



Report from the event supported by RadioNet

TITLE *IAU SYMPOSIUM 333, "PEERING TOWARDS COSMIC DAWN"*

DATE: *2 – 6 OCTOBER 2017*

LOCATION: *DUBROVNIK, CROATIA*

MEETING WEBPAGE: *<https://iaus333.irb.hr>*

HOST INSTITUTE: *RUBER BOŠKOVIĆ INSTITUTE, ZAGREB, CROATIA*

**RADIONET
BENEFICIARY / NO:** *TO BE FILLED BY MANAGEMENT*

Report:

1. SCIENTIFIC SUMMARY

The results from the current Epoch of Reionization (EoR) experiments (using e.g. LOFAR, MWA and PAPER) are currently under way. These very deep observations will not only set constraints on when and where the first sources formed in the early Universe and began (re)ionizing the predominantly neutral all-pervasive intergalactic medium, but they are also providing high-quality data for cutting edge auxiliary foreground science.

Obviously studying the physical origin of the foregrounds, whether Galactic or extragalactic, is a very exciting field in its own right and is of fundamental importance for perfecting the foreground removal techniques in the cosmological experiments.

This symposium discussed both through: (i) giving the clearest and widest possible view on the EoR; (ii) showing the richness of data and presenting the state-of-the-art foreground science; and (iii) discussing challenges of upcoming and planned radio facilities (e.g. HERA and SKA).

Based on presented results of the major low-frequency radio telescopes there is substantial overall progress towards the detection of the cosmological 21cm signal. However, the effort required is much more demanding than it previously thought. Issues related to precision calibration of the instruments and subtle systematic biases are mainly hindering detection at present. Different teams are now working on resolving some of these issues. In the coming months, the LOFAR-EoR team expects to set soon the best upper limits on the EoR signal, ruling out some unusual reionization history scenarios.

Recent low frequency observations also revealed a bewildering variety of Galactic structures in polarization. Some of them are very long and straight filaments that resemble the observed HI fibers and correlate well with the magnetic field probed by the Planck mission. Their origin is still not known. This clearly calls for a multi-frequency study which, probes different physical quantities of the interstellar medium and its complicated structure.

Deep EoR observations started to reveal the true underlying distribution of very faint extragalactic sources. Theoretical source counts predict a significant contribution of star-forming galaxies at sub-mJy flux densities, but there is also the possibility of an unknown distribution of radio sources that might dominate at these flux densities. Combining these deep low-frequency radio data with observations at other frequencies will allow a detailed study of the formation and evolution of galaxies as a function of cosmic time and their environment.

This symposium highlighted the accomplishments of several RadioNet associated facilities, in particular LOFAR as the premier instrument to probe the signal of the EoR and simultaneously measure all emission from the contaminating (but scientifically very interesting) foregrounds.

The symposium topics were:

- (a) Cosmic Dawn and Epoch of Reionization: theory and simulations
- (b) Epoch of Reionization: observations and challenges
- (c) The first stars/galaxies and Epoch of Reionization
- (d) Galactic foreground science and multi-wavelength approach
- (e) Extragalactic foregrounds science, multi-wavelength approach and cosmic evolution
- (f) Foreground removal techniques

Dissemination of knowledge about these topics was given by the participants who come from different areas of radio astronomy and was a very important result of this meeting, as well as, spreading the notion that the RadioNet facilities are supporting fore-front science.

The scientific programme of the symposium was organized in 15 x 90min sessions, consisting of 8 invited reviews, 12 invited talks and 48 contributed talks. There were 3 posters and a 60min discussion.


The outreach programme of the symposium was directed to the general public and high school students. V. Jelic (RBI) gave a public lecture followed by stargazing. This event was organized at The Museum of Modern Art in Dubrovnik in collaboration with the Technical educational association of the city of Dubrovnik and the

Astronomy Club Korčula. Several local and national media followed this event, reaching more than 50 000 viewers/readers.

