ALMA for Solar System science was briefly outlined by M. Zwaan. Since solar observations will not be offered in Cycle 0, the current focus is expected to lie in observations of the atmospheres of planets and their moons, Kuiper Belt and trans-Neptunian objects, and the study of comets. Ironically, the only ALMA test data currently available for a Solar System body are single-dish observations of the Sun taken during a period of particularly bad weather, when the thick cloud cover effectively acted as a solar filter!

Star formation, both at low- and high-mass, is another research area that will benefit extensively from ALMA's unique capabilities, as shown by J. Pineda and P. Klaassen. ALMA band 7 test data have already revealed outflows for a number of molecular species in NGC 1333 IRAS4B, and the unprecedented sensitivity achievable even during Early Science is expected to have a strong impact on our understanding of core formation, fragmentation, disc and planet formation, to give just a few examples. A 14.7 GHz wide band 7 spectral sweep of the Orion Kleinmann–Low region, taken during ALMA commissioning as part of a spectral scan test, impressively illustrates the potential of ALMA for spectral line detection. With the large bandwidth covered and the high sensitivity achieved, the ALMA test observations already entirely surpass SMA data (see Figure 1 of Longmore et al. p. 42).

Hands-on software tutorials

The second and last day of the workshop was devoted entirely to hands-on software tutorials. Around 80 interested participants were split into two groups depending on their previous experience in radio/sub-mm interferometry. Each group was given a hands-on tutorial on the two major pieces of software relevant to ALMA proposal preparation: the OT and the ALMA simulators. While the tutorials were held simultaneously for the two groups, those for the novice users were slightly longer and included an introduction to radio/sub-mm concepts (presented by A. Biggs) and interferometry basics (given by A. Richards) in the OT and the simulator sessions respectively. Both groups were given software-specific presentations and live demonstration sessions (with presenters A. Avison, A. Biggs, E. van Kampen and S. Randall), followed by a few hours in which tutees could experiment with the software, with the help of a number of tutors (see upper figure on p. 38).

The enthusiastic response of the European astronomical community to this workshop and the lively discussions among the participants indicate that the groups specialising in the radio/sub-mm, and other wavelength regimes, are eagerly awaiting ALMA and Early Science operations. We look forward to a flood of excellent observing proposals and some spectacular scientific results during Cycle 0 — and beyond!

The presentations and most of the tutorial material are available in electronic form from the conference website: http://www.eso.org/sci/meetings/2011/alma_es_2011.html.

Acknowledgements

The organisation of the ALMA Community Days would not have been possible without the help of C. Stoffer, who took care of many of the practical aspects of the workshop and kept an overview at all times. We would also like to thank the members of the Organising Committee, S. Longmore, the entire ESO ARC staff and the ESO Garching IT Helpdesk staff for their help. The tutorials on the second day could not have taken place without the tutors: A. Biggs, A. Bridger, V. Casasola, B. Dabrowski, L. Humphreys, A. Kospal, S. Muller, S. Randall (OT) ; A. Avison, A. Richards, A. Rushton, E. van Kampen, M. Zwaan (Simulators). Finally, we would like to thank all the speakers for putting so much work into their presentations. The workshop was sponsored by ESO and Radionet, which provided travel support to a number of speakers and tutors.

References

Olofsson, H. et al. 2010, A&A, 515, 270

Links

[1] ALMA Science Portal: www.almascience.org

Report on the

ALMA Early Science Massive Star Formation Workshop

held at ESO Headquarters, Garching Germany, 8 April 2011

Steven Longmore[1]
Leonardo Testi[1]
Pamela Klaassen[1]

[1] ESO

With the deadline for ALMA Early Science Cycle 0 proposals fast approaching, a workshop was held for members of the European massive star formation community to discuss ideas for potential ALMA Early Science projects. The workshop began with short summary talks on the ALMA Early Science capabilities, the multi-wavelength large-area survey data available as ALMA source-finder charts and the modelling/analysis tools that are available to help interpret future ALMA data. The rest of the meeting was spent discussing science ideas and proposal strategies. There was general agreement on the main science questions to be addressed, the basic observing strategies required to achieve the goals and the future steps needed to develop the ideas into proposals.

With the deadline for ALMA Early Science Cycle 0 proposals fast approaching[1], a dedicated workshop was organised, providing a forum for members of the European massive star formation community to get together and discuss ideas for potential ALMA Early Science projects. The workshop, which followed the ALMA Community Days (see Randall et al. p. 39), was attended by 35 participants from many institutions across Europe[2] (see Figure 2).

High-mass star formation is one of the key science topics that will exploit the order of magnitude improvements in sensitivity, resolution, dynamic range and image fidelity offered by ALMA over existing millimetre and submillimetre interferometers. ALMA will excel at providing images in unprecedented detail and is the obvious follow-up instrument for lower-resolution, large-scale surveys.

