

1. Meeting number: IAU Symposium 336
2. Meeting Title: Astrophysical Masers: Unlocking the Mysteries of the Universe
3. Coordinating Division: Division H Interstellar Matter and Local Universe
4. Dedication of meeting: Malcolm Walmsley (1941-2017)
5. Location: Conference Room, Hotel Regina Margherita, Cagliari (Italy)
6. Dates of meeting: 4-8 September 2017
7. Number of participants: 156 (30 IAU Grants)
8. Scientific Organising Committee

Andrea Tarchi (Chair)	INAF Cagliari, Italy
Mark Reid (co-Chair)	CfA/Harvard, USA
Zulema Abraham	IAG/Univ. San Paulo, Brazil
Anna Bartkiewicz	N. Copernicus Univ., Poland
Phil Diamond	SKA Office, UK
Simon Ellingsen	Univ. Tasmania, Australia
Guido Garay	DAS/Univ. Chile, Chile
Sharmila Goedhart	SKA-SA, South Africa
Mareki Honma	NAOJ, Japan
Laurent Loinard	National Univ. Mexico, Mexico
Naomi McClure-Griffiths	Australian National Univ., Australia
Karl Menten	MPIfR, Germany
Luca Moscadelli	INAF Arcetri, Italy
Ylva Pihlstrom	New Mexico Univ., USA
Alberto Sanna	MPIfR, Germany
Xing-Wu Zheng	Nanjing Univ., China

9. Local organizing Committee

Silvia Casu (Chair)	INAF Cagliari, Italy
Andrea Tarchi (co-Chair)	INAF Cagliari, Italy
Paola Castangia	INAF Cagliari, Italy
Davide Coero Borga	INAF, Italy
Tiziana Coiana	INAF Cagliari, Italy
Giuseppe Melis	INAF Cagliari, Italy
Sergio Poppi	INAF Cagliari, Italy
Paolo Soletta	INAF Cagliari, Italy
Gabriele Surcis	INAF Cagliari, Italy

10. List of represented countries: Participants from 25 countries attended:

Australia (7), Brazil (1), Bulgaria (2), Canada (1), Chile (1), China (14), Finland (1), France (2), Germany (13), India (1), Italy (18), Japan (18), Korea (8), Latvia (3), Mexico (4), Poland (5), Russia (7), South Africa (8), Spain (4), Sweden (4), Thailand (2), The Netherlands (6), UK (6), Ukraine (2), USA (18); see also plot at the end of the participants list.

11. Report submitted by: Andrea Tarchi and Mark J. Reid

12. Date and place: October 17, 2017

13. Signature of SOC Chairperson



Andrea Tarchi

(i) Scientific Programme

Sunday, September 3

18:00 - 21:00 *Welcoming reception and initial registration*

Monday, September 4

08:15 - 08:50 *Registration*

08:50 - 09:05 *Official greetings* (by Andrea Tarchi and Piero Benvenuti)

Dedication to Malcolm Walmsley (by Karl M. Menten)

Session 1: Theory of masers and maser sources

Chair: M. Reid

09:05 – 09:50 Karl M. Menten- MPIfR - Germany (review)

Fifty Years of Maser Research

09:50 – 10:15 Malcolm Gray- JBCA, University of Manchester - UK (invited)

Maser Theory – Old Problems and New Insights

10:15 – 10:30 Ruby van Rooyen- North-West University/SKA - South Africa

MASERS: A Python package for statistical equilibrium calculations applied to masers

10:30 - 11:00 *Coffee Break*

Chair: T. Robishaw

11:00 – 11:25 Silvia Leurini- INAF OACagliari - Italy (invited)

Physical properties of Class I methanol masers

11:25 – 11:40 Boy Lankhaar- Chalmers University of Technology - Sweden

Quantum-chemical calculations revealing the effects of magnetic fields on methanol

11:40 – 12:05 Gabriele Surcis- INAF OACagliari - Italy (invited)

Maser Polarization

12:05 – 12:20 Sergey Kalenskiy- Astro Space Center, Lebedev Physical Institute - Russia

Class I methanol masers in low-mass star formation regions

12:20 – 12:35 Bringfried Stecklum-Thueringer Landessternwarte Tautenburg- Germany

R variability, maser activity & protostellar accretion

12:35 – 12:50 Marian Szymczak- Toruń Center for Astronomy - Poland

On the origin of methanol maser variability: Clues from long-term monitoring

12:50 - 14:20 [Lunch](#)

Chair: S. Goedhart

14:20 – 14:35 Koichiro Sugiyama- National Astronomical Observatory of Japan - Japan

Long-term and highly frequent monitor of 6.7 GHz methanol masers to statistically research periodic flux variations around high-mass protostars using Hitachi 32-m

14:35 – 14:50 Mark J. Claussen- National Radio Astronomy Observatory - USA

Isotopic SiO Maser Emission from the BAaDE Survey

14:50 – 15:05 Taylor Tobin- University of Illinois Urbana-Champaign - USA *Constraining Theories of SiO Maser Polarization: Analysis of $\pi/2$ EVPA Change*

Session 2: Galaxies and Supermassive Black Holes

Chair: P. Castangia

15:05 – 15:50 Christian Henkel- MPIfR - Germany (review)

Extragalactic Maser Surveys

15:50 - 16:30 [Coffee Break & Poster Session I](#)

16:30 – 16:55 Sherry Suyu- MPA - Germany (invited)

Progress toward an accurate Hubble Constant

16:55 – 17:20 Jim Braatz- NRAO - USA (invited)

The Megamaser Cosmology Project

17:20 – 17:35 Jiang-Shui Zhang- Guangzhou University - China

A systematic observational study of radio properties of H₂O megamaser hosts: Guide for H₂O megamaser survey