IAUS333 remained well attended up to and including the last sessions on Friday with lively discussion during the sessions and the coffee and lunch breaks. Immediate feedback from many participants indicated that overall IAUS333 was experienced as a successful and timely meeting, generating many new ideas and forging new collaborations.



IAUS333 website (<https://iaus333.irb.hr>)



IAU333

Welcome

The results from the current Epoch of Reionization (EoR) experiments (e.g. LOFAR, MWA and PAPER) are expected in coming years. These very deep observations will not only set constraints on when and where the first sources formed in the early Universe and began reionizing the predominantly neutral all-pervasive intergalactic medium, but will provide high-quality data for cutting edge auxiliary foreground science.

Obviously studying the physical origin of the foregrounds, whether Galactic or extragalactic, is a very exciting field in its own right and is of fundamental importance for perfecting the foreground removal techniques in the cosmological experiments.

This symposium, aimed at discussing both, is perfectly timed for: (i) getting the clearest and widest view possible on the EoR; (ii) showing the richness of data and presenting the state-of-the-art foreground science; and (iii) discussing challenges of coming and planned facilities (e.g. HERA and SKA).

Proceedings submission deadline 10 Dec 2017

IAU333 Programme

EXPLORE IAU333

- Scientific Rationale and Topics
- Committees and Organisers
- Invited Speakers
- Programme
- Conference Venue and Lodging
- Participants
- IAU Travel Grants
- Public Outreach
- Code of Conduct
- Sponsors

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2. AGENDA OF THE EVENT

The detailed programme of the IAU333 symposium is attached to this report.

It was organized in 15 x 90min sessions, consisting of 8 invited reviews, 12 invited talks and 48 contributed talks. There were 3 posters and a 60min discussion.

3. PARTICIPANTS

The list of participants (name/institutes/countries) is attached to this report.

In total 83 participants attended the conference: 62% from Europe, 11% from North America, 11% from Asia, 12% from Australia, and 4% from Africa. The fraction of female participants was 26.5%. The fraction of students and young researchers was around 60%. Four students from Europe (2 female and 2 male) were supported by RadioNet.

There were 20 invited speakers: 55% from Europe, 15% from North America, 15% from Australia, 10% from Asia and 5% from Africa. The fraction of female invited speakers was 50%. Two invited speakers from Europe (1 female and 1 male) were supported by RadioNet.





4. RADIONET FINANCIAL CONTRIBUTION

1. Invited speakers (1500 EUR)
 - a. 980 EUR - Isabela Prandoni (INAF - Istituto di Radioastronomia, Bologna, Italy, Italian)
 - b. 520 EUR - Mathieu Langer (IAS - Université Paris-Sud, France, French)
2. Students and young researchers (2500)
 - a. 625 EUR - Dora Klindzic (University of Zagreb, Croatia, Croatian)
 - b. 625 EUR - David Prelogovic (University of Zagreb, Croatia, Croatian)
 - c. 625 EUR - Marta Colakovic-Benceric (University of Zagreb, Croatia, Croatian)
 - d. 625 EUR - Luka Turic (University of Zagreb, Croatia, Croatian)
3. Organizational costs (500 EUR)
 - a. 500 EUR - Conference room

TOTAL 4500 EUR

5. PUBLICATIONS

The proceedings of IAUS333 will be dedicated to Prof. dr. Ger de Bruyn (1948-2017), who has been a leading figure in radio astronomy in the last few decades and has been instrumental in the development of LOFAR, especially the LOFAR-EoR key science project. The proceedings will be published as an International Astronomical Union Proceedings Series within six months of the symposium by Cambridge University Press.

