

REPORT ON THE RADIONET3 NETWORKING ACTIVITY

TITLE: SOLAR ALMA WORKSHOP

DATE: JAN 14-17 2013

TIME: (WHOLE DAY) 3.5

LOCATION: GLASGOW, UK

MEETING WEBPAGE: <http://www.gla.ac.uk/~eduard/solaralma/>

HOST INSTITUTE: UNIVERSITY OF GLASGOW

PARTICIPANTS NO: 37

REPORT:

1. Agenda of the meeting

Attached

2. Scientific Summary

Attached

3. Attendance list (incl. participant names, affiliation and country) signed by the participants and confirmed by the organizer

Attached

4. Financial Report / RadioNet3 contribution

The total RadioNet3 contribution was £1550 (approximately €1800). This was allocated entirely to partial travel and subsistence for participants, as follows.

Fleishman (US)	£300
Hills (UK)	£350
Loutchikeva (Germany)	£300
Mendoza-Torres (Mexico)	£300
Trigilio (Italy)	£300

5. Conference Proceedings and Web page

All of the presentations are linked from the web page
<http://www.astro.gla.ac.uk/~eduard/solarALMA/program.html>

Solar ALMA Workshop: Science Summary

1 Introduction

The aim of the workshop was to bring together the solar radio astronomy community and technical experts from the ALMA Project, in order to develop science cases, understand calibration requirements and plan initial observing proposals.

The workshop proper was held over 3 days (Jan 13 – 17 2013), followed by a half-day CASA tutorial. It was hosted by the Astronomy and Astrophysics Group of the University of Glasgow.

2 Solar Observing with ALMA

The first session of the workshop was concerned with the capabilities of ALMA for solar observing. Richard Hills introduced ALMA and summarised the current status. At the time of the workshop, 53 antennas (out of an eventual total of 66) had been delivered to the ALMA Project. The first period of scheduled observing (Cycle 0) finished at the end of 2012 and the first exciting science results had already been published. ALMA was designed from the start with solar observing in mind: the antenna surfaces are roughened on small scales to prevent overheating of the subreflector by optical/infrared radiation, the heat reaching the receivers is negligible and attenuators (“solar filters”) have been provided for solar observing, as discussed by Pavel Yagoubov. Some initial commissioning work has already taken place (Roman Brajsa). Nevertheless, solar observing remains a demanding application, particularly in the areas of phase and amplitude calibration and high-fidelity imaging of complex structures. The outcome of a general discussion on technical issues was summarised by Robert Laing.

3 Solar Science with ALMA

3.1 Overview

Tim Bastian gave an overview of solar radio interferometry and the main issues affecting observing with ALMA, including estimates of sensitivity and imaging performance. He highlighted the difficulty of imaging transient structures on the Sun and the trade-offs involved in large mosaics, simultaneous observing at different frequencies and rapid response to transient events such as solar flares. Nicole Vilmer then reviewed lower-frequency (MHz - GHz) observations of the Sun and Kiyoto Shibasaki summarised the extensive observations made with the Nobeyama Radio Heliograph at GHz frequencies. Current sub-millimetre observations of the Sun were reviewed by Pierre Kaufmann, emphasising the work of the Solar Submillimeter-wave Telescope and polarimeters in Argentina and noting the poorly-understood “sub-THz” component of radiation from solar flares.

3.2 The Quiet Sun

Our current knowledge of the complex physics of the quiet chromosphere was reviewed by Sami Solanki, emphasising problems of thermal structure, heating and magnetic fields. He also pointed out that sub-mm imaging is complementary to observations of CO and atomic lines. and that higher resolution than provided by existing arrays is now essential. Detailed numerical simulations of mm and sub-mm emission from the quiet chromosphere were presented by Sven Wedemeyer-Böhm and used to simulate ALMA observations by Maria Loukitcheva. In a similar context, Mykola Gordovskyy discussed the detectability of chromospheric magnetic fields with ALMA via Zeeman splitting. Finally, Stephen White presented imaging of the quiet Sun with the BIMA and CARMA arrays at 86 GHz.

3.3 The Active Sun

ALMA should also be able to image limb prominences, allowing the derivation of their temperature structures (Peter Heinzel, presented by Miroslav Barta). Corrado Triglio described a model for solar flares which is consistent with their emission up to 40 GHz and used it to simulate observations at ALMA frequencies.