17:35 – 17:50 Francesca Panessa- INAF-IAPS Roma - Italy

Water maser emission in hard X-ray selected AGN

17:50 – 18:15 Xi Chen- Guangzhou University - China (invited)

Extragalactic class I methanol maser: A new probe for starbursts and feedbacks of active galaxies

18:15 – 18:30 Tieghe Patrick McCarthy- University of Tasmania - Australia

Class I Methanol Maser Emission in NGC4945

Tuesday, September 5

Session 2: Galaxies and Supermassive Black Holes *(continue)*

Chair: J. Moran

09:00 – 09:45 Till Sawala- University of Helsinki - Finland [\(review\)](#)

The Local Group mass and its connection to outstanding cosmic puzzles

09:45 – 10:05 Andrea Tarchi- INAF OACagliari - Italy

SRT observations of Local Group dwarf galaxies

10:05 – 10:20 Ylva Pihlstrom- University of New Mexico - USA

Methanol masers in the Andromeda galaxy

10:20 – 10:35 Simon Ellingsen- University of Tasmania - Australia

The Maser-Starburst connection in NGC253

10:35 - 11:00 [Coffee Break](#)

Chair: W. Baan

11:00 – 11:15 Megan Argo- University of Central Lancashire - United Kingdom

Over-resolving the masers in M82?

11:15 – 11:30 Tim Robishaw- Dominion Radio Astrophysical Observatory - Canada

Zeeman Splitting of OH Megamasers as a Probe of Magnetic Fields in Starburst Galaxies

11:30 – 11:55 Jenny Emma Greene- Princeton University- USA [\(invited\)](#)

Using Megamaser Disks to Probe Black Hole Accretion

11:55 – 12:20 Dominic Pesce- University of Virginia - USA

AGN accretion disk physics using water megamasers

12:20 – 12:35 Paola Castangia- INAF OACagliari - Italy

A new jet/outflow maser in the nucleus of the Compton-thick AGN IRAS15480-0344

12:35 - 14:00 Lunch

Session 3: The Structure of the Milky Way

Chair: Y. Xu

14:00 – 14:45 Ortwin E. Gerhard- MPIfEA - Germany [\(review\)](#)

Perspectives on Galactic Structure

14:45 – 15:10 Mark Reid- Harvard-Smithsonian CfA - USA [\(invited\)](#)

Structure and Kinematics of the Milky Way

15:10 – 15:25 Lucas Jordan Hyland- University of Tasmania - Australia

The Structure of the Milky Way: View from the Southern Hemisphere

15:25 – 15:40 Maxim Voronkov- CSIRO - Australia

Interferometry of class I methanol masers, statistics and the distance scale

15:40 – 15:55 Jingjing Li- Purple Mountain Observatory, CAS - China

Trigonometric Parallaxes of Star Forming Regions in the Scutum Arm

15:55 - 16:25 [Coffee Break](#)

Chair: S. Ellingsen

16:25 – 16:50 François Mignard- Observatoire de la Côte d'Azur - France ([invited](#))

Gaia explores the Milky Way

16:50 – 17:15 Mareki Honma- NAOJ - Japan ([invited](#))

Maser Astrometry and Galactic structure studies with VLBI

17:15 – 17:30 Nobuyuki Sakai- National Astronomical Observatory of Japan - Japan

Eight new astrometry results of 6.7 GHz CH₃OH and 22 GHz H₂O masers in the Perseus arm

17:30 – 17:45 Jürgen Ott- National Radio Astronomy Observatory - USA

SWAG Water Masers in the Galactic Center: Tracing and Timing Stages of Star Formation in Molecular Gas Streamers

17:45 – 18:00 Katharina Immer- Joint Institute for VLBI ERIC - The Netherlands

How maser observations unravel the gas motions in the Galactic Center

18:00 – 18:15 Lorant Sjouwerman- National Radio Astronomy Observatory - USA

Thousands of Stellar SiO masers in the Galaxy: The Bulge Asymmetries and Dynamic Evolution (BAaDE) survey

18:15 - 18:30 Symposium Official Group Picture

Wednesday, September 6

Session 4: Star Formation

Chair: J.-M. Torrelles

09:00 – 09:45 Maite Beltrán- INAF OAArcetri - Italy ([review](#))

Perspectives on Star Formation: the formation of high-mass stars

09:45 – 10:10 Luca Moscadelli- INAF OAArcetri - Italy ([invited](#))

Masers as probes of the gas properties close to forming stars

10:10 – 10:25 Tomoya Hirota- National Astronomical Observatory of Japan - Japan

ALMA observations of submillimeter H₂O and SiO lines in Orion Source I

10:25 – 10:40 Anna Bartkiewicz- Nicolaus Copernicus University - Poland

Expansion of methanol maser rings

10:40 – 10:55 Ciriaco Goddi- Radboud University/Leiden Observatory - The Netherlands *Measuring Magnetic Fields from Water Masers in the Synchrotron Protostellar Jet in W3(H₂O)*

10:55 - 11:25 [Coffee Break](#)

Chair: K.-T. Kim

11:25 – 11:50 Shari Breen- University of Sydney - Australia (invited)

A Golden Age for Maser Surveys

11:50 – 12:15 Sharmila Goedhart- SKA SA - South Africa (invited)

Periodic Masers in Star Forming Regions

12:15 – 12:30 Alberto Sanna- Max-Planck Institut für Radioastronomie - Germany

The CepHeus-A Star formation and proper Motions (CHASM) Survey – Where is the mass reservoir of massive young stars? –

Free Afternoon

12:30 - 13:45 [Bus Trip to Gerrei area](#)

13:45 - 15:45 [Sardinian Lunch Buffet](#)

