Figure 1 (above). The three ALMA antennas on Chajnantor working as an interferometer. The APEX telescope is also visible in the background.

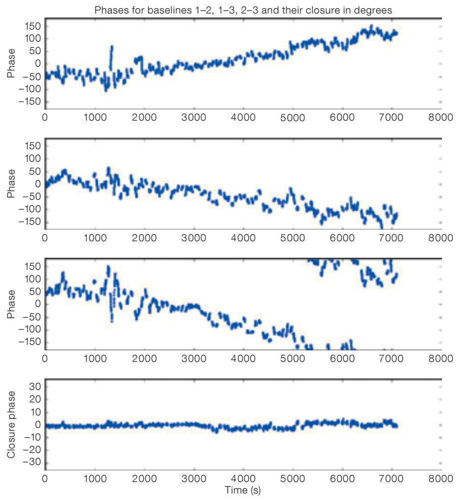

Figure 2 (right). Test of closure phase with three antennas at AOS. The upper three panels show the phase as measured on each of the three baselines and the bottom panel shows the closure phase.

and perform the necessary tests to allow a release of the first call for proposals for Early Science observations with ALMA.

This progress has been made possible by the many people intent on keeping to the schedule for the hardware and software deliveries for the closure phase and the start of CSV activities, as well as by the tireless efforts of the ALMA AIV and CSV teams led by Joe McMullin and Richard Hills.

Report on the Workshop

Data Needs for ALMA

From Data Cubes to Science: Ancillary Data and Advanced Tools for ALMA

held at the I. Physikalisches Institut, Universität zu Köln, Germany, 5–7 October 2009

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A summary of a workshop bringing together laboratory physicists, chemists and astronomers to discuss the needs and strategies for developing common approaches to data and models for ALMA is presented.

The Atacama Large Millimeter/submillimeter Array (ALMA) will revolutionise many scientific areas by providing an unprecedented quantity and quality of high spatial and spectral resolution (sub)millimetre wavelength spectral line data. These data will allow detailed observational tests of astronomical models of astrochemistry, star and planet formation, galaxy formation and evolution, and many others. The high quality ALMA data will allow much more stringent comparison between observations and models than has been possible with data from current instruments. Nevertheless, to achieve this, the models (e.g., chemical network models, radiative transfer programmes, etc.) need to be of commensurate quality. Additionally, given the expected ALMA data production rates, easy and perhaps innovative ways of comparing and visualising models and data must be available. The models need to have access to fundamental physical data, such as molecular and atomic line frequencies and strengths, collision rates, dust properties, etc. While producing the models themselves is a science activity, adapting them for use with ALMA data, and making them available to a larger community (including testing, documentation, etc.) is not. This latter is especially critical since one of the goals for ALMA is to be easily useable by the wider astronomical community and not to be restricted only to experts in millimetre and radio interferometry.

In order to optimise the science output from ALMA, there is therefore a need to produce and gather ancillary data and make them available to ALMA users, as well as adapting and making available scientific models for use by the ALMA community at large. While some efforts along these lines exist, such as the Cologne Database for Molecular Spectroscopy

(CDMS), the Jet Propulsion Laboratory (JPL) Splatalogue, the Observatoire de Paris ro-vibrational collisional excitation database BASECOL, the Leiden Atomic and Molcular Database (LAMDA), the RATRAN radiative transfer programmes, the ease of use of these tools for both data and models is not at the level desired. In addition there is significant concern in the astronomical community regarding the long-term availability of support for the laboratory and theoretical efforts that have been, and are continuing, to produce the basic physical and chemical data required for astrophysical modelling.

The workshop “Data Needs for ALMA”, organised with the sponsorship of Radionet and the major ALMA partners, ESO, the National Radio Astronomy Observatory (NRAO) and the National Astronomical Observatory of Japan (NOAJ), was dedicated to the discussion of the above topics. The workshop brought together laboratory physicists, chemists, and astronomers as providers of data and models, together with astronomers as customers, to discuss data and modeling needs and strategies for developing common databases both of physical data and models for use with ALMA data. The programme and many of the talks are available[1].