The workshop therefore began with review talks on the many single-dish Galactic Plane surveys that have been conducted over the past few years; these surveys will act as ALMA source-finder charts. The advent of new facilities and instrumentation means that these surveys are now available over most of the electromagnetic spectrum, both in continuum from centimetre to near-infrared wavelengths (CORNISH[3], BGPS[4], ATLASGAL[5], Hi-GAL[6], HOBYS[7], MIPSGAL[8], GLIMPSE[9], RMS[10], UKIDSS[11]) and for spectral-line emission (HOPS[12], MALT90[13]). The typical angular resolution of these surveys range from one to a few times the ALMA primary beam. This makes ALMA an ideal

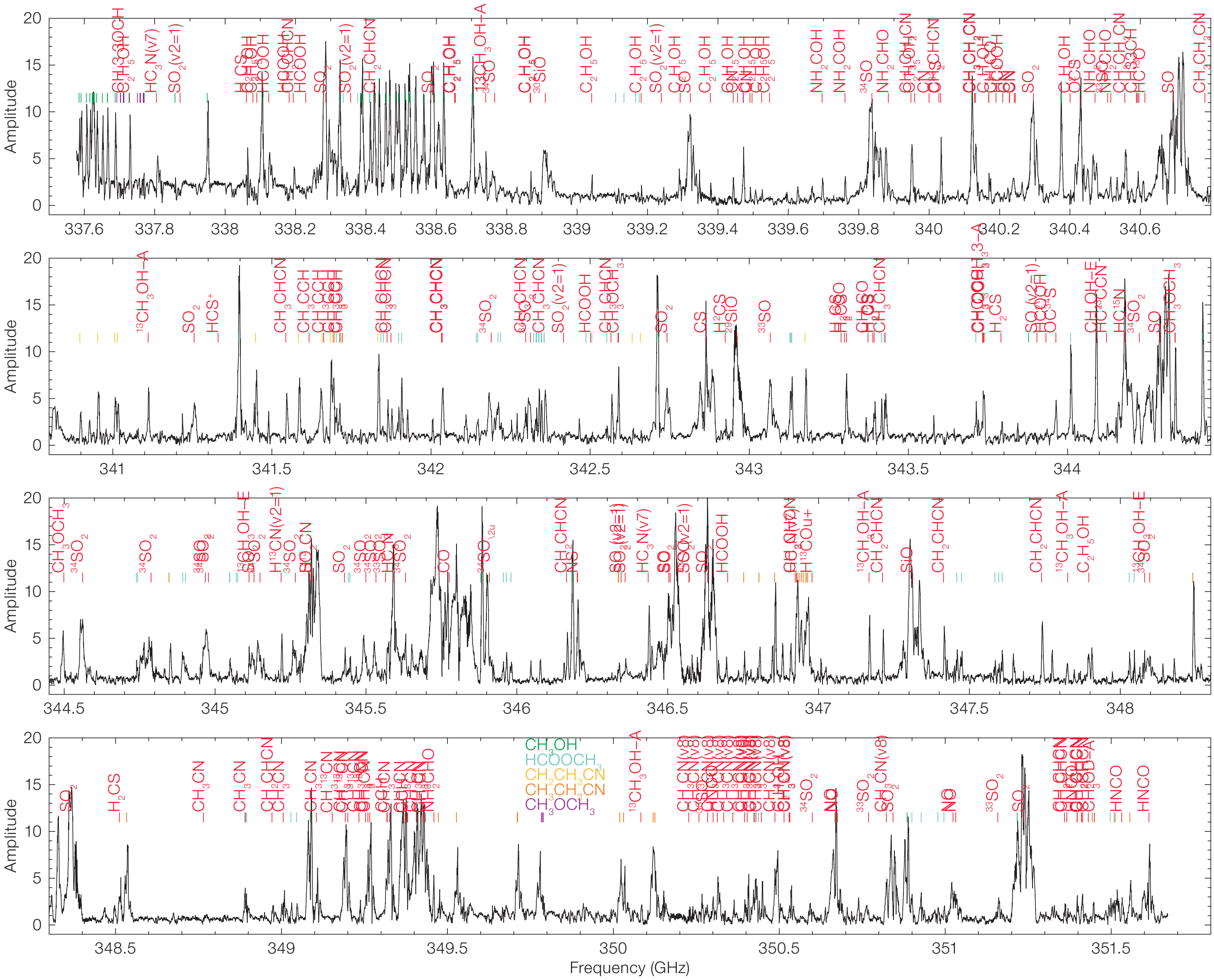

Figure 1. Continuum-subtracted single polarisation *uv*-spectrum of Orion BN-KL. These observations consist of four frequency setups which have been concatenated together. With only five antennas, each frequency setup was observed for 14 minutes, giving a total on source integration time of 56 minutes. The lines identified at the Caltech Submillimeter Observatory by Schilke et al. (1997) are overplotted and labelled in red, except for transitions of CH_3OH (green), $HCOOCH_3$ (cyan), CH_2CH_3CN (yellow), CH_3CH_3CN (orange) and CH_3OCH_3 (magenta).

instrument for exploring the structure and physical properties of the compact sources found in the surveys. Indeed, the talks highlighted that several classes of sources that require such follow-up are already being identified.

