

Future Ground-based Solar System Research: Synergies with Space Probes and Space Telescopes

held at Portoferraio, Elba, Italy, 8-12 September 2008

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An interdisciplinary workshop bringing together Solar System researchers, space mission engineers and scientists, ground- and space-based observers and theoreticians is summarised. The broad scope of the meeting covered current and future space missions, planned ground-based facilities and their closer interaction.

In a previous issue of *The Messenger* (Käufel & Sterken, 2006) there was a report of a dedicated workshop, co-sponsored by ESO and held in Brussels, in the context of NASA's Deep Impact space mission to comet 9P/Tempel 1. This comet had been the focus of an unprecedented worldwide long-term multi-wavelength observation campaign. Many participants at this workshop, looked beyond their direct involvement in the Deep Impact experiment, and frequently noted how useful it was to hold interdisciplinary workshops, which bring together Solar System researchers, those involved in spacecraft experiments, ground- and space-based remote observers and theoreticians. The idea of a similar meeting was born. Part of the programme of the Brussels workshop was a joint excursion to the battlefield at Waterloo, close to the conference venue. Standing at the monument there, some participants remarked how incredible it was that this battle took place only 100 days after Napoleon's escape from the island of Elba, and how difficult it often is these days to get anything going within a few months. Somehow this sparked the idea of the "Route Napoleon Reverse" that is to say, the next such workshop should happen on the island of Elba. Needless to say, it took us more than 100 days to organise it!

Fundamentally new observing platforms and space probes will become available for Solar System research in the coming decades. The Elba 2008 workshop



provided a forum to discuss the use of these future facilities, and especially how to optimise the scientific returns and to establish synergies. It was particularly interesting to identify, or at least start the process of identifying, the potentially paradigm-shifting observations that will become possible with the next generation of large ground-based telescopes and their advanced instrumentation.

Among the various goals of the workshop, the fostering of collaborations between ground and space projects, such as those between ESO (ground) and ESA (space), was the primary goal. In general we sought to create synergies between research programmes at different wavebands into Solar System objects. For the ground-based projects the aims were to define the Extremely Large Telescope (ELT), and in particular the European ELT (E-ELT), science cases for the Solar System science and to refine the science case for the Atacama Large Millimeter/submillimeter Array (ALMA).

The topics that were specifically addressed during the meeting fall under the two headings of ground-based support for existing or planned space missions and new facilities for remote observations. There are missions to comets and asteroids (e.g., Rosetta, Dawn, Deep Impact and Stardust Wrap-up), to the outer Solar System planets and moons (e.g., Cassini-Huygens and New Horizons), to terrestrial planets and the Moon (e.g., Mars and

Figure 1. The workshop took place in the historic centre of the city of Portoferraio, dominated by the Renaissance fortifications erected in the 16th century under the reign of Cosimo I de' Medici. The venue, near the centre of the photograph, is flanked to the left by a building of reddish ochre colour, to the right by a small church tower, and was originally commissioned as a barracks. It later became a monastery, but serves now as a cultural and congress centre (named after Cesare De Laugier), as well as a picture gallery (Pinacoteca Foresiana) and the city library (Biblioteca Comunale).

Venus Express, Messenger and BepiColombo). In the ESA Cosmic Vision 2015–20 programme there are also expected to be a number of planetary missions. In the area of new facilities for remote observations the planned ELTs (E-ELT, Thirty Meter telescope [TMT] and Giant Magellan telescope [GMT]) were considered, as well as ALMA.

Following a first series of reviews and status reports on the major observing facilities, topical sessions were held on main belt asteroids, the giant planets, including their moons and magnetospheres, Trans-Neptunian Objects (TNOs), including Pluto, comets and the formation of the Solar System. A bridge was made from the study of our Solar System to the relatively new field of extrasolar planetary systems. We are starting to consider our Solar System as one of many possible planetary systems, or alternatively, our Solar System to be in range of extrapolation of current theories of star and planetary system formation. Our Solar System is also the yardstick that will define the

characteristic observables when direct observations of extrasolar planets become feasible, with future facilities such as the E-ELT.

The detailed scientific programme of the meeting is available at <http://www.arcetri.astro.it/elba2008/>. The scientific scope ranged from the detection of the tenuous sodium atmospheres of Mercury and our Moon to the bio-signatures of extrasolar planets. The proceedings will be published in a special edition of *Earth, Moon and Planets*, with a target publication date in the first half of 2009.

In the conference summary, provided by Hermann Boehnhard, the following main conclusions were reached and agreed:

- Even the most advanced and sophisticated space missions that provide for *in situ* data need the complement of remote sensing data to place the observations in their wider scientific context.
- The Solar System inventory is far from complete and there is a strong need for more surveys. For the faintest objects a serendipitous occultation mode (e.g.,

involving telescope acquisition cameras) shows great promise.

- For the inventory of asteroid and cometary nuclei, systematic statistical studies of shapes, sizes, albedos and rotation will depend critically on ground-based telescopes as well as the James Webb Space telescope (JWST). The same conclusion holds for the study of their surface chemistry.
- Paradigm-changing observations can, for example, be expected in the field of planetary atmospheres. Currently the long-term stability of planetary atmospheres against erosion by solar UV radiation and particle flux is not understood; high resolution spectral and spatial observations may provide for fundamentally improved insights into the relevant processes.
- In order to achieve a synthesis between the observations and theory of extrasolar protoplanetary discs and our Solar System, more mineralogical data (e.g., mid-infrared low resolution spectroscopy) for primitive bodies in our Solar System are mandatory.

- European astronomers will be in the front seat for these research programmes, thanks to participation in ALMA and the instrumentation suite under study for the E-ELT (D'Odorico et al., 2008). For Solar System studies, the METIS instrument (Mid-infrared Imager and Spectrograph with Adaptive Optics) and EPICS (the Planet Imager and Spectrograph with extreme adaptive optics) are most relevant.

In a splinter session, some 20 participants also convened to form the kernel of a working group to complement the Science Case of the E-ELT with a special Solar System section. Follow-up activities of this group are being planned soon¹.

References

D'Odorico, S. et al. 2008, SPIE, 7014, 70141
 Käufel, H.U. & Sterken, C. 2006, *The Messenger*, 126, 48

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Report on the ALMA Workshop

Simulations for ALMA

held at IRAM, Grenoble, France, 8–10 September 2008

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A workshop on Simulations for ALMA was held on 8–10 September 2008 at IRAM. About 40 participants from Europe, North America and Japan attended, and discussed many aspects

of ALMA imaging: topics included detailed scientific simulations of astronomical observations together with more technical simulations of instrumental and atmospheric effects and the strategies for their correction. The workshop web page contains the presentations made at the meeting and is available from <http://www.mrao.cam.ac.uk>.

Construction of the Atacama Large Millimeter/submillimeter Array (ALMA) in northern Chile is proceeding rapidly. The majority of the hardware design is

complete, and in many cases full production is underway. Eleven antennas have already been delivered to the mid-level site, the Operations Support Facility (OSF), near San Pedro de Atacama. With interferometric fringes expected next year, now is a good time to revisit in detail the plans for ALMA data analysis to ensure that ALMA scientists have the necessary tools both to develop their scientific observing programmes with ALMA and produce the best possible datasets for scientific analysis.

Extensive work is being done in many of the ALMA partner countries to develop