IAUS333: Peering towards Cosmic Dawn

Oct 2-6, 2017, Dubrovnik, Croatia

ATTENDANCE LIST

1. Dominique Aubert (Observatoire Astronomique de Strasbourg, France)
2. Gianni Bernardi (IRA-INAF, Italy and Rhodes University, South Africa)
3. Christian Binggeli (Uppsala University, Sweden)
4. Anna Bonaldi (SKA Organization, United Kingdom)
5. Sarah Bosman (Kavli Institute of Cosmology, United Kingdom)
6. Francois Boulanger (Institut d'Astrophysique Spatiale, France)
7. Judd Bowman (Arizona State University, United States of America)
8. Enzo Branchini (University Roma Tre, Italy)
9. Tzu-Ching Chang (Caltech, United States of America)
10. Lana Ceraj (University of Zagreb, Croatia)
11. Emma Chapman (Imperial College London, United Kingdom)
12. Xuelei Chen (NAO, Chinese Academy of Sciences, China)
13. Samir Choudhuri (National Centre for Radio Astrophysics, India)
14. Susan Clark (The Institute for Advanced Study, United States of America)
15. Marta Colakovic-Benceric (University of Zagreb, Croatia)
16. Abhirup Datta (IIT Indore, India)
17. Josh Dillon (UC Berkeley, United States of America)
18. Jean-Baptiste Durrive (Nagoya University, Japan)
19. Evan Eames (l'Observatoire de Paris, France)
20. Michael Eastwood (Caltech, United States of America)
21. Anastasia Fialkov (Harvard University, United States of America)
22. Miroslav Filipovic (Western Sydney University, Australia)
23. Enrico Garaldi (Argelander-Institute for Astronomy, Germany)
24. Bharat Kumar Gehlot (Kapteyn Astronomical Institute, RuG, Netherlands)
25. Raghunath Ghara (Stockholm University, Sweden)
26. Sambit Giri (Stockholm University, Sweden)
27. Bradley Greig (Scuola Normale Superiore, Italy)
28. Martin Haehnelt (University of Cambridge, United Kingdom)
29. Sultan Hassan (University of the Western Cape, South Africa)
30. Marijke Haverkorn (Radboud University Nijmegen, Netherlands)
31. Kai Hoffmann (Tsinghua Center for Astrophysics, China)
32. Anne Hutter (Swinburne University of Technology, Australia)
33. Zeljko Ivezic (University of Washington, United States of America)
34. Matt Jarvis (University of Oxford, United Kingdom)
35. Vibor Jelic (Ruder Boskovic Institute, Croatia)
36. Ronniy Joseph (Curtin University, Australia)
37. Christos Karoumpis (Argelander-Institute for Astronomy, Germany)
38. Dora Klindzic (University of Zagreb, Croatia)
39. Robin Kooistra (Kapteyn Astronomical Institute, RuG, Netherlands)
40. Leon Koopmans (Kapteyn Astronomical Institute, RuG, Netherlands)
41. Girish Kulkarni (University of Cambridge, United Kingdom)
42. Guilaine Lagache (LAM - France, France)
43. Mathieu Langer (IAS - Université Paris-Sud, France)