Workshop topics

The workshop opened with a summary of the status of ALMA construction and a summary of the plans for ALMA Early Science and user support software and databases. ALMA will provide software to support the various phases of observing programme preparation, from proposal submission (Phase 1) to Scheduling Block preparation (Phase 2), pipeline and offline data reduction software, which, together with the widespread user support through the ALMA Regional Centres, will allow ALMA users to plan for their observations and produce quality-assured data cubes (“ALMA images”) ready for scientific analysis. The need for advanced analysis tools and catalogues for proper exploitation of ALMA data was clearly demonstrated with Institut de Radioastronomie Millimétrique (IRAM) and SubMillimeter Array (SMA) observations of the molecular cores surrounding forming low- and high-mass stars. With a fraction of the bandwidth and sensitivity of the future ALMA observations, we are already detecting not only a variety of molecular lines that require proper chemical modelling, but a large fraction of emission features from molecular species that are not yet identified (see example in Figure 1).

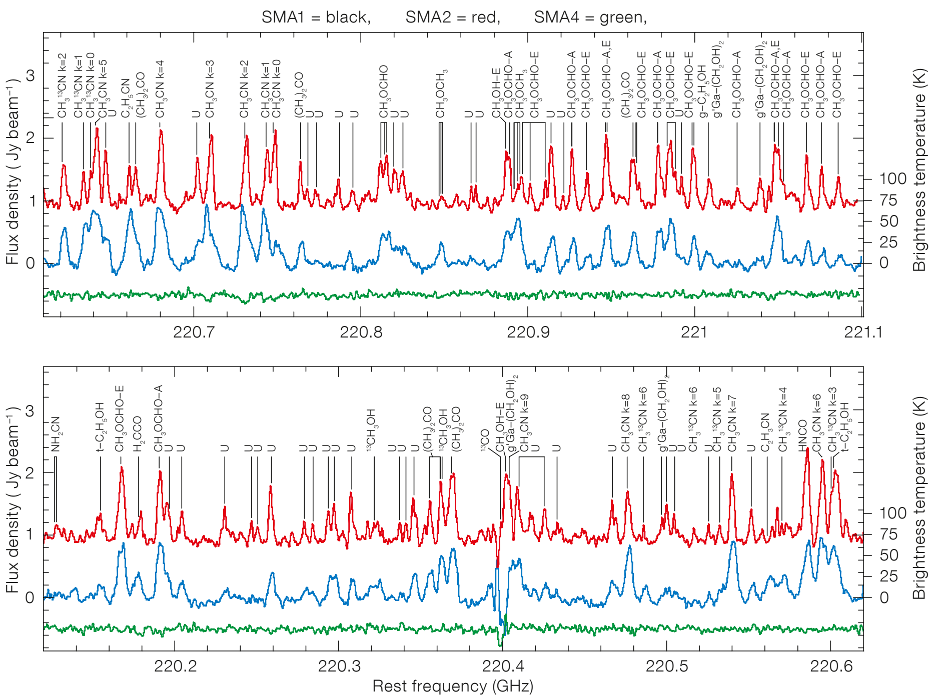

Figure 1. Example of SMA hot core spectra from three massive star-forming cores separated by less than 5000 AU in NGC 6334I, showing the richness of molecular species and the large fraction of unidentified lines (Brogan et al., in preparation).

The need for the development of advanced chemical models, which have to include the treatment of fractionation of different isotopic species, for at least the most common atoms and molecules, was evident from observations of molecules such as CCS, ^{13}CCS and C^{13}CS that were presented at the meeting. These observations show different abundance ratios for the isotopologues than predicted in current chemical models of molecular clouds. In addition, the importance of proper modelling of source structure, and its impact on the chemical structure, the radiation transfer, and ultimately the observed spectrum of the observed sources, was emphasised in several talks.