15:45 - 17:15 [Tour of an archeological site](#)

17:15 - 18:15 [Visit to the Sardinia Radio Telescope site](#)

18:15 - 19:15 [Bus trip to Cagliari](#)

Thursday, September 7

Session 4: Star Formation (*continue*)

Chair: Z. Abraham

09:00 – 09:25 James Moran- Harvard-Smithsonian CfA - USA

The Structure of the Maser Emission in MWC349

09:25 – 09:40 Carolina B. Rodríguez-Garza- IRYA, UNAM - Mexico

Interferometric and single-dish observations of 44, 84 and 95 GHz Class I methanol masers

09:40 – 09:55 Jihyun Kang- KASI - Republic of Korea

Linear Polarization of Class I Methanol Masers in Massive Star Forming Regions

09:55 – 10:10 James Okwe Chibueze- Square Kilometre Array - South Africa

Class II 6.7 GHz Methanol Maser Association with Young Massive Cores Revealed by ALMA

10:10 – 10:25 Todd Hunter- National Radio Astronomy Observatory - USA

The extraordinary outburst in the massive protostellar system NGC6334I-MM1: the rise of dust and emergence of Class II 6.7 GHz methanol maser emission

10:35 – 10:50 Crystal Brogan- National Radio Astronomy Observatory - USA

The extraordinary outburst in the massive protostellar system NGC6334I-MM1: dimming of the hypercompact HII region and destruction of water masers

10:50 - 11:40 [Coffee Break & Poster Session II](#)

Chair: C. Goddi

11:40 – 11:55 Kee-Tae Kim- KASI - Republic of Korea

Understanding high-mass star formation through KaVA observations of water and methanol masers

11:55 – 12:10 Ross Alexander Burns- Joint Institute for VLBI ERIC - The Netherlands

Water masers in bowshocks: Addressing the radiation pressure problem of massive star formation

12:10 – 12:25 Kazuhito Motogi- Yamaguchi University - Japan

A Face-on Accretion System in High Mass Star-Formation: Possible Dusty Infall Streams within 100 Astronomical Unit

12:25 – 12:40 Zulema Abraham- IAG - Universidade de São Paulo - Brazil

Maser Effects in Recombination Lines: the case of Eta Carinae

12:40 - 14:10 [Lunch](#)

Session 5: Evolved Stars

Chair: W.H.T. Vlemmings

14:10 – 14:55 Guy Perrin- CNRS-INSU - France ([review](#))

Perspectives on Evolved Stars

14:55 – 15:20 Hiroshi Imai- Kagoshima University - Japan ([invited](#))

Towards decadal continuous viewing of circumstellar maser sources

15:20 – 15:35 Anita Richards- JBCA, University of Manchester - United Kingdom

Hot and cold running water: understanding evolved star winds

15:35 – 15:50 Gábor Orosz- Kagoshima University - Japan

Water Fountains and the Formation of Planetary Nebulae

15:50 – 16:05 Andrés Felipe Pérez-Sánchez- European Southern Observatory - Chile

Deep into the Water fountains: A detailed study toward IRAS 15445-5449

16:05 - 16:35 [Coffee Break](#)

Chair: A. Richards

16:35 – 17:00 Se-Hyung Cho- KASI - Republic of Korea ([invited](#))

A Study of Evolved Stars by Simultaneous Observations of H₂O and SiO Masers Using KVN

17:00 – 17:15 Akiharu Nakagawa- Kagoshima University - Japan

Astrometric VLBI observation of the Galactic LPVs; Miras and OH/IR stars

17:15 – 17:30 Liz Humphreys- European Southern Observatory - Germany

SiO Masers With ALMA Long Baselines

17:30 – 17:45 Daniel Tafuya- Chalmers University of Technology - Sweden

Sub-millimeter maser emission from warm water-fountain nebulae

[Conference Dinner](#)

18:45 [Buses leave](#)

19:00 - 20:00 [Aperitif](#)

20:00 - 22:30 [Conference Dinner](#)

23:30 [Buses leave](#)

Friday, September 8

[Session 5: Evolved Stars \(continue\)](#)

Chair: L. Humphreys

09:15 – 09:30 Dong-Hwan Yoon- KASI/SNU - Republic of Korea

Simultaneous VLBI observations of H₂O and SiO masers toward VX-Sgr

09:30 – 09:45 Richard Dodson- ICRAR/UWA - Australia

KVN astrometric observations of H₂O and SiO masers in Calabash Nebula

09:45 – 10:00 Jose-Francisco Gómez- Instituto de Astrofísica de Andalucía - Spain

Water masers as signposts of extremely young PNe

10:00 – 10:25 Sandra Etoka- University of Hamburg/JBCA - Germany/United Kingdom

Distances of Stars by mean of the Phase-lag Method

[Session 6: New facilities](#)

Chair: H.-J. van Langevelde

10:25 – 10:50 Alison Peck- Gemini Observatory - USA [\(invited\)](#)

Masers and ALMA

10:50 – 11:15 Francisco Colomer- JIVE/OAN-IGN - The Netherlands/Spain [\(invited\)](#)

Masers! What can VLBI do for you?

