbits of binary systems or perform stellar astrometry. Limitation to stellar physics only results from the limited sensitivity of these instruments. The recently developed adaptive optics technique corrects for wavefront distortions in real time allowing the use of much bigger apertures. Similarly fringes can also be stabilized actively and summed up to increase the quality of the signal. These two techniques are the main features of the new generation interferometers. With a better sensitivity fainter sources can be observed and new astrophysical domains become reachable as for example extragalactic astronomy.

Access to optical interferometers has been limited until now to a small community of experts because the instruments were essentially prototypes with a large number of sub-systems to handle that observers needed to understand and master in order to perform observations. New interferometers like VLTI have been designed to be operated like regular astronomical instruments for which technical knowledge is not mandatory. This is a very important progress: a much wider community of astrophysicists can have their own observations. In addition, VLTI will be among new born interferometers one of the most powerful with four 8-m unit telescopes and at least three 1.8-m auxiliary telescopes. VLTI will push the boundary of current investigations from studies on multiple stellar systems and determination of stellar diameters to the fields of star formation, extra-solar planets and for the first time the study of the inner part of galaxies. VLTI will be able to probe the objects with an angular resolution 20 times better than the biggest telescopes on Earth.

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The motivation to organize this school was the perspective that a large fraction of astronomers are going to use VLTI instruments, MIDI and AMBER, to make progress in their own research fields. We are confident that the imagination and creativity of these astrophysicists will generate many new programs and important results in still virgin fields. One of the challenges of this school is to convince participants that training to interferometric observations is not very demanding and in turn will be very rewarding. This training can be split into two parts: (i) preparation of observations and (ii) data analysis. This first school covers the preparation of observations. A second school of this series will focus on data reduction and analysis with VLTI.

Although not difficult, the philosophy of the preparation of the observations is somewhat specific to astronomical interferometry. Observability of sources not only requires that the source be properly located in the sky but also that the array of telescopes be well configured at the time when the source is observable. It is important that the configuration is optimized to ensure that the searched information on the object be measured or that the imaging quality is the best. This specificity makes the preparation more demanding than it is for usual single-telescope observations as sources may only be observable more than a few minutes for a given configuration. The optimization of the duty cycle is an important feature of interferometric observations. Other items than geometrical constraints such as computing exposure times, choosing spectral resolution and filters, etc., also play a major role in the preparation of observations.

We have selected lectures to cover most of aspects of astronomical interferometry which are of importance for preparing observations. Lectures include both theoretical and practical aspects of interferometry to give participants a complete and coherent basis from the theory of aperture synthesis to the optimization of the array and the computation of exposure times. We have made the choice to allocate a large fraction of time for practical sessions and put the emphasis on the use of tools developed to prepare observations which will be available to VLTI users. Lectures also include examples of real observations with their astrophysical analysis to illustrate the power of the technique and give hints on how to address some classes of problems.

The scientific program of the school has been divided into five main parts which are the main chapters of this book. The first two parts are on the theoretical and practical principles of interferometry. The third part is on VLTI and its instruments MIDI and AMBER. The fourth part deals with the details of the preparation of an observation. The fifth part is dedicated to the interferometric information with examples of astrophysical projects based on the use of visibilities, closure phases and differential phases or spectral visibilities. Projects and proposals to use the Very Large Telescope Interferometer (VLTI) presented by the participants have been added to this chapter. The last chapter includes poster contributions presented by the participants. The chapters also feature the exercizes of the practical work sessions.

Advertizing of the school has met a good success and twice more applications than the number of possible attendees were rapidly collected. Fifty four participants from twenty two different countries were eventually welcomed. Most of astrophysical fields of interest were represented. As we believe the school was useful to all, we wish to thank the lecturers who dedicated their time to prepare their presentations, to discuss with the participants and also to contribute to this book.

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