Report on the Workshop on

Deep Impact as a World Observatory Event

held in Brussels, Belgium, 7–10 August 2006

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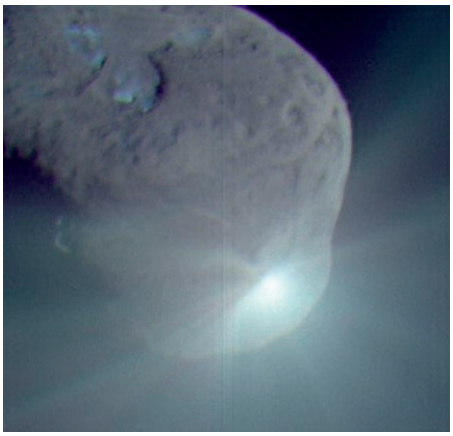
In the context of NASA's Deep Impact space mission, Comet 9P/Tempel 1 has been at the focus of an unprecedented worldwide long-term multi-wavelength observation campaign. The comet has been studied through its perihelion passage by various spacecraft including the Deep Impact mission itself, HST, Spitzer, Rosetta, XMM and all major ground-based observatories in basically all wavelength bands used in astronomy, i.e. from radio cm-waves to X-rays. For some 'glossy-print' information please have a look to e.g. ESO's dedicated web-pages (*deepimpact.eso.org*). Due to the dynamical and other technical constraints of the space mission, ESO's telescopes could not observe the moment of impact – the comet was indeed exactly setting on the western horizon. However, the ESO observatory sites, La Silla and Paranal were more or less the worldwide hub of the mid- and long-term ground-based observations for monitoring. Predictions for cometary activity induced by the experiment made before the impact ranged from 'very little' to the instantaneous release of material equivalent to ~ 10 days of normal activity of the comet close to perihelion. In summary, Mike A'Hearn, the PI of Deep Impact, confirmed in his review talk, that the release was at the lower end of expectations and that there was no activity of the impact site induced after the crater had formed. Especially as the long-term signatures after impact were rather subtle, the use of the world's best facilities to document the event was well warranted in retrospect.

The ground-based observing campaign has been described in a recent Science publication by 209 authors from 85 academic institutions all around the world (Meech et al. 2005). Some early results from the ESO observations have been reported earlier in The Messenger (Käufl et al. 2005).



One of the spectacular deconvolved images from the Deep Impact Spacecraft High Resolution Imager shown in the conference (courtesy Mike A'Hearn and the Deep Impact Team). This is a colour composite of an infrared, a green and a violet filter forced to average grey. Note the blueish areas on the surface close to the crater-like structure. Those were entirely unexpected. It is highly interesting to find out if those structures can be correlated with the jets which were meticulously monitored from ground-based observers worldwide. This aspect in the picture – entirely unrelated to the impact plume – illustrates very well how comet research, apart from the impact experiment, will profit from the synergy of spacecraft data and the unprecedented worldwide coordinated observing campaign.

To make full use of the global data set, a workshop bringing together observers across the electromagnetic spectrum and from different sites and projects was considered of great value. Synergy between the different data sets can only be achieved if observers share their data and arrive at a coherent interpretation. Therefore the astronomers participating in the ESO campaign took the lead to organise this workshop on a rather short notice. The workshop was held in Brussels, Belgium from 7 to 10 August. More than 70 colleagues presented 50 oral papers and 18 posters. The proceedings will be published in the ESO Springer conference series.

At the Brussels workshop – 12 months after Deep Impact – all participants had progressed sufficiently in the analysis and understanding of their data sets. The coherent presentation of many diverse results allowed for a synthesis. Thanks to the Deep Impact campaign, many properties from thermal inertia to tensile strength of the cometary nuclear surface are now well constrained. Already at the workshop an intense discussion to arrive at synergies – which will be transcribed for the proceedings – took place. Particularly interesting and exciting, however, are the open questions such as: the chemical composition of the ejecta; the correlation of the complex observed dust fans reported from many weeks of ground-based monitoring of nuclear surface features, as imaged by the spacecraft; and the absence of long-term effects from the impact site. Indeed the nature and physics of jets and active zones of comets appears more enigmatic than ever.

