EURO-VO Data Centre Alliance workshop: Theory in the Virtual Observatory

Garching, April 07-09, 2008

Scientific Organizing Committee

S. Cassisi (INAF),
M. Cervino (IAA-CSIC),
D. De Young (NOAO),
G. Lemson (ARI-ZAH, MPE),
P. Osuna (ESAC),
J. Schaye (Leiden),
H. Wozniak (Lyon),
N. Walton (Cambridge)

Local Organizing Committee

A. Carlson (MPI for Extraterrestrial Physics, Garching, Germany),
J. W. Kim (MPI for Extraterrestrial Physics, Garching, Germany),
G. Lemson (ARI-ZAH, Heidelberg; MPI for Extraterrestrial Physics, Garching, Germany),
G. Taffoni (INAF Trieste, Italy),
J. Zuther (MPI for Extraterrestrial Physics, Garching, Germany)

Sponsorship

EURO-VO Data Centre Alliance (EURO-VO DCA), Max-Planck-Institute for Extraterrestrial Physics, The German Astrophysical Virtual Observatory (GAVO)

FOREWORD

The Virtual Observatory (VObs) is an international astronomical community-based initiative. It aims to allow interoperable global electronic access to the available astronomical data archives of space and ground-based observatories, as well as simulation databases. It also aims to enable data analysis techniques through a coordinating entity that will provide common standards, wide-network bandwidth, and state-of-the-art analysis tools[1]. The EURO-VO[2] is an EU co-funded initiative to establish a working VObs within Europe and to co-operate with other VObs initiatives around the Globe. The EURO-VO Data Center Alliance (EURO-VO DCA[3]), which is funded within the EU FP6 *e*-infrastructure framework, aims at "coordinating and assisting European data centers to take up VObs standards, sharing best practice for data providers, consolidating operational requirements for VObs-enabled tools and systems and enabling the identification and promotion of scientific requirements from programs of strategic national interest that require VObs technologies and services". VObs efforts have mainly concentrated on observational data archives and services[4] , but recently, results from theoretical research, especially simulation, have started attracting more attention. As part of the EURO-VO DCA, work package WP4 - Theory[5] accounts for this development. This workshop[6], being a deliverable of WP4, was held at the Max-Planck-Institute for Extraterrestrial Physics (Germany). It was the first workshop to bring together about 60 participants from astrophysics and VObs projects to outline needs and challenges that computational and theoretical astrophysics will be facing in the coming years, and to identify how the unique capabilities intrinsic to the VObs concept can meet them. We decided to organise the workshop accoring to different topics that were meant to demarcate somewhat coherent areas of interest for the VO. These were 3+1D simulations, micro-simulations, theory-theory interoperability, theory-observational interface, and computational infrastructure. All sessions were composed of presentations, posters, and were followed by discussions.

Introduction: An introductory session was aimed to setting the stage of the VObs in general, its results so far with special emphasis on theory.
3+1D simulations: The second session dealt with what are generally called cosmological simulations, those that aim to directly model the evolution of a part of 3D space. One feature of these is that in general the results are very large and have very different content compared to the more common observational standards and there is in general no pre-existing data standardization. Presentations were given about the largest N-body simulations to date, both pure dark matter and hydro-dynamical, and thoughts, some implemented, how to publish these to the community.
Micro simulations: Here we heard discussions on simulation approaches in the field of stellar evolution codes, population synthesis, PDR codes and attempts to publish these.
Theory-theory interoperability & Theory-observational interface: One of the promising features of the Virtual Observatory is that different archives and services might be combined together by publishing them in an interoperable manner. For observational archives this is obviously of use, as information on the same objects may be available in different observations form the same part of the sky. For theory this is less obvious. We had two sessions to

[1] See, e.g., http://www.ivoa.net
[2] http://www.euro-vo.org
[3] See project overview at http://www.euro-vo.org/pub/dca/overview.html
[4] See, e.g., introductory session of these proceedings
[5] http://cds.u-strasbg.fr/twikiDCA/bin/view/EuroVODCA/WP4Theory
[6] http://cds.u-strasbg.fr/twikiDCA/bin/view/EuroVODCA/WCAWP4Workshop

investigate interoperability, one on theory-theory and one on theory-observations. Theory-theory interoperability was represented amongst others by presentations on code comparison and code combination projects. Theory-observational interoperability deals with the various means by which observers can use the results of theory, be it via virtual telescopes or advanced fitting methods.

Computational infrastructure: The final session dealt with computational infrastructure. Here we heard talks about applications of the Grid, relational databases, VObs aware tools to the publication and analysis of theory data for a larger audience. This session also provided the bridge to the *Grid and the Virtual Observatory* workshop following subsequently to the theory one.

We had lively discussions after each session, emphasizing the interest of the astronomical community in the synergies of theory and the VObs. The results of the discussions found entry into a Theory-VObs white paper, which is the main deliverable of WP4, and is about a framework for the inclusion of theory data and services into the VObs. Here, we briefly state the discussion results.

- Recent work shows that, although the theory meta data models and data access standards are not fully mature yet, it is already possible to publish simulation data and services using the current state.
- In order to foster the evolution of the theory standards, it is important to get theoretical researchers involved into the IVOA standardization process. It was noted that the involvement should not focus on the technical level but on the scientific/work requirements. For (potential) users to get a better view of the current situation it was mentioned that a cookbook/tutorial style documentation is urgently needed.
- Micro-simulations have turned out to deserve a renewed focus (after the support for theory spectra in SSAP) of the VObs efforts in terms of data models and interoperability. Especially the interoperability is of great interest, since individual micro simulations can build on each other.
- Are there two classes of theoretical products/services? On the one hand, data services related to huge data sets (cutout, mock observation, rough analysis, quick look, etc.) should be installed close to the data. Most of the large data sets are produced by almost standalone codes (N-body, hydro, etc.) for 3+1D simulations. On the other hand, 'quick' codes could be implemented as 'on-the-fly' services and might be inserted in workflows (typical of micro simulations).
- There might be synergy between large surveys (e.g., SDSS) and large simulations in terms of internal consistency, uniformity, and size that prevents practical downloading of the entire data set. Perhaps some effort should be made to adapt existing tools and applications that are used for survey data sets to theory data sets instead of reinventing tools just for theory.
- There are concerns about credits, description of the physical assumptions, and about (the need for) preservation of the archives. These require intense interaction between experts in the fields and the VObs partners.

We acknowledge the co-operation of all Scientific and Local Organizing Committee members and their contribution to the organization of this workshop at all levels. We would also like to thank all participants who have added to such a successful and fruitful workshop, and all the authors who have dedicated their time and effort in the preparation of the present proceedings volume.

G. Lemson, J. Zuther, and J. W. Kim