



Report from event supported by RadioNet

TITLE *VIEWS ON THE INTERSTELLAR MEDIUM IN GALAXIES IN THE ALMA ERA*

DATE: *SEPTEMBER, 2-6, 2019*

LOCATION: *BOLOGNA, ITALY*

MEETING WEBPAGE: *<https://eventi.unibo.it/ism-difa-bologna-2019>*

HOST INSTITUTE: *INAF-OAS BOLOGNA, DIFA UNIVERSITY ALMA MATER OF BOLOGNA*

**RADIONET
BENEFICIARY / NO:** *INAF / 04*

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Report:

1 SCIENTIFIC SUMMARY

Event webpage: <https://eventi.unibo.it/ism-difa-bologna-2019>



Conference picture of the event. © F. Loiacono/DIFA, Univ.Bologna

1.1 SCIENTIFIC SUMMARY

Galaxies accrete gas from the intergalactic medium, thus building their gaseous reservoirs, which fuel the formation of stars and the growth of supermassive black holes. Feedback mechanisms then return part of this material into the circum-galactic environment, thus completing the so-called 'baryon cycle'. Understanding this process and its dependence on different galaxy properties and cosmic times is one of the key-questions of modern astrophysics and is very challenging, given the complexity and interplay of the physical mechanisms involved and the difficulty to be observed the interstellar gas in distant galaxies.

The advent of the power of the Atacama Large Millimeter Array (**ALMA**) and the upgraded capabilities of other sub-mm/mm facilities are now opening a complete new window of the baryon cycle. On one hand, local galaxies are exploited as 'laboratories' where the interstellar medium is studied down to molecular cloud scales and the physical processes can be investigated in detail. On the other hand, thanks to the unprecedented sensitivities of the new facilities, systematic surveys of the gaseous content in high redshift galaxies are starting to characterize the gas cycle throughout cosmic time. Dedicated observations have revealed gas in the most distant galaxies, all the way to the reionization epoch, and have started to dissect the interplay between luminous active galactic nuclei and their host galaxy. These new observational constraints are guiding the next generation of galaxy evolution models.

The aim of this conference was to review the latest results on extragalactic studies of the baryon cycle, obtained thanks to IR/(sub-)mm facilities, and in particular with ALMA, and to discuss their impact and consequences on our understanding of galaxy evolution from nearby galaxies up to the early Universe.

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The conference was held at the prestigious **Giorgio Prodi lecture hall**, located at the heart of the monumental complex of San Giovanni in Monte. The program included 5 sessions (one per day), spanning various aspects of ISM studies in distant galaxies, including: studies of the local universe; the impact of active galactic nuclei; theoretical models; surveys of high-z galaxies; and the very high redshift universe. All coffee breaks and the lunch on Monday, Tuesday, Thursday and Friday happened in the courtyard just outside the Prodi lecture hall, thus facilitating interactions between the conference participants. In addition, an outreach public event (an outreach talk by prof. Roberto Maiolino, SOC member of the conference) took place on September 3.



Pictures from scheduled talks during the conference. © F. Loiacono/DIFA, Univ.Bologna



Photos of the open discussions. © F. Loiacono/DIFA, Univ.Bologna

1.2 RADIONET RELEVANCE

The conference included several presentations of work based on RadioNet infrastructures, in particular IRAM / NOEMA and APEX (e.g., invited reviews by Amelie Saintonge, Bram Venemans, and Manuel Aravena, invited talks by Susanne Aalto and Rodrigo Herrera-Camus, contributed talks by Dieter Lutz, Deanne Fisher, and Chentao Yang).

1.3 IMPACT

The workshop represented a great opportunity to present and discuss new results on the study of the interstellar medium in high-redshift galaxies, a key scientific interest for the RadioNet community. Besides regular talks, most of which involving data from RadioNet facilities or addressing topics that are central in the scientific interests of the RadioNet community, the workshop had 30 min of open discussion scheduled at the end of each session, to further explore, in a collegial way, the open questions and debated topics raised during the talks. The long lunch breaks with catering present on the venue also contributed in establishing an interactive, open environment that funneled scientific discussions.