44. Rene Laureijs (ESA/ESTEC, Netherlands)
45. Benjamin Magnelli (Argelander-Institute for Astronomy, Germany)
46. Suman Majumdar (Imperial College London, United Kingdom)
47. Benjamin McKinley (Curtin University, Australia)
48. Garrelt Mellema (Stockholm University, Sweden)
49. Florent Mertens (Kapteyn Astronomical Institute, RuG, Netherlands)
50. Andrei Mesinger (Scuola Normale Superiore, Italy)
51. Attila Meszaros (Charles University, Czech Republic)
52. Marc-Antoine Miville-Deschenes (Institut d'Astrophysique Spatiale, France)
53. Steven Murray (Curtin University, Australia)
54. Pierre Ocvirk (Observatoire Astronomique de Strasbourg, France)
55. Lucas Olivari (University of Manchester, United Kingdom)
56. Hamsa Padmanabhan (ETH Zurich, Switzerland)
57. Krisztina Perger (Eotvos Lorand University, Hungary)
58. Bart Pindor (University of Melbourne, Australia)
59. Sandor Pinter (Eotvos University, Hungary)
60. Jonathan Pober (Brown University, United States of America)
61. Isabella Prandoni (INAF - Institute of Radioastronomy, Italy)
62. David Prelogovic (University of Zagreb, Croatia)
63. Istvan Racz (Konkoly Observatory, Hungary)
64. Hannah Ross (University of Sussex, United Kingdom)
65. Mario Santos (University of Western Cape, South Africa)
66. Claude Schmit (Imperial College London, United Kingdom)
67. Jacob Seiler (Swinburne University, Australia)
68. Hayato Shimabukuro (Observatoire de paris - LERMA, France)
69. Marta Silva (Kapteyn Astronomical Institute, RuG, Netherlands)
70. Charlotte Sobey (ICRAR/CSIRO, Australia)
71. Nithyanandan Thyagarajan (Arizona State University, NRAO, United States of America)
72. Krešimir Tisanic (University of Zagreb, Croatia)
73. L. Viktor Toth (Konkoly Observatory, Hungary)
74. Cathryn Trott (ICRAR - Curtin University, Australia)
75. Luka Turic (University of Zagreb, Croatia)
76. Thijs van der Hulst (Kapteyn Astronomical Institute, RuG, Netherlands)
77. Catherine Watkinson (Imperial College London, United Kingdom)
78. Rachel Webster (University of Melbourne, Australia)
79. Yidong Xu (NAO, Chinese Academy of Sciences, China)
80. Naoki Yoshida (University of Tokyo, Japan)
81. Shintaro Yoshiura (Kumamoto University, Japan)
82. Bin Yue (NAO, Chinese Academy of Sciences, China)
83. Saleem Zaroubi (Kapteyn Astronomical Institute, RuG, Netherlands and Open University, Israel)