Observations conducted during commissioning in 2010 already demonstrate ALMA's potential as a probe of the chemical structure of high-mass star formation regions, thanks to the unprecedented combination of wide instantaneous bandwidth and sensitivity. Figure 1 shows a spectral sweep across part of the band 7 (~ 345 GHz, 850 μm) window towards the Orion Becklin–Neugebauer Kleinmann–Low (BN-KL) high-mass star formation region. Despite only 14 minutes on-source integration per frequency set-up and only five antennas, ALMA detects a plethora of spectral-line emission features from a wide range of complex molecules towards this hot core. This gives some idea of the complexity of the ALMA datasets that can be expected from more distant and fainter high-mass star forming regions, as the number of ALMA antennas increases from 5 to 16 in Early Science and finally to more than 50 in full operation. Given the expected complexity of ALMA data, the workshop continued with a session discussing the various tools already available and being developed (e.g., XCLASS[14], LIME[15], RADMC-3D[16], MOLLIE[17]) that will be necessary to analyse such datasets. These tools are now maturing to a level that will allow many future ALMA users to perform detailed analysis of the datacubes.

The remainder of the workshop was devoted to the presentation and discussion of science ideas and potential proposal strategies. This began with suggestions on possible ways to organise the community to maximise the science output during ALMA Cycle 0. Some ideas raised were: complementary frequency and line selection; co-ordinated proposals; and the relative merits of surveys and single-object proposals. In the science discussions that followed, several key areas were highlighted which exploit the unique ALMA Early Science capabilities and focus on well-selected samples or unique objects chosen from the large-area surveys. The participants then split into smaller groups to further develop these ideas before reporting back to the full group on the outcome of their discussions. In general there was agreement within the groups on the main science questions to be addressed, the basic observing strategies required to achieve the goals and the future steps needed to develop the ideas. At the close of the workshop, it was decided that each of these groups would plan to continue these discussions in an ongoing build-up to the proposal deadline.

Hans Zinnecker

Figure 2. Group photo of the workshop participants.

Links

1. ALMA Cycle 0 Call for Proposals: http://www.almascience.eso.org/call-for-proposals
2. Workshop website: http://www.eso.org/sci/meetings/2011/alma_es_2011.html
3. CORNISH (COordinated Radio 'N' Infrared Survey for High-mass star formation): http://www.ast.leeds.ac.uk/Cornish/public/index.php
4. BGPS (Bolocam Northern Galactic Plane Survey): http://milkyway.colorado.edu/bgps/
5. ATLASGAL (APEX Telescope Large Area Survey of the Galaxy): http://www.mpifr-bonn.mpg.de/div/atlasgal/
6. Hi-GAL (Herschel Infrared Galactic Plane Survey): https://hi-gal.ifsi-roma.inaf.it/higal/
7. HOBYS (Herschel imaging survey of OB Young Stellar objects): http://www.herschel.fr/cea/hobys/en/
8. MIPSGAL (Spitzer MIPS Galactic Plane survey): http://mipsgal.ipac.caltech.edu/
9. GLIMPSE (Galactic Legacy Infrared Mid-Plane Survey Extraordinaire): http://www.astro.wisc.edu/sirtf/
10. RMS (Red MXS Source survey): http://www.ast.leeds.ac.uk/RMS/
11. UKIDSS (UKIRT Infrared Deep Sky Survey): http://www.ukidss.org/
12. HOPS (H_{MALT90} (O southern Galactic Plane Survey): http://www.jcu.edu.au/school/mathphys/astronomy/awalsh/HOPS/ and Walsh, A. et al, 2008, PASA, 25, 105
13. MALT90 (Millimetre Astronomy Legacy Team 90 GHz Survey): http://malt90.bu.edu/
14. XCLASS: http://www.astro.uni-koeln.de/projects/schilke/XCLASS
15. LIME (LIne Modelling Engine): http://www.strw.leidenuniv.nl/~brinch/website/lime.html
16. RADMC-3D (Radiative transfer Monte Carlo 3D): http://www.ita.uni-heidelberg.de/~dullemond/software/radmc-3d/
17. MOLLIE (MOLecular LIne Explorer): https://www.cfa.harvard.edu/~eketo/