11:15 - 11:45 [Coffee Break](#)

11:45 – 12:00 Andrej M. Sobolev- Ural Federal University - Russia [\(invited\)](#)

RadioAstron space-VLBI project: studies of masers in star forming regions of our Galaxy and megamasers in external galaxies

12:00 – 12:15 Willem Baan- ASTRON - The Netherlands

H₂O MegaMasers at High Resolution

12:15 – 12:40 Eric Murphy- NRAO - USA [\(invited\)](#)

The Next Generation Very Large Array (ngVLA)

12:40 - 14:10 [Lunch](#)

Chair: S. Breen

14:10 – 14:35 Anna Bonaldi- SKA Organization Jodrell Bank - United Kingdom ([invited](#))

The SKA

14:35 – 14:50 Maria Rioja- ICRAR-UWA, CSIRO/OAN-IGN - Australia/Spain

"MultiView" Calibration for Precise Astrometry at Low Frequencies

15:00 – 16:00 Phil Diamond- SKA Organisation - United Kingdom

Summary

16:00 - 16:30 [Coffee & End of Sessions](#)

Outreach and Educational Programme*

17:00 - 18:00 Astrokids Hands-on activities for children

18:30 - 19:30 Public Conference

Prof. Dr. Piero Benvenuti - IAU General Secretary

Origine ad evoluzione dell'Universo. Quello che la scienza può e non può dire.

19:30 - 20:30 Wine & Cheese

*These Educational and Outreach activities were held close to the Venue, in the "Sala Officine" of the Ex-Manifattura Tabacchi, Viale Regina Margherita 33.

End of Symposium

[\(ii\) Summary of the scientific highlights of the meeting](#)

The key topics of the Symposium, grouped in six sessions, covered:

- Theory of Masers
- The Cosmic Distance Scale and the Hubble Constant
- Galaxy Kinematics and Black Hole Masses
- The Structure of the Milky Way
- Star-Formation
- Pulsation and Outflows in Evolved Stars
- New Facilities and Perspectives

While the main focus of the Symposium has been on cosmic masers, in order to broaden the impact of the Symposium, we invited speakers from outside the maser science community who work on similar topics as those listed above. In particular, it has been possible during the

Symposium to compare the astrometric results reached using masers on the structure of the Milky Way and the cosmological distance scale with those obtained using other methods, e.g. the Gaia mission for the Galaxy and Cepheids and gravitational lensing for the extragalactic distance scale.

The important results presented in over 140 contributions (oral and posters), all of very high quality, have, once again unequivocally ratified that molecular masers are fundamental tools to tackle and provide answers to many of the most important and puzzling mysteries of modern astronomy. Among these, some achievements have been recognised as true highlights and, below, a short description of some of these results is reported.

In particular, maser astrometry has achieved trigonometric parallax accuracies of better than 10 micro-arcseconds, comparable to that hoped for from Gaia. By using Very Long Baseline Array (VLBA) studies, in the framework of the BeSSeL project, and VLBI Exploration of Radio Astrometry (VERA) measurements most of the major spiral arms visible from the northern hemisphere have been accurately located for the first time and the Galaxy's fundamental parameters (the distance to the Center and the circular rotation speed at the Sun) and the slope of the rotation curve -- have been accurately measured. Plans for complementary surveys in the southern hemisphere have been also presented and discussed at the Symposium.

In the extragalactic-maser related topic, maps of water masers that trace sub-parsec scale accretion disks around super massive black holes (disk-masers) have been shown to provide geometry-based estimates of the host galaxy distances. Combining ten such measurements, the Megamaser Cosmology Project is in the process of determining the H_0 with better than 4% accuracy, directly (without "standard candles") and independently of all other methods. In addition, exploiting disk-masers, estimates of the masses of supermassive black holes at the centers of about twenty galaxies have been obtained, anchoring the low-mass end of the M-sigma relation and indicating tantalizing departures from a simple line.

On the star-formation side, the maser VLBI works presented have clearly shown successful studies of the structure and kinematics of forming stars at AU and larger scales. Combined with infrared and mm/sub-mm observations (in particular, with ALMA), they are paving the way for understanding the much debated formation channels for massive stars.

A number of talks have also been focussed on the observation and analysis of maser polarization, showing that the orientation and strength of the magnetic field in several astrophysical environments (e.g., star-forming regions, evolved stars) can now be (almost) routinely determined, with a fundamental impact on our understanding on the gas behaviour in these objects.

Reported results on maser theory, evolved stars, proper motions of Local Group galaxies and the perspectives offered by new and future observing facilities have further contributed to underline the achievements and potential of maser studies from the scientific and technical points of view.

(iii) List of participants

The Symposium was attended by 156 participants from all over the world (see also double bar chart at the end of the participants list).

	Name	Institution	Country
1	Artis Aberfelds	VIRAC	Latvia
2	Zulema Abraham	University of Sao Paulo	Brazil
3	Aleksei Alakoz	Astro Space Center of the P.N. Lebedev Physical Institute RAS	Russia
4	Megan Argo	University of Central Lancashire	UK
5	Yoshiharu Asaki	NAOJ	Japan
6	Kitiyanee Asanok	National Astronomical Research Institute of Thailand	Thailand
7	Willem A. Baan	Astron	The Netherlands
8	Alejandro Baez Rubio	Instituto de Astronomia, Universidad Nacional Autonoma de Mexico	Mexico
9	Anna Bartkiewicz	Torun Centre for Astronomy	Poland
10	Olga Bayandina	Astro Space Center of P.N. Lebedev, Moscow	Russia
11	Maite Beltran	INAF – OAArcetri	Italy
12	Piero Benvenuti	IAU	France
13	Karlis Berzins	VIRAC	Latvia
14	Anna Bonaldi	SKA Organization Jodrell Bank	UK
15	Jan Brand	INAF – IRA, Bologna	Italy
16	Jim Braatz	NRAO	USA
17	Shari Breen	University of Sydney	Australia
18	Crystal L. Brogan	NRAO	USA
19	Ross A. Burns	JIVE	the Netherlands