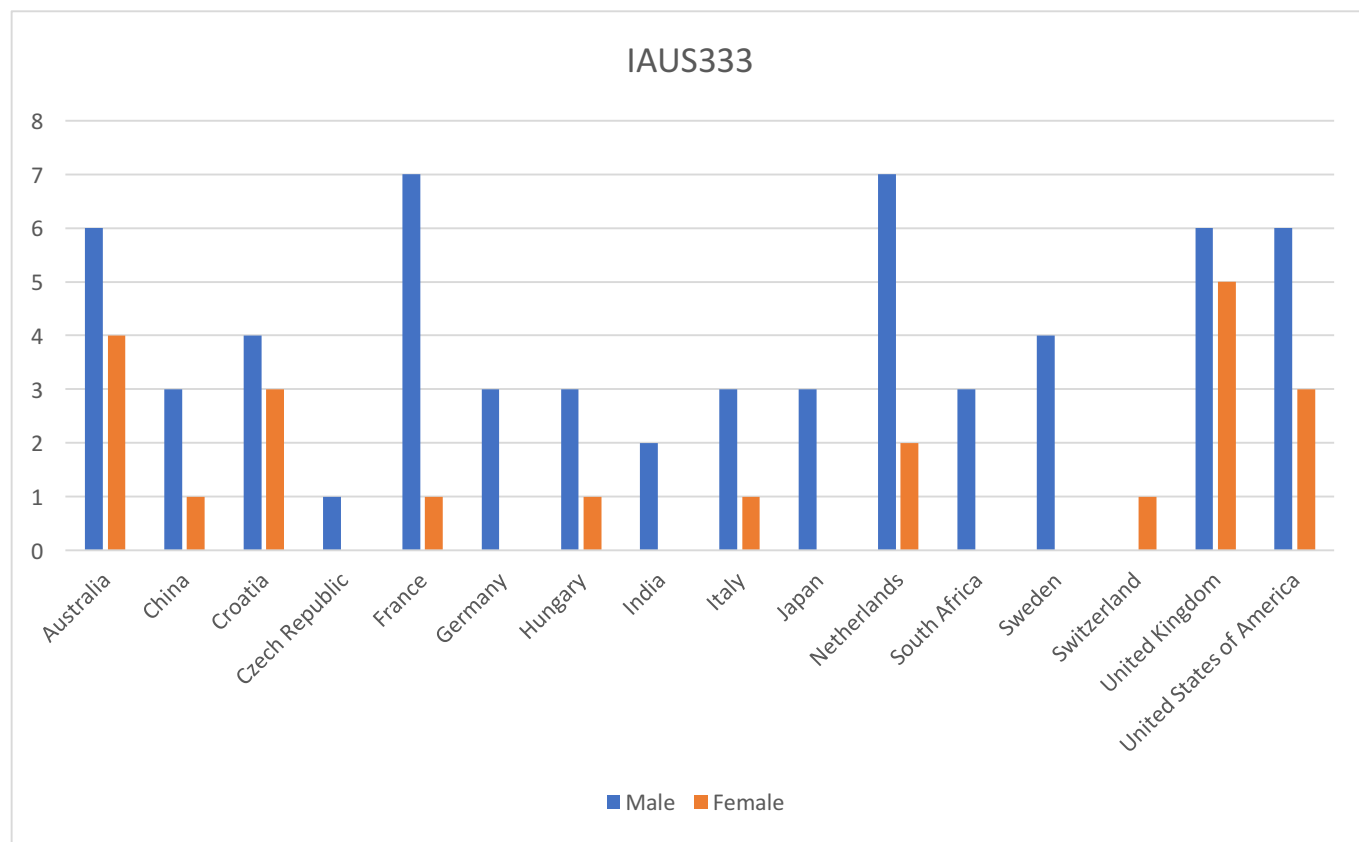


Dr. sc. Vibor Jelić, chair SOC/LOC
Oct 06, 2017, Dubrovnik, Croatia

IAUS333: Peering towards Cosmic Dawn

Oct 2-6, 2017, Dubrovnik, Croatia

PARTICIPANTS DISTRIBUTION BY COUNTRY AND GENDER



*****IAUS333 PROGRAMME - FINAL*****

Sun, 01 Oct 2017**17:30-19:00****REGISTRATION and WELCOME DRINK**

Mon, 02 Oct 2017**08:30-09:00****REGISTRATION****09:00-10:30 Session 1****Chair: M. Santos**

Welcome

10min

Cosmic Dawn and Epoch of Reionization: theory and simulations

A. Mesinger (IR)	Cosmic Dawn and Epoch of Reionization: theory and simulations	35min
B. Greig	Simultaneously constraining the astrophysics of reionisation and the epoch of heating with 21CMMC	15min
Y. Xu	Modeling the Neutral Islands during the Late Epoch of Reionization	15min
J.-B. Durrive	Mean Energy Density of Photogenerated Magnetic Fields Throughout the Epoch of Reionization	15min

10:30-11:00 Coffee Break**11:00-12:30 Session 2****Chair: M. Santos**

K. Datta (IT - remote talk)	Towards simulating and quantifying the light-cone EoR 21-cm signal	25min
E. Garaldi	Quasars at the Cosmic Dawn: effects on Reionization properties in cosmological simulations	15min
J. Seiler	Exploring Reionization With Semi-Analytics: The Escape Fraction Strikes Back	15min
H. Ross	Simulating X-ray heating during the Cosmic Dawn	15min
P. Ocvirk	Cosmic Dawn II: radiation-hydrodynamics of galaxy formation during the epoch of reionization	15min

