Editorial

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Optics for astronomy – Editorial

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Astronomy is a science that anybody can relate to: There is not a person under the Sun (or, at night, under other suns) who has never looked up at the sky with a sense of fascination, awe, and curiosity. Humanity's long-standing quest and formidable effort to understand the universe may have its roots in our desire to understand our own place in it. This is as much a philosophical question as a scientific one. Astronomy keeps contributing to the progress of humanity, as shown by the change in attitude with which we have received news from the sky over the centuries. Whereas it used to be dangerous to publish results showing the Earth is not the centre of the universe, today we are actively constructing instruments that will discover potentially habitable planets outside of our solar system. Whereas we used to have to find sometimes convoluted explanations for what our eyes could see, we are now enthusiastically making better and better instruments to see so much more (and explain that too in due course).

It is against this backdrop of human inquisitiveness that you, the audience, may wish to appraise the selection of topics offered in this Topical Issue. Whilst there is much to be learnt from the entire electromagnetic spectrum (and soon gravitational waves as well), the emphasis here is on optical telescopes, instruments and related sub-systems, because it was our eyes that made us so curious in the first place.

We start with three review papers on design considerations for new and improved instruments. The first article by Lemaitre deals with terrestrial telescopes and describes how active optics can achieve the best possible wavefront correction with the minimum number of actuators, using optimised structural mechanics.

A passive method to contribute to better image quality for both terrestrial and space-borne telescopes is described in the article by Moretto and Kuhn: They suggest off-axis telescope designs leading to higher dynamic range. Such telescopes are excellent candidates for investigating stellar atmospheres and finding faint companions, and the authors enumerate some instruments whose construction is already underway.

Identifying chemical compounds in space requires spectroscopy, but the scientific throughput of a telescope is limited by the aperture size (number of photons collected from a single source) and the number of simultaneous observations. Hill presents a forward-looking solution of using multiple spectrographs to collect data on over 30,000 regions in the sky at the same time.

The next section could be titled "space optics fabrication", as all the technologies presented include flight-qualifiable hardware. In another review paper, Kong and Young show the application of ultra-smooth finishing technology to selected demanding examples of Zerodur and silicon carbide mirrors for astronomy.

Despite the progress in polishing technology, some instruments must still be assembled, and this is the topic of the last review paper for this issue, where van Veggel and Killow give an overview of applications and the state of the art in glass-bonding for making monolithic and very stable instruments from many small parts.

The first research paper in our selection, and the last one on space-flight hardware, is by Gensemer and Farrant, who describe how tunable narrow-band etalons can be made to observe a very specific wavelength for a Sun-orbiting observatory.

Measuring and validating the very demanding specifications for one-of-a-kind astronomy instrumentation has already been a recurring theme in the previous section; the last three research papers deal specifically with the science of measurement. First, Noethe et al. introduce a promising way to deduce telescope prescription errors from images obtained over the full field of view.

Besides interferometry, the new incoherent technique of deflectometry has recently emerged for optical testing, and the paper by Olesch et al. showcases its surprising strength in the simple, fast, and accurate testing of telescope mirrors.

The final article by Bonaccini Calia et al. discusses the challenges and the state of the art for laser guide stars, a key technology in enabling the new generation of Extremely Large Telescopes to meet their resolution limit through a turbulent atmosphere by using active optics, which neatly concludes the issue with a reference to the beginning.

We sincerely thank all the invited authors for their contributions and for their obvious enthusiasm in writing and illustrating. Also, we thank the Editor-in-Chief and the publisher for the opportunity to put this issue together, and the reviewers and the staff at AOT for making it a reality. Finally, thank you, dear reader; we do hope you come away from this cornucopia of human resourcefulness as we did, with a sense of fascination, awe, and curiosity.

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Andrew Rakich has been “playing” with astronomical optics since, as a teenager in New Zealand, he learned how to make his own paraboloid mirrors for amateur telescopes. In a classic case of hobby-leading-to-career, Andrew went on to complete an MSc and PhD at the University of Canterbury in New Zealand, writing theses on the aberration theory based approaches to optical design. As a professional Andrew has been especially interested in all aspects of astronomical optics, from design through manufacture and into integration, commissioning and operations. Working in this field has seen him based around the world; from KiwiStar Optics in New Zealand, to EOS Space Systems in Australia, to the LBT in Tucson, Arizona, and currently to Munich, Germany. Here Andrew is engaged as an optics specialist and is contributing to the development of the European Southern Observatory E-ELT, a 39 m diameter optical and near infrared telescope.

Jan Burke holds a PhD in physics from the University of Oldenburg, Germany, awarded in 2000 for a thesis on speckle interferometry. From 2000 to 2002 he worked at MetroLaser in California, on topics such as digital holography and fringe projection. In 2002 he joined the CSIRO in Sydney, Australia, where he contributed low-uncertainty metrology, absolute calibration methods, and highly customised phase-shifting methods to the work of CSIRO Precision Optics. In 2010 after seeing large telescope mirrors being tested with deflectometry at the Steward Observatory Mirror lab in Tucson, he became interested in exploring the potential of incoherent methods for absolute figure measurement. In 2011 he joined BIAS in Bremen, Germany, where he is currently pursuing this interest among others, as leader of the Geometric Metrology research group. In 2012 he won the SPIE Technology Award together with the CSIRO Precision Optics team for its contributions to numerous domestic and international astronomy instruments.

Jim Burge is Professor of Optical Sciences, Astronomy, and Mechanical Engineering at the University of Arizona where he directs the Large Optics Fabrication and Testing group and the Optomechanical Engineering Laboratory. Dr. Burge has published over 300 papers that span the fields of optical design, fabrication, testing, alignment, instrumentation, and optomechanics. Dr. Burge is fellow of SPIE and OSA.