A number of areas were identified as requiring significant additional resources including: laboratory measurements and theoretical calculations of line frequencies; collisional and reaction rates; and numerical codes to integrate these data with proper source modelling and radiation transfer. One of the major problems, which is especially critical for groups performing laboratory measurements or running theoretical computations to provide data for astrophysical modelling, is the recognition of their “service” work and long-term funding for these efforts. It was also recognised that new software interfaces that allow easy access to the different existing databases, while allowing a more efficient use of the observational data, can introduce an additional divide between the catalogue producers and the astronomers, making it even more difficult to provide the proper recognition for the catalogue contributors and providers. As an additional difficulty, most of the physical and chemical experiments and computations required by the astronomers are not always considered as the highest priority for funding in their own field. It was thus recognised that the laboratory and computational work needed for astrophysical purposes

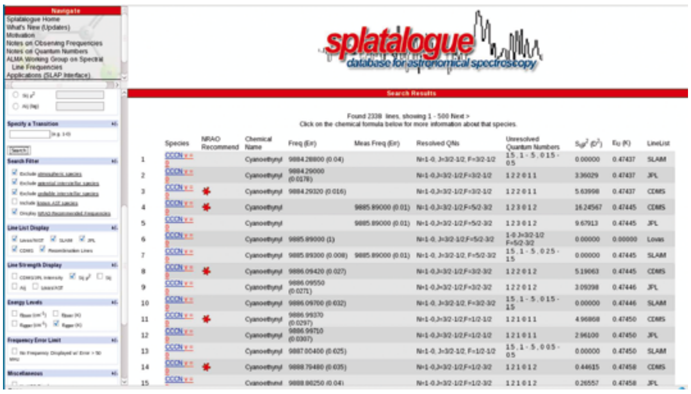

Figure 2. Example of a Splatalogue[2] search for molecular transitions near 220 GHz.

should be at least partially supported as part of astrophysics programmes.

Several possible models to mitigate this problem were discussed, ranging from direct support of these efforts from the observatories, to automatically providing the proper references to be cited whenever data from the original catalogues or calculations are used (similar to the path followed by the particle physics community). Of the various alternatives, the latter seemed to be favoured by the majority of the participants at the workshop. A first step in this direction is already ongoing with the drafting of a Memorandum of Understanding for collaboration between the Köln astrophysical laboratory spectroscopy group, providing the CDMS, and the JPL spectroscopy group, providing the JPL catalogue. At the same time, an effort is ongoing to find general agreement between the catalogue providers and the Splatalogue spectral line database (also functioning as the data provider for a number of additional catalogues) and query tool developed at NRAO. Splatalogue is available[2] and Figure 2 shows an example search. The aim is to provide a common catalogue interface that will be integrated with the ALMA and Expanded Very Large Array (EVLA) observation preparation and data analysis software. A similar path could be followed by the providers of collisional and reaction rates of astrophysical interest.

Proposals

The participants agreed at the workshop that there is a pressing need to acknowledge and support efforts to secure long-term funding for the community of physicists and chemists who are providing the data necessary to perform the scientific analysis of ALMA data. It was decided to write a White Paper that will highlight the importance of this work for the scientific output of the millimetre and submillimetre observatories. Such a White Paper could be used as a reference when asking for support from funding agencies.

The production of more advanced chemical network models, radiation transfer codes and source structure codes are the result of astronomical research; obtaining proper credit or funding for developing these is not expected to be harder than for any other astrophysical research project. The issue in this case is more to make sure that codes are available and properly documented for the potential users to obtain the best out of them. It was thus suggested that the ALMA Regional Centres could set up web pages to collect links to the available codes in a homogeneous way and in a single easily accessible location.

The workshop was regarded as very useful as a forum for discussions between astronomers, physicists and chemists. The needs posed by the new generation of millimetre observatories were identified and actions on how to provide data and models were defined. It was suggested that these workshops should be organised on a regular basis to track the progress and new developments both on the side of the astronomers needs and on the new developments with experiments, computations and catalogues.

Links

[1] Workshop programme: http://www.astro.uni-koeln.de/projects/schilke/DataNeedsForALMA/Program
[2] Splatalogue: http://www.splatalogue.net

The Messenger on the Web

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As part of a new ESO initiative, under the direction of the ESO Library, all ESO *Messenger* content from 1974 to the present is now fully available on the ESO web. The project involved scanning roughly the first 80 issues of *The Messenger* for which there were no electronic copies available. In some cases, original copies were obtained from retired staff or from the ESO library in Chile. The greater task, however, required the addition, correction and migration of over 3500 records to a database management system. As a result, improved browsing and search functions are now available on the ESO *Messenger* webpage for all issues from the first, in May 1974, to the present.

Behind the scenes, the journal publication process for *The Messenger* is now handled through a new electronic publishing platform called Marathon. Through Marathon, the *Messenger* editor and layout