20	Paola Castangia	INAF – OACagliari	Italy
21	Silvia Casu	INAF – OACagliari	Italy
22	Thanapol Chanapote	Department of Physics, Faculty of Science, Khon Kaen University	Thailand
23	Xi Chen	CfA-Guangzhou University	China
24	James O. Chibueze	SKA	South Africa
25	Se-Hyung Cho	Korea Astronomy and Space Science Institute	Republic of Korea
26	Mark J. Claussen	NRAO	USA
27	Tiziana Coiana	INAF-Cagliari	Italy
28	Francisco Colomer	Instituto Geografico Nacional, Madrid	Spain
29	Timea Csengeri	MPfRI, Bonn	Germany
30	Nichol Cunningham	NRAO	USA
31	Claudia Cyganowski	University of St Andrews	UK
32	Daria Dall'Olio	Chalmers University of Technology	Sweden
33	Jean-Francois Desmurs	Observatorio Astronomico Nacional	Spain
34	Phil J. Diamond	SKA Organisation	UK
35	Richard Dodson	University of Western Australia	Australia
36	Simon Ellingsen	School of Physical Sciences, Univ. of Tasmania	Australia
37	Dieter Engels	Hamburger Sternwarte Universitat Hamburg	Germany
38	Sandra Etoke	Hamburger Sternwarte Universitat Hamburg	Germany
39	Elena Fedorova	National Taras Shevchenko Univ. of Kyiv	Russia
40	Yasuo Fukui	Nagoya University	Japan
41	Ortwin E. Gerhard	MPIfEA Garching	Germany
42	Ciriaco Goddi	IMAPP, Radboud University – ALLEGRO/Leiden Observatory	The Netherlands
43	Sharmila Goedhart	SKA SA	South Africa
44	Jose-Francisco Gomez	Instituto de Astrofisica de Andalucia, CSIC	Spain
45	Malcolm Gray	Jodrell Bank Centre for Astrophysics	UK

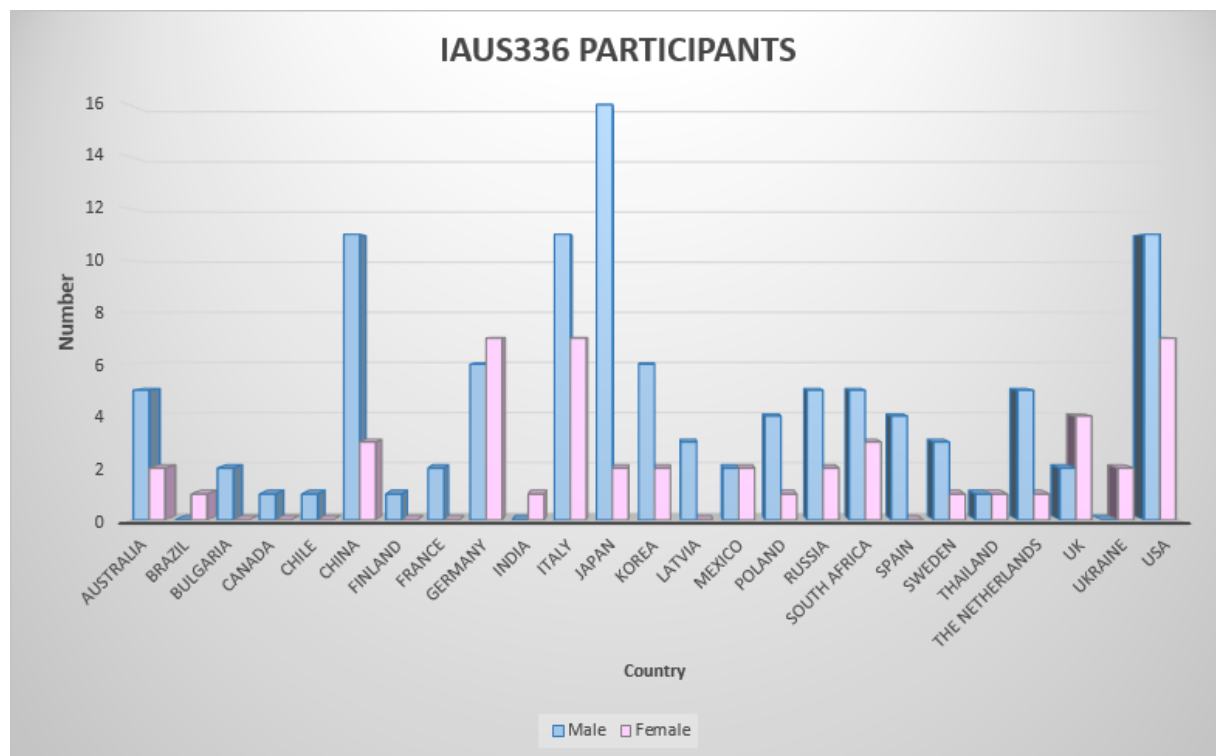
46	Jenny E. Greene	Princeton University Dept of Astrophysics	USA
47	Yuxin He	Xinjiang Astronomical Observatory	China
48	Christian J. Henkel	MPIf, Bonn	Germany
49	Stefanus P. van den Heever	Hartebeeshoek Radio Astronomy Observatory.	South Africa
50	Tomoya Hirota	NAO	Japan
51	Mareki Honma	Mizusawa VLBI Observatory, NAOJ	Japan
52	Bo Hu	Nanjing University	China
53	Liz Humphreys	ESO Garching	Germany
54	Edoam Hwang	Kasi	Republic of Korea
55	Todd R. Hunter	NRAO	USA
56	Lucas J. Hyland	University of Tasmania	Australia
57	Hiroshi Imai	Kagoshima University	Japan
58	Katharina Immer	Joint Institute for VLBI ERIC	Netherlands
59	Kim Jeoung Sook	Astronomical Observatory of Japan	Japan
60	Sergey Kalenskiy	Lebedev Physical Institute RAS	Russia
61	Fateme Kamali	MPIfR, Bonn	Germany
62	Ji-hyun Kang	Korea Astronomy and Space Science Institute	Republic of Korea
63	Athol Kemball	University of Illinois Urbana-Champaign	USA
64	Jaeheon Kim	Shanghai Astronomical Observatory	China
65	Jungha Kim	NAOJ	Japan
66	Kee-Tae Kim	KASI	Korea
67	Soon-Wook Kim	KASI	Korea
68	Yuta Kojima	Yamaguchi university	Japan
69	Liudmyla Kozak	Taras Shevchenko National University of Kyiv	Ukraine
70	Busaba H. Kramer	MPIfR/NARIT	German/Thailand and