12:30-13:30 Lunch Break**13:30-15:00 Session 3****Chair: E. Chapman**

D. Aubert	The reionization epoch of $z=0$ halos.	15min
S. Hassan	Reionization Models Classifier using 21cm Maps Deep Learning	15min
R. Kooistra	Detecting HI 21 cm emission from the IGM in large scale filaments with current and future radio telescopes	15min
K. Hoffmann	Signatures of Cosmic Reionization on the 21-cm 3-Point Correlation	15min
G. Mellema	Analysis of Tomographic 21-cm Data	15min
S. Majumdar	Quantifying the non-Gaussianity in the EoR 21-cm signal through bispectrum	15min

15:00-15:30 Coffee Break**15:30-17:00 Session 4****Chair: E. Chapman**

H. Padmanabhan (IT)	Neutral hydrogen in the post-reionization universe	25min
M. Silva	Line Intensity Mapping during the Epoch of Reionization	15min

Cosmic Dawn and Epoch of Reionization: observations, challenges and first results

S. Zaroubi (IR)	Cosmic Dawn and Epoch of Reionization: observational challenges	35min
J. Bowman	Results from EDGES	15min

Tue, 03 Oct 2017**09:00-10:30 Session 5****Chair: S. Zaroubi**

J.C. Pober (IT)	Results from PAPER	25min
R. Webster (IT)	Results from MWA-EoR	25min

	L. Koopmans (IT)	Results from LOFAR-EoR	25min
	B.K. Gehlot	Epoch of Reionization on large angular scales with LOFAR and AARTFAAC	15min
10:30-11:00	Coffee Break		
11:00-12:30	Session 6		
	B. Pindor	MWA Observations of EOR1 field	15min
	G. Bernardi	Measurements of the global signal from the Cosmic Dawn	15min
	B. McKinley	Measuring the Global EoR Signal using the Moon and the MWA	15min
	J.S. Dillon	Precision Calibration for 21 cm Cosmology with HERA	15min
	C. Trott (IT)	SKA-CD/EoR project	25min
12:30-13:30	Lunch Break		
13:30-15:00	Session 7		
	R. Dr. Ghara	21-cm signature of the first sources in the Universe: Prospects of detection with SKA using matched filters	15min
	N. Thyagarajan	Status of Foreground and Instrument Challenges for 21cm EoR Experiments - Design and Analysis Strategies for SKA and HERA	15min
	R. Joseph	Redundant Calibration: Breaking the constraints of limited sky information	15min
	H. Shimabukuro	Analysing the 21cm signal with artificial neural networks	15min
	M.W. Eastwood	Full-Sky Maps of the VHF Radio Sky with the Owens Valley Long Wavelength Array	15min

14:45-15:30 Coffee Break

15:30-17:00 Session 8

Chair: G. Mellema

The first stars/galaxies, EoR and multi-frequency constrains

	M. Langer (IT)	CMB constraints on the EoR through the measurement of the Thompson optical depth	25min
	M. Haehnelt	Probing reionization with Lyman-alpha and 21cm emission/absorption	15min
	S.E.I. Bosman	The opacity of Lyman-alpha absorption up to $z = 6.2$ with a sample of 90+ $z > 5.7$ quasars	15min
	N. Yoshida (IR)	First stars/galaxies and EoR	35min

17:00-17:30 Coffee Break

17:30-18:30

DISCUSSION

Wen, 04 Oct 2017

09:00-10:30 Session 9

Chair: G. Bernardi

Galactic foreground science

	M. Haverkorn (IR)	Galactic foreground science: radio emission, polarisation, ISM and magnetic fields	35min
	S. Choudhuri	The angular power spectrum measurement of the Galactic synchrotron emission in two fields of the TGSS survey	15min
	C. Sobey (IT)	Using low-frequency pulsar observations to study the 3-D structure of the Galactic magnetic field	25min
	F. Boulanger	Statistical modelling of dust polarization as a CMB foreground	15min

10:30-11:00 Coffee Break

11:00-12:30 Session 10

Chair: G. Bernardi

	M.-A. Miville-Deschenes (IR)	Galactic foreground science: multi-wavelength approach to constrain ISM	35min
	S. Clark (IT)	Galactic HI and the Magnetic ISM Foreground	25min