Valery Nakariakov pointed out that flaring energy releases often show quasi-periodic pulsations and that these are important diagnostics of wave and oscillatory processes in the solar corona. ALMA observations with high temporal and spatial resolution could make a unique contribution here. There was considerable discussion of the emission mechanism of the sub-THz component in flares (Gregory Fleishman, Victor Melnikov, Alexander Stepanov). Free-free, gyrosynchrotron and plasma-wave emission were all advocated, along with more esoteric effects such as Razin suppression and Vavilov-Cherenkov emission, but there was no overall consensus and it is clear that ALMA will be needed in order to differentiate between competing models.

3.4 Priorities for ALMA

The open discussion on solar science with ALMA, summarised by Eduard Kontar, highlighted four key applications:

1. sub-arcsecond structure and dynamics of the chromosphere (spicules, shocks and loops);
2. temperature and density structure of cold plasma in prominences;
3. structure, dynamics and magnetic fields in solar prominences and
4. broad-band spectra and polarization of the sub-THz component in solar flares.

4 Background Information, Tutorials and Support

In order to introduce solar astronomers to interferometric observations in general and ALMA in particular, several background presentations were arranged. Robert Laing outlined the basic principles of radio interferometry. George Bendo described the support available for observers through the ALMA Regional Centres (ARC's) and Anita Richards outlined the ALMA proposal process. Specific details of the work of the European ARC Node in Ondrejov and the East Asian ARC in supporting solar observations were given by Bartosz Dabrowski and Masumi Shimojo. The workshop ended with a CASA tutorial led by Anita Richards, including analysis of real and simulated solar data from the workshop presentations.

5 Outcomes of the Workshop

The presentations have all been made available at the meeting web-site. The workshop was extremely valuable in communicating the requirements for solar observing to the ALMA Project and, conversely, in educating the solar community about ALMA's capabilities. One important new idea which emerged during the workshop was the possibility of improving the dynamic range of the ALMA receivers for solar observing by detuning the mixers: this has subsequently been pursued at ESO. In addition, it was decided to develop use cases for solar observing with ALMA, in order to refine the calibration and observing strategies. A number of science verification proposals were also discussed, and the willingness of the solar community to participate in ALMA solar commissioning was made clear to the Project.

6 Participants

There were 37 participants from 13 countries in 4 sub-continent (North and South America, Europe and Asia). Of these, 9 were female and 8 were students or early-career researchers.

Meeting Agenda

Time	Name	Title
Monday Jan 14th		
Introduction to ALMA		
13:25 – 13:30	Eduard Kontar	Welcome and Workshop Rationale
13:30 – 14:10	Richard Hills	ALMA: Introduction and Solar Observing
14:10 – 14:50	Robert Laing	Introduction to interferometry
14:50 – 15:10	Pavel Yagoubov	ALMA engineering and solar filters
15:10 – 15:30	Miroslav Barta	Solar interferometric observations and CASA
16:00 – 17:00	Roman Brajsa	Summary of solar ALMA commissioning
Tuesday Jan 15th		
Solar submillimetre astronomy		
09:00 – 09:45	Tim Bastian	Solar radio interferometry
09:45 – 10:30	Nicole Vilmer	Observations of the active Sun in the MHz to GHz range
11:00 – 11:45	Kiyoto Shibasaki	Highlights of Nobeyama solar results
11:45 – 12:30	Pierre Kaufmann	Submillimetre solar observations
Support for ALMA solar observing		
13:30 – 13:50	George Bendo	ALMA technical support
13:50 – 14:10	Bartosz Dabrowski	Solar ARC node in Czech Republic
14:10 – 14:30	Masumi Shimojo	The ARC activities for solar ALMA observations in Japan
15:00 – 17:00	Robert Laing (chair)	Discussion on practical issues with using ALMA for solar observations
Wednesday Jan 16th		
Solar radio science		
09:00 – 09:45	Sami Solanki	Dynamic Chromosphere and Quiet Sun
09:45 – 10:05	Mykola Gordovsky	Can we observe photospheric magnetic field with ALMA?
10:05 – 10:30	Maria Loukitcheva	Simulating what ALMA will see using 3D MHD simulations
11:00 – 11:20	Sven Wedemeyer	Synthetic millimeter maps of quiet Sun regions
11:20 – 11:40	Petr Heinzel	ALMA observations of solar prominences
11:40 – 12:00	Jose-Eduardo Mendoza-Torres	Microwave observations of the first AR of 24 cycle observed with RATAN-600
12:00 – 12:30	Steven White	Imaging the Sun with a Millimeter-wavelength Interferometer: Experience from BIMA and CARMA