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2 AGENDA OF THE EVENT

The workshop was articulated in 5 sessions (one per day). Each session started with a review talk, and included 1-3 invited speakers and a number of contributed talks. At the end of each session, we allocated 30 min of open discussion on some of the topics of the session. The detailed program was as follows:

Monday

8:30 Registration opens

9:00-9:30 Roberto Decarli + Francesca Pozzi, Welcome

Local Universe - Chair: Marcella Massardi

9:30-10:05 Adam Leroy, [Review] ALMA Brings Molecular Gas in Galaxies Into Focus

10:05-10:20 Jiayi Sun, PHANGS-ALMA: Demographics and Environment-dependence of Molecular Cloud Properties

10:20-10:35 Andreas Schrubba, The Cloud-scale Baryon Cycle of Nearby Galaxies

10:35-10:50 Timothy Davis, Parsec scale views of the molecular gas in bulges with WISDOM

10:50-11:20 coffee break

11:20-11:45 Alberto Bolatto [Invited], The Central Engine and Outflows in the Nuclear Starburst of NGC 253

11:45-12:00 Jeff Mangum, ALCHEMI: First Results from the ALMA Comprehensive High-resolution Extragalactic Molecular Inventory of NGC253

12:00-12:15 Nico Krieger, A detailed ALMA look into the NGC253 starburst and its connection to the Galactic Center

12:15-12:30 Melanie Chevance, A systematic characterisation of the evolutionary cycling between molecular clouds, star formation, and feedback in nearby galaxies

12:30-14:00 lunch

Chair: Miroslava Dessauges-Zavadsky

14:00-14:25 Amelie Saintonge [invited], Molecular gas and dust in the nearby Universe: the global perspective

14:25-14:40 Dieter Lutz, Molecular outflows in the local universe

14:40-14:55 Loreto Barcos-Munos, Star Formation and ISM Properties in Local U/LIRGs at GMC scales: The Case of Arp 220

14:55-15:10 Katie Jameson, The first large, unbiased ALMA survey of CO at parsec resolution in the Small Magellanic Cloud

15:10-15:25 Matilde Mingozzi, Investigating the ISM of local Seyfert galaxies by modelling their CO SLED

15:25-16:00 coffee break

16:00-16:15 Isabella Cortzen, PAHs trace the molecular gas in star-forming galaxies

16:15-16:30 Deanne Fisher, Star Formation in Turbulent, Clumpy Disk Galaxies

16:30-16:45 Christine Wilson, Dense gas and star formation in nearby galaxies with a range of morphologies

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- 16:45-17:00 Viviana Casasola, Definitive view of the ISM in the Local Universe
- 17:00-17:15 Rosita Paladino, Dust polarization measurements in nearby galaxies to investigate magnetic fields in cold gas
- 17:15-17:30 Nikki Zabel, How the cluster environment affects the baryon cycle
- 17:30-17:45 Ashley Bemis, Star Formation and Dense Gas in Extreme Environments with ALMA
- 17:45-18:15 Discussion