71	Vasaant Krishnan	INAF – OAArcetri	Italy
72	Elisabetta Ladu	Università degli studi di Cagliari	Italy
73	Huib J. van Langevelde	JIVE ERIC	the Netherlands
74	Boy Lankhaar	Chalmers University of Technology	Sweden
75	Katharina Leiter	University of Wuerzburg – ECAP	Germany
76	Silvia Leurini	INAF – OACagliari	Italy
77	Dalei Li	Purple Mountain Observatory	China
78	Jingjing Li	Xinjiang Astronomical Observatory	China
79	Ivan Litovchenko	Astro Space Center of Lebedev Physical Institute	Russia
80	Gordon MacLeod	Hartebeesthoek Radio Astronomy Observatory	South Africa
81	Alberto Masini	INAF – OABologna	Italy
82	Fabrizio Massi	INAF – OAArcetri	Italy
83	Jabulani Maswanganye	North West University	South Africa
84	Tiege P. McCarthy	University of Tasmania	Australia
85	Giuseppe Melis	INAF-Cagliari	Italy
86	Karl M. Menten	MPIfR Bonn	Germany
87	Francois Mignard	Observatoire de la Cote d'Azur	France
88	James M. Moran	Harvard-Smithsonian CfA, Boston	USA
89	Luca Moscadelli	INAF-OAArcetri	Italy
90	Kazuhito Motogi	Yamaguchi University	Japan
91	Eric J. Murphy	NRAO	USA
92	Akiharu Nakagawa	Kagoshima University	Japan
93	Jun-ichi Nakashima	Ural Federal University	Russia
94	Mateusz Olech	Torun CfA Nicolaus Copernicus University	Poland
95	Luca Olmi	INAF – OAArcetri	Italy
96	Gabor Orosz	Kagoshima University	Japan

97	Juergen Ott	NRAO	USA
98	Tomoaki Oyama	NINS, NAOJ	Japan
99	Francesca Panessa	INAF – IAPS Roma	Italy
100	Sonu T. Paulson	Indian Institute of Space Science and Technology	India
101	Alison Peck	Gemini Observatory	USA
102	Andres F. Perez-Sanchezk	ESO	Chile
103	Guy Perrin	CNRS Institut des Sciences de l'Univers	France
104	Ylva Pihlstrom	University of New Mexico	USA
105	Dominic Pesce	University of Virginia	USA
106	Sergio Poppi	INAF – OACagliari	Italy
107	Hai-Hua Qiao	Shanghai Astronomical Observatory / ICRAR, Curtin University	China/Australia
108	Luis H. Quiroga Nunez	Leiden Observatory – JIVE	the Netherlands
109	Mark J. Reid	Harvard-Smithsonian CfA	USA
110	Anita M.S. Richards	JBCA. University of Manchester	UK
111	Maria Rioja	ICRAR/UWA, CASS, OAN	Australia
112	Tim Robishaw	Dominion Radio Astrophysical Observatory	Canada
113	Carolina B. Rodriguez-Garza	IRA – Universidad Nacional Autónoma de México	Mexico
114	Ruby van Rooyen	North West University – SKA	South Africa
115	Daisuke Sakai	University of Tokyo	Japan
116	Nobuyuki Sakai	NAOJ	Japan
117	Alberto Sanna	MPfRI Bonn	Germany
118	Hidetoshi Sano	IAR, Nagoya University	Japan
119	Rafal Sarniak	Torun CfA Nicolaus Copernicus University	Poland
120	Till Sawala	University of Helsinki	Finland
121	Evgeni Semkov	Institute of Astronomy and NAO, Sofia	Bulgaria
122	Nadezhda N. Shakhvorostova	Astro Space Center of P.N. Lebedev,	Russia

		Moscow	
123	Hiroko Shinnaga	Kagoshima University	Japan
124	Ivar Shmeld	Ventspils International Radio Astronomy Centre	Latvia
125	Lorant Sjouwerman	NRAO	USA
126	Andrey M. Sobolev	Astronomical Observatory Ural Federal University	Russia
127	Paolo Soletta	INAF – OACagliari	Italy
128	Bringfried Stecklum	Thueringer Landessternwarte Tautenburg	Germany
129	Angelica E. Strack	Western Illinois University	USA
130	Anton A. Strigachev	Institute of Astronomy and NAO, Sofia	Bulgaria
131	Michael Stroh	University of New Mexico	USA
132	Koichiro Sugiyama	Mizusawa VLBI Observatory, NAOJ	Japan
133	Yan Sun	Purple Mountain Observatory, Nanjing	China
134	Kazuyoshi Sunada	NAO	Japan
135	Gabriele Surcis	INAF – OACagliari	Italy
136	Sherry Suyu	MPIfA	Germany
137	Daniel Tafoya	OSO	Sweden
138	Kazuhiro Takefuji	NICT	Japan
139	Andrea Tarchi	INAF – OACagliari	Italy
140	Talor Tobin	University of Illinois Urbana-Champaign	USA
141	Jose M. Torrelles	Institut de Ciencies de l'Espai	Spain
142	Miguel A. Trinidad	University of Guanajuato	Mexico
143	Lucero Uscanga	University of Guanajuato	Mexico
144	Wouter Vlemmings	Onsala Space Observatory	Sweden
145	Maxim Voronkov	CSIRO	Australia
146	Johan van der Walt	North West University	South Africa
147	Marion E. West	Hartebeesthoek Radio Astronomy Observatory	South Africa