To inspire new ideas, it was very helpful and interesting to have Roberta Olson from the New York Historical Society, author of the book *Fire in the sky* (Olson and Pasachoff 1999), at the workshop delivering a lecture titled *Comets, Charisma, and Celebrity: Reflections on Their Deep Impact*. Comets, like no other class of celestial objects, have spurred intense attention of mankind to watch the skies and to wonder about the underlying principles and messages. For many participants, however, it was new how far reaching the impact of apparitions of bright comets on the general public are and how this manifests itself in many diverse pieces of art.

As with any good research project, the Deep Impact experiment and the associated observation campaign have answered a fair set of questions about comets, but there are still open questions and there is now a full set of new questions. On the other hand, the next generation of spacecraft, especially the ESA-mission ROSETTA, to land in August 2014 on Comet 67P/Churyumov-Gerasimenko and the next generation of optical and radio telescopes, e.g. ALMA and the ELT, will be the keys to solve at least some of the truly enigmatic aspects of comets (and create new questions).

Acknowledgements

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References

Meech K. et al. 2005, Science 310, 265
Käufl H. U. et al. 2005, The Messenger 121, 11
Olson R. and Pasachoff J. M., "Fire in the Sky", ISBN 0521663598. Cambridge, UK: Cambridge University Press, November 1999

Photo: T. Tuvikene

The participants to this workshop, in the great hall of the magnificent palace of the Royal Academies for Science and the Arts of Belgium. The very special atmosphere of this historical building was very inspiring for this workshop. During the worldwide ground-based Deep Impact follow-up observing campaign, all observatories were basically linked and exchanging data, views and strategies quasi in real-time. This unique spirit prevailed also during this dedicated workshop.

Around and about "Europe's Quest for the Universe"

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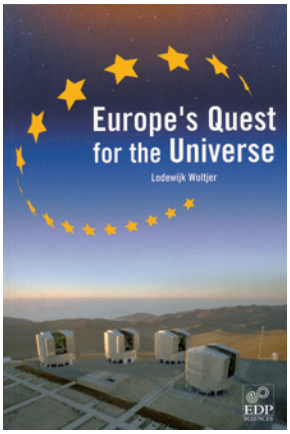
Before even starting a review of "Europe's Quest for the Universe", I think one should say a few words about its author. A truly impressive characteristic of Professor Lodewijk Woltjer is indeed his vision towards excellence, in particular towards excellence in observational astrophysics in (and for) Europe. One example: almost thirty years ago, he 'forced' some fairly conventional European observers to start working on extragalactic astrophysics on the occasion of the erection of ESO's 3.6-metre telescope, and even more so when the 3.5-m New Technology Telescope became available. As far as my own research group was concerned, this led to the discovery, via these ESO telescopes, of several gravitational lenses. This type of research was in fact made possible because Lo Woltjer put together excellent teams of engineers and scientists at ESO dedicated to developing innovative and sophisticated telescopes and their auxiliary instruments.

Professor Woltjer, ESO's Director General for 13 years, was also instrumental in initiating studies towards conceiving and building a European Very Large Telescope (the VLT), and getting the VLT construction started. Having been deeply involved in the VLT advisory structure (which he kindly mentions in his book!) I can testify that Lo Woltjer's role was incredible: from a European vision to a remarkable ground-based astronomy machine.

In parallel to this, he also had another vision, this one about interesting objects to observe, and at which wave-bands. Here again his role in chairing the groups defining the future of European space astrophysics was really fundamental, so that ESA's Horizon 2000+ objectives became fantastic challenges.



So, in addition to his skills in theoretical astrophysics, a very interesting characteristic of Lo Woltjer concerns the two complementary facets: ground-based and space-borne astrophysics. In both cases, as briefly outlined above, he played a pivotal role. He is therefore highly qualified to have written the recent 300-page book about the origins and evolution of the European Southern Observatory (ESO) and of the science pro-