Tuesday

AGN - Chair: Carlotta Gruppioni

- 9:30-10:05 Bram Venemans, [Review] (Sub)millimetre observations of $z>6$ quasar hosts: massive galaxy formation in the epoch of reionisation
- 10:05-10:20 Mladen Novak, Interstellar medium in the early universe: a multi-line ALMA survey of a redshift 7.5 quasar
- 10:20-10:35 Antonio Pensabene, The ALMA view of quasars host galaxies at the dawn of cosmic time
- 10:35-10:50 Tanio Diaz-Santos, ALMA Reveals the Interstellar Medium Dynamics of Hyper-luminous Obscured Quasars
- 10:50-11:20 coffee break
- 11:20-11:45 Marcella Brusa [Invited], The molecular gas content of obscured Quasars at high- z
- 11:45-12:00 Vincenzo Mainieri, The role of AGN-feedback in the baryon cycle of $z\sim 2$ galaxies: what we learn from the ionized and molecular gas kinematics
- 12:00-12:15 Giulia Rodighiero, AGN in dusty Starbursts at $z=2$: feedback still to kick in
- 12:15-12:30 Quirino D'Amato, On the dust and gas content of high-redshift galaxies hosting obscured AGN in the CDF-S
- 12:30-14:00 lunch
- Chair: Cristian Vignali
- 14:00-14:25 Susanne Aalto [Invited], Feeding and feedback in dusty galaxy nuclei and AGNs
- 14:25-14:40 Tom Oosterloo, Molecular outflows in young AGN
- 14:40-14:55 Anelise Audibert, Feeding and Feedback in NUClei of GALaxies (NUGA)
- 14:55-15:10 Manuela Bischetti, The gentle monster PDS456 as seen by ALMA: implications for AGN feedback
- 15:10-15:25 Masatoshi Imanishi, ALMA dense molecular gas survey of nearby ultraluminous infrared galaxies
- 15:25-16:00 coffee break
- 16:00-16:15 Irina Smirnova-Pinchukova, The Close AGN Reference Survey: Discovering a [CII] line excess in a multi-phase AGN-driven outflow
- 16:15-16:30 Federico Lelli, Gas dynamics at $z=4.8$ with high-resolution ALMA observations
- 16:30-16:45 Andrea Enia, The nature of the strongly lensed SMG J091043.0-000322
- 16:45-17:00 Matthew Doherty, A magnified view of the ISM and star formation in a strongly lensed AGN hosting SMG at $z = 2.6$
- 17:00-17:30 Poster session

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17:30-18:00 Discussion

Wednesday

Theory - Chair: Livia Vallini

9:30-10:05 Desika Narayanan [Review], A theoretical view of dust in galaxies near and far

10:05-10:20 Lichen Liang, Probing ISM conditions of high redshift galaxies with dust emission: A view from the FIRE simulations

10:20-10:35 Mahsa Kohandel, Kinematics of $z \geq 6$ galaxies from [CII] line emission

10:35-10:50 Andrea Pallottini, The interstellar medium and radiation field of the galaxies in the Epoch of Reionization.

10:50-11:20 coffee break

11:20-11:45 Francesco Calura [Invited], Scaling relations and interstellar dust mass budget in galaxies

11:45-12:00 Alessandro Lupi, Kinematics and dynamics of molecular gas in high redshift quasars

12:00-12:15 Rowan Smith, Introducing the Cloud Factory: How galactic scale forces affect cloud morphology and dynamics

12:15-12:30 Diederik Kruijssen, The baryon cycle from molecular clouds to galaxies

12:30-12:45 Thales Gutcke, Resolving chemistry and clouds on galactic scales

12:45-13:15 Poster session

Thursday

Surveys - Chair: Margherita Talia

9:30-10:05 Manuel Aravena [Review] The new era of galaxy evolution studies from sensitive molecular and dust deep field surveys

Survey

10:05-10:20 Melanie Kaasinen, Contributed Comparing Molecular Gas Tracers at $z \sim 2$: Do CO and dust continuum emission trace the same regions of the ISM?

10:20-10:35 Rychard Bouwens, Dust Emission from $z \geq 2$ Lyman-Break Galaxies in the HUDF ASPECS Program

10:35-10:50 Caitlin Casey, Constraints on the ISM dust-temperatures of galaxies across cosmic time

10:50-11:20 coffee break

11:20-11:45 Rodrigo Herrera-Camus [Invited] Molecular gas properties of typical galaxies and their outflows at $z \sim 1-3$

11:45-12:00 Helmut Dannerbauer, Impact of environment on molecular gas reservoirs probed in distant cluster and field galaxies

12:00-12:15 Bitten Gullberg, Contributed High resolution ALMA imaging of SMGs

12:15-12:30 Paolo Cassata, Probing the molecular gas content of normal star-forming galaxies at $3 < z < 3.5$ with ALMA