148	Pawel Wolak	Torun CfA Nicolaus Copernicus University	Poland
149	Gang Wu	Xinjiang Astronomical Observatory, CAS	China
150	Ye Xu	Purple Mountain Observatory	China
151	Jiarken Yeshengbieke	Xinjiang Astronomical Observatory	China
152	Dong-Hwan Yoon	KASI	Republic of Korea
153	Jinghua Yuan	NAO, CAS	China
154	Youngjoo Yun	Kasi	Republic of Korea
155	Jiang-Shui Zhang	CfA-Guangzhou University	China
156	Jianjun Zhou	Xinjiang Astronomical Observatory	China

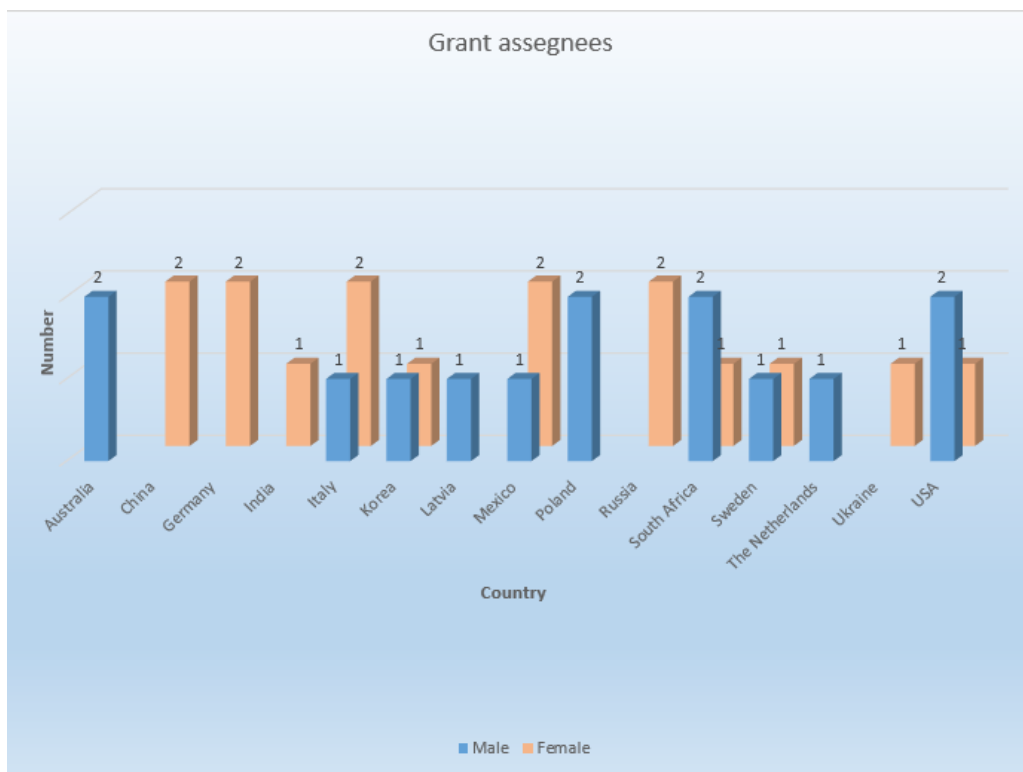


(iv) List of recipients of IAU grants

IAU Grants for a total of 19500 euro were assigned to the following 30 participants (53% women, see also double bar chart at the end of the table):

First Name	Family Name	Gender	Country	Amount received (€)
Artis	Aberfelds	Male	Latvia	700
Alejandro	Báez Rubio	Male	Mexico	300
Olga	Bayandina	Female	Russia	500
James	Chibueze	Male	South Africa	1000
Daria	Dall'Olio	Female	Sweden	500
Sandra	Etoka	Female	Germany	500
Elena	Fedorova	Female	Ukraine	1000
Lucas	Hyland	Male	Australia	300
Fateme	Kamali	Female	Germany	500
Jeoung Sook	Kim	Female	Japan	1200
Elisabetta	Ladu	Female	Italy	250
Boy	Lankhaar	Male	Sweden	450
Jingjing	Li	Female	China	1000
Alberto	Masini	Male	Italy	450
Tiege	McCarthy	Male	Australia	300
Mateusz	Olech	Male	Poland	250
Francesca	Panessa	Female	Italy	450
Sonu	Paulson	Female	India	1200
Dominic	Pesce	Male	USA	1000
Hai-Hua	Qiao	Female	China/Australia	1200
Luis Henry	Quiroga Nuñez	Male	Netherlands	300

Carolina	Rodríguez-Garza	Female	Mexico	1200
Rafał	Sarniak	Male	Poland	300
Nadezhda	Shakhvorostova	Female	Russia	300
Angelica	Strack	Female	United States	200
Michael	Stroh	Male	USA	350
Lucero	Uscanga	Female	Mexico	800
Stefanus	van den Heever	Male	South Africa	1200
Ruby	Van Rooyen	Female	South Africa	1000
Dong-Hwan	Yoon	Male	Korea	800



(v) Executive Summary of the Meeting

The Osservatorio Astronomico di Cagliari of the Istituto Nazionale di Astrofisica (INAF), with the sponsorship of the IAU, hosted the Symposium 336, titled 'Astrophysical Masers: Unlocking the Mysteries of the Universe'. The Conference was held from 4th to 10th of September at the Hotel Regina Margherita, in the centre of Cagliari. The Conference took profit of relevant contributions from the IAU, to support thirty attendees from economically less privileged countries and young scientists via IAU Travel grants, and from INAF, mainly used to further foster the participation at the Symposium and for organisational purposes. In addition, we are indebted to a number of additional sponsors and partners that, in different ways, provided support to the Symposium (a full list of sponsors is available at: <http://iaus336.oa-cagliari.inaf.it/sponsors/>).