Time	Name	Title
13:30 – 13:50	Corrado Trigilio	An evolutive model for the radio emission in solar flares
13:50 – 14:10	Valery Nakariakov	MHD Coronal Seismology with ALMA
14:10 – 14:30	Veronika Reznikova	Spatial structure of sunspot oscillations observed with SDO/AIA and a diagnostics of a sunspot atmosphere
14:30 – 14:50	Gregory Fleishman	Emission mechanisms forming solar radiation in the sub-mm range
14:50 – 15:10	Victor Melnikov	Spatial Brightness Distribution of Microwave and Sub-THz emission along a flaring loop
15:10 – 15:30	Alexander Stepanov	Plasma mechanism of sub-terahertz radiation from solar flares
16:00 – 17:00	Eduard Kontar (Chair)	Discussion on solar science projects with ALMA
Thursday Jan 17th		
Meeting summary		
09:00 – 10:30	Anita Richards et al.	Writing a Solar ALMA Proposal
11:00 – 11:30	Tim Bastian (Chair)	Plans for the future
11:30 – 12:00	Robert Laing	Technical Summary
12:00 – 12:30	Eduard Kontar	Science Summary
Tutorial Session		
14:00 – 17:00	Anita Richards et al.	CASA tutorial

List of Participants

Sergey Anfinogentov	Institute of solar-terrestrial physics, Irkutsk	Russia
Adam Avison	UK ARC Node, JBCA, University of Manchester	UK
Miroslav Barta	Astronomical Institute of Academy of Sciences, Ondrejov	Czech Republic
Tim Bastian	National Radio Astronomy Observatory	USA
George J. Bendo	UK ARC Node, JBCA, University of Manchester	UK
Nicolas Bian	University of Glasgow	UK
Roman Brajsa	Hvar Observatory, University of Zagreb	Croatia
Philippa Browning	University of Manchester	UK
Bartosz Dabrowski	Astronomical Institute, Academy of Sciences, Ondrejov	Czech Republic
Gregory Fleishman	New Jersey Institute of Technology	USA
Mykola Gordovskyy	University of Manchester	UK
Iain Hannah	University of Glasgow	UK
Richard Hills	University of Cambridge	UK
Jing Huang	Beijing Observatory	China
Natasha Jeffrey	University of Glasgow	UK
Pierre Kaufmann	Mackenzie P. Univ & State Univ. Campinas	Brazil
Eduard Kontar	University of Glasgow	UK
Robert Laing	ESO	Germany
Maria Loukitcheva	Max-Planck-Institute for Solar System Research, Lindau	Germany
Victor Melnikov	Pulkovo Observatory	Russia
Jose-Eduardo Mendoza-Torres	INAOE	Mexico
Tom Muxlow	UK ARC Node, JBCA, University of Manchester	UK
Valery Nakariakov	University of Warwick	UK
Heather Ratcliffe	University of Glasgow	UK
Hamish Reid	University of Glasgow	UK
Veronika Reznikova	Center for Plasma Astrophysics, KU Leuven	Belgium
Anita Richards	UK ARC Node, JBCA, University of Manchester	UK
Kiyoto Shibasaki	Nobeyama Solar Radio Observatory	Japan
Masumi Shimojo	National Astronomical Observatory of Japan	Japan
Paulo Simoes	University of Glasgow	UK
Sami Solanki	Max-Planck-Institute for Solar System Research, Lindau	Germany
Corrado Trigilio	INAF-Osservatorio Astrofisico di Catania	Italy
Nicole Vilmer	LESIA-Paris Obs	France
Sven Wedemeyer-Böhm	University of Oslo	Norway
Stephen M White	AFRL	USA
Pavel Yagoubov	ESO	Germany
Francesca Zuccarello	Department of Physics and Astronomy, Univ. Catania	Italy

R. A. Laing

February 18th 2013

Prof Robert Laing
European ALMA Instrument Scientist
ESO