Extragalactic foreground science

	A. Meszaros	Spatial distribution of the gamma-ray bursts at very high redshift	15min
	K. Tisanic	Average radio spectral energy distribution of highly star forming galaxies	15min

12:30-13:30 Lunch Break

16:30-17:30

GUIDED TOUR OF OLD TOWN DUBROVNIK sponsored by Dubrovnik Tourist Board

60min

meeting pont: in front of Tourist Information Office at Pile, Brsalje 5, Dubrovnik

19:30-22:00

CONFERENCE DINNER

Gradska kavana Arsenal, Pred Dvorom 1 - Old Town Dubrovnik

Thu, 05 Oct 2017

09:00-10:30 Session 11

Chair: T. van der Hulst

I. Prandoni (IR)

Galaxies/AGNs and their evolution

35min

M. Jarvis (IR)

Extragalactic foreground science: multi-wavelength approach and cosmic evolution

35min

L. Ceraj

Radio luminosity functions of AGN with moderate-to-high radiative luminosities out to $z \sim 6$ in the COSMOS field

15min

10:30-11:00 Coffee Break

11:00-12:30 Session 12

Chair: T. van der Hulst

The first stars/galaxies, EoR and multi-frequency constrains

Z. Ivezić (IT)

LSST and the Epoch of Reionization experiments

25min

A. Fialkov

Tracing Cosmic Dawn

15min

R. Laureijs

Observing the high redshift Universe with Euclid

15min

G. Lagache (IT)

Exploring the dusty star-formation in the early Universe using CIB and [CII]-line intensity mapping

25min

A. Hutter

Exploring 21cm - galaxy synergies

15min

12:30-13:30 Lunch Break

13:30-15:00 Session 13

Chair: T.-C. Chang

Foreground mitigation

E. Chapman (IR)

Methods of foreground mitigation in the EoR

35min

A. Bonaldi (IT)

EoR imaging with the SKA: the challenge of foreground removal

25min

S. Murray

Between Window and Wedge: An Improved Statistical Point-Source Foreground Model for the EoR

15min

The first stars/galaxies, EoR and multi-frequency constrains

E. Evan

A new public 21-cm EoR signal database, and how it can make your life sunnier

15min

15:00-15:30 Coffee Break

15:30-17:00 Session 14

Chair: T.-C. Chang

B. Yue

Detecting the reionization galaxies through the gravitational lensing

15min

G. Kulkarni

Evolution of the UV luminosity function of AGN and its implications for the 21 cm signal from the epoch of reionization

15min

L.V. Toth

The structure of the ISM in the Zone of Avoidance by high-resolution multi-wavelength observations

15min

C. Binggeli

LYCAN: The LYman Continuum ANalysis project

15min

S. Giri

Constraining Lyman continuum escape using Machine Learning

15min

C. Schmit

Emulation of reionization simulations for Bayesian inference of astrophysics parameters using neural networks.

15min

18:15-21:15

PUBLIC TALK in Croatian and STARGAZING

The Museum of Modern Art Dubrovnik, Frana Supila 23, Dubrovnik

Fri, 06 Oct 2017

09:00-10:30 Session 15

Chair: V. Jelic

Foreground mitigation

A. Datta	Foreground Subtraction in redshifted 21cm Global Signal Experiments using Artificial Neural Networks	15min
L. Olivari	Intensity Mapping Foreground Cleaning with Generalized Needlet Internal Linear Combination	15min
F.G. Mertens	A non-parametric method for clean foregrounds removal in 21-cm EoR observations	15min
S. Yoshiura	Foreground mitigation strategy for measuring the 21cm-LAE cross-correlation	15min

SUMMARY AND FINAL DISCUSSION

30min

10:30-11:00 Coffee Break**12:30-13:30 Lunch**

IR an invited review

IT an invited talk