12:30-14:00 lunch

Chair: Dieter Lutz

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- 14:00-14:25 Matus Rybak [Invited], Dissecting sub-millimeter galaxies: ALMA studies of dust and gas on (sub-)kpc scales
- 14:25-14:40 Francesco Valentino, A survey of atomic carbon [C I] in normal main sequence galaxies at high redshift
- 14:40-14:55 Patrick Kamieneski, Gas and star formation at sub-100 pc scales in lensed hyper-luminous SMGs at Cosmic Noon
- 14:55-15:10 Bunyo Hatsukade, ALMA twenty-six arcmin² survey of GOODS-S at one millimeter (ASAGAO)
- 15:10-15:25 Chentao Yang, Studying the ISM in high-redshift strongly gravitational lensed galaxies in the ALMA era
- 15:25-16:00 coffee break
- 16:00-16:25 Matthieu Bethermin [Invited], Exploring the [C II] and the dust continuum with the ALPINE survey: first scientific results
- 16:25-16:40 Federica Loiacono, Cold gas across cosmic time from CO and [C II] serendipitous discoveries
- 16:40-16:55 Yoshinobu Fudamoto, Dust Attenuation of Star-Forming Galaxies in the First 2Gyr of the Universe
- 16:55-17:10 Gareth Jones, Kinematics of z~4-6 Lyman Break Galaxies in ALPINE
- 17:10-17:25 Michele Ginolfi, [C II]-Line Properties and Star Formation-driven Outflows in high-z Galaxies: early results from ALPINE
- 17:25-18:00 Discussion

Friday

High-z - Chair: John Silverman

- 9:30-10:05 Renske Smit [Review], An ALMA view of galaxies in the Epoch of Reionisation
- 10:05-10:20 Sander Schouws, New observations of Dust and [C II] in the Epoch of Reionization
- 10:20-10:35 Zhiyu Zhang, Top-heavy IMF found in dusty starburst galaxies across cosmic time
- 10:35-10:50 Shuowen Jin, Extremely cold dusty galaxies at z=4--6: first direct evidence of CMB impact on high-z galaxy observables
- 10:50-11:20 coffee break
- 11:20-11:45 **Takuya Hashimoto [Invited]**, Properties of galaxies at z ~ 6 - 9 revealed by ALMA
- 11:45-12:00 Valentina D'Odorico, Witnessing galaxy assembly at the reionization epoch
- 12:00-12:15 Tao Wang, On the nature of HST-dark sources revealed by ALMA
- 12:15-12:30 Stefano Carniani, ALMA witnesses assembly of first galaxies
- 12:30-12:45 Miroslava Dessauges-Zavadsky, Molecular clouds in a Milky Way progenitor observed 8 billion years ago
- 12:45-13:00 Seiji Fujimoto, First Identification of 10-kpc Scale [C II] 158um Halos around Star-Forming Galaxies at z=5-7
- 13:00-13:30 Discussion and concluding remarks

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3 PARTICIPANTS

The list of participants included 116 scientists affiliated to institutes from 17 different countries (Australia, Canada, Chile, Czech Republic, Denmark, France, Germany, Hungary, Italy, Japan, the Netherlands, Poland, Spain, Sweden, Switzerland, UK, USA) from all over the world. About 41% of the participants were women. The 14 invited speakers included scientists from Chile, France, Japan, Italy, UK, Germany, the Netherlands, Sweden, USA. RadioNet support was critical in order to support the participation of our invited speaker Dr. Takuya Hashimoto from Japan.

4 RADIO NET FINANCIAL CONTRIBUTION

The RadioNet contribution (800 euros) was used for the travel costs of one invited speaker, a leader of the field of very high-redshift galaxy studies in the rest-frame FIR. The RadioNet contribution allowed us to: 1) support the participation of a well-recognized junior scientist; 2) promote the geographical diversity of the speakers.

5 PUBLICATIONS

We do not plan to publish proceedings of the conference. However, all of the presentations are available online.

6 CONFIRMATION

We confirm that RadioNet is allowed to publish this report, incl. participants lists, statistic's details, pictures, etc, following the Regulation (EU) 2016/679 - General Data Protection Regulation.