The Symposium was attended by 156 participants from all over the world, with the Asian and African communities represented by 43 and 8 colleagues, respectively.

The Symposium was opened by the IAU General Secretary, Prof. Piero Benvenuti, who, after having introduced the main aims and tasks of the IAU, and underlined the relevance of the IAU Symposia, welcomed the Participants and gave the official start of the Symposium. The opening was followed by the heart-felt dedication of the Symposium to Malcolm Walmsley made by Prof. Karl Menten.

The scientific program of the meeting consisted of 78 oral contributions (including 6 reviews and 20 invited talks) and 66 posters that covered the full range of maser topics.

The key topics of the Symposium were grouped in six sessions:

- 1) Theory of Masers and Maser Sources
- 2) Galaxies and Supermassive Black Holes
- 3) The Structure of the Milky Way
- 4) Star Formation
- 5) Evolved Stars
- 6) New Facilities

Each session was introduced by a review talk. In particular, for most of the sessions, the review was given by an eminent colleague from outside the maser science community. This fact, particularly appreciated by the entire audience, allowed the participants to gain an important broad, un-biased background on the session topic useful to pave the way for the following, more maser-oriented, talks of the same session and to foster discussions on the individual topics from a more comprehensive perspective. The session covered a wide range of astrophysical topics, e.g., AGN, proper motions of Local Group Galaxies, massive star formation, pulsations and outflows in evolved stars, theory and polarization of maser sources, and the impact on new observational facilities on maser science.

The abstract of the oral and poster contributions are available online at:

<http://iaus336.oa-cagliari.inaf.it/wp-content/uploads/2016/11/abstract-book-iaus336.pdf>

The slides of the oral presentations and images of the poster displayed are available online at:

<http://iaus336.oa-cagliari.inaf.it/post-meeting/presentations/>

The timing of this meeting coincided with the culmination of a number of large maser projects, like the Megamaser Cosmology Project (MCP) and the Bar and Spiral Structure Legacy (BeSSeL) Survey, and of a number of major maser monitoring programmes. Indeed,

this has reflected in the talks where truly relevant outcomes have been reported during the Symposium on the cosmic distance scale and the structure of the Milky Way, and many promising inputs have been provided to supply a deeper understanding on the theoretical modelling of the different maser species.

In the framework of the particularly intense programme spiced up with stimulating discussions, the participants had the chance to visit the Sardinia Radio Telescope site, located in the Gerrei area. This facility, as also illustrated during the Symposium in a couple of scientific talks, is indeed an excellent instrument to perform forefront observational programme in maser science, both in Galactic and extragalactic environments, as a single-dish and as part of VLBI arrays. In that occasion, participants, received by the Major of the municipality of San Basilio, representative of the authority that coordinates all the municipalities of the Gerrei area (named 'Unione dei Comuni del Gerrei'), benefit of a typical sardinian lunch buffet in the attractive location of Pitzu e Pranu, accompanied by traditional songs and dances. After the lunch, participants visited also the suggestive archeological park of Pranu Muttetdu, where the largest concentrations of menhirs in Sardinia could be found, together with several pre-nuragic graves.

They also enjoyed a gala dinner held in the historical complex of '*La Corte in Giorgino*', a complex of great historical value under the protection of the Ministry of the Cultural Heritage, that contains a wealth of vestiges of the life and culture of the city of Cagliari, including the small church of Saint Efsio in which for centuries the martyr has completed the first leg of the long journey to the place of his martyrdom at Nora.

To leave a significant legacy in the community after the IAU Symposium 336, educational and outreach activities took place in parallel with the scientific programme. The programme was structured along two main lines of activities:

Educational Activities:

In order to remove the prejudice rooted in many people that spectroscopy and maser physics is a too complicated topic for people not expert in astronomy, we worked with a high school (Liceo scientifico Pitagora, Selargius) class and their teachers during the School Academic Year 2016/2017. Together with them we designed an educational activity based on spectroscopy for kids. The activity has been focused on how spectra are produced (continuum, emission, absorption phenomena) and detected in space and addressed the basic of maser theory using simple approximation of the theory and the similarities with laser devices.

Outreach Activities:

In the last day of the Symposium (Friday, September 8), just after the conclusion of the scientific activities, we organized a public event addressed to the Cagliari community, in the beautiful and suggestive location of the Sala Officine, a conference room recovered from previous mechanical workshops inside the old building of the Ex Manifattura Tabacchi, downtown in Cagliari.

The public event started with an hands-on activity for kids, titled "*Il codice a barre dell'universo: alla scoperta dello spettro elettromagnetico e della spettroscopia*", devoted to explain the electromagnetic spectrum and the basics of spectroscopy to children from 6 to 10 years. The activity was based on the educational project described above (together with Liceo scientifico Pitagora), and it was designed to be consistent with the INAF Astrokids format (see <http://astrokids.inaf.it/>). Students from Liceo Pitagora supported the activity. About 20 children took part at the activity together with their parents.

The second part of the evening was devoted to a public conference titled "*Origine ed evoluzione dell'Universo. Quello che la scienza può e non può dire*", given by the IAU general secretary Piero Benvenuti. Almost 150 people, including several very interested and curious kids, attended the public talk. The audience interacted very actively with the speaker making the event very lively and successful.

All public outreach activities were free-entry events.