Dr. Manuela Bischetti - Curriculum vitae et studiorum

PhD in Astronomy, Astrophysics and Space Science

INAF Osservatorio Astronomico di Trieste (OATs)

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Current position
Fixed term researcher since 1st October 2022 at the Physics Department of Università degli Studi di Trieste (UniTs), Italy.

Previous positions
- Postdoctoral researcher at INAF Osservatorio Astronomico di Trieste (OATs), Italy (Jan 2020 - Sept 2022)
- Postdoctoral researcher at INAF Osservatorio Astronomico di Roma (OAR), Italy (Jan 2019 - Dec 2019)
- Visiting student at Kavli Institute for Cosmology Cambridge, KICC, Cambridge University (May 2017-May 2018)
- European PhD in Astronomy, Astrophysics and Space Science at Università di Roma Tor Vergata, awarded on 21 December 2018, *excellent cum laude* qualification (Nov 2015 - Oct 2018)

Publication highlights (The complete publication list is reported in section Bibliography)
- A total of **33 publications** on peer reviewed journals
- **6 publications as first author**, of which is **1 publication in Nature**
- **1066 citations**, of which 251 citations as first author (source ADS)
- 4 non-reviewed publications as first author and 17 as co-author

Invited talks at international conferences & Colloquia
- Presentation at the Multiphase AGN feeding and feedback II meeting, *Suppression of black-hole growth by strong outflows at redshifts 5.8-6.6*, June 2022 (Sesto, IT)
- Presentation at the Young Astronomers on Galactic Nuclei (YAGN) meeting, *Balancing black-hole and galaxy growth in the high-redshift Universe*, Oct 2022 (San Sebastian, ES)
- Presentation at the European Astronomical Society (EAS) Annual Meeting, *Quasar feedback at the epoch of Reionization*, July 2021 (Leiden, NL)
- Presentation at the YAGN rendezvous IAC, *Hyper-luminous QSOs as probes of the maximum impact of AGN feedback*, Sep 2019 (Tenerife, ES)
- Solicited presentation at COSPAR 44th Scientific Assembly, *Widespread and strong outflows in quasars at the Reionisation epoch*, July 2022 (Athens, GR)
- Review presentation at INAF OATs, Postdoc/PhD Seminars, *AGN-driven outflows, host-galaxy and environment properties in luminous quasars*, July 2021 (Trieste, IT)
- Colloquium at INAF OAR, *Black-hole feedback shapes the evolution of massive galaxies across*
- *Cosmic time*, 31st May 2022 (Rome, IT)
- Colloquium at Instituto de Astrofisica de Canarias, *A multiwavelength look into the common evolution of luminous quasars and their host-galaxies*, May 2021 (IAC Tenerife, ES)

- Colloquium at University of Sao Paulo AIG/USP, AGN Webinars, *Probing AGN-driven outflows, host-galaxy and environment properties in luminous quasars,* Nov 2021 (Sao Paulo, BR)

Contributed talks at international conferences

Since 2016, I have participated with 19 contributed talks in 16 conferences, including: *HACK100: Past, Present and Future of Astrophysical Spectroscopy,* (June 2022*,* Trieste, IT); *AGN XIV: The Renaissance of Black Holes and Galaxies* (May 2022, Firenze, IT); IRAM conference *Multi-line Diagnostics of the Interstellar Medium* (April 2022, Nice, FR); *SAZERAC-Quasars During Reionisation (*Dec 2022, virtual); *Epoch of Galaxy Quenching* (Sep 2020 Cambridge, UK); *ALMABO19-Views on the ISM in galaxies in the ALMA era* (Sep 2019, Bologna, IT); *Extremely Big Eyes on the Early Universe* (Sep 2019, Roma, IT); 3 talks at *EWASS 2019* (June 2019,Lyon, FR); *Supermassive Black Holes: Environment and Evolution (*June 2019, Corfù, GR); IAU symposium 352: *Uncovering early galaxy evolution in the ALMA and JWST era* (June 2019, Viana do Castelo, PT); *AGN XIII* (Oct 2018, Milano, IT); *Birth, life and fate of massive galaxies and their central beating heart (*Sep 2018, Favignana, IT); *Are AGN special?* (Aug 2018 Durham, UK); *EWASS 2017,* (June 2017, Prague, CZ); *AGN XII (*Sep 2016, Napoli, IT); *Super Eddington* (Sep 2016, Arbatax, IT)

Bibliography

Publications selected for evaluation are in boldface. Publications as second/third author are underlined.

First author publications

In these publications I led the data analysis, interpretation and writing of the paper.

- **Bischetti et al. (2022)**, Suppression of black-hole growth by strong outflows at redshifts 5.8-6.6, Nature, 605, 244.
  I identified and characterised black-hole driven outflows in z~6 quasars, as traced by broad-absorption line (BAL) features, based on deep X-shooter spectroscopy. I built a spectral decomposition tool to model the quasar intrinsic continuum based-on composite spectra, which I applied to 1800 quasars at z>2 to determine the redshift evolution of the BAL outflow properties.
- **Bischetti et al. (2021),** The WISSH quasars project IX. Cold gas content and environment of luminous QSOs at z~2.4-4.7, A&A, 645, A33.
  I exploited ALMA, NOEMA and JVLA observations of CO and (sub-)millimetre continuum emission for high-luminosity quasars at z~2-4.5. I characterised the molecular gas reservoirs and the physical conditions of the interstellar medium (gas excitation, dynamics, SFR) in the quasar host galaxies. I determined galaxy overdensities up to 150-200 kpc scales.
- **Bischetti et al. (2019b)**, Widespread evidence of [CII] outflows in the early Universe, A&A 630, A59.
  I assessed the occurrence, typical morphology and energetics of quasar-driven outflows in the cold gas phase at 5<z<7, by performing a stacking analysis of ALMA spectra and datacubes of [CII] emission in quasars. I studied correlations between outflow, BH and host-galaxy properties to determine the driving mechanism of the high-velocity [CII] emission.
- **Bischetti et al. (2019a)**, The gentle monster PDS 456. The kpc-scale molecular outflow and its implications for QSO feedback, A&A 628, A118.

  I exploited the highest-resolution, ALMA spectroscopic and imaging data of the host-galaxy of a high-luminosity quasar. I accurately modelled the host-galaxy dynamics and performed a pixel-by-pixel spectral decomposition of the gas kinematic components, to accurately map a kpc-scale molecular outflow and measure its impact on galaxy growth.

- Bischetti et al. (2018), The assembly of a giant galaxy around a hyper-luminous QSO, A&A 617, A82.
  I exploited high-resolution ALMA observations of [CII] and dust-continuum in a z~4 quasar to characterise ISM properties and gas dynamics, in the quasar host and in companion galaxies, to the early mass assembly of black-holes and galaxies.
- **Bischetti et al. (2017)**, Powerful ionised outflows in the most luminous quasars, A&A 598, A122.
  I exploited near-infrared LBT/LUCI spectra to perform a spectral decomposition and measure quasar nuclear properties, identify and quantify the energetics of ionised outflows, as traced by broad, blue-shifted wings in the [OIII] emission line. I measured the size of extended [OIII] emission via near-slit spectroscopy.

Publications as co-author

- Tripodi et al. (2022), Weighting the black hole and host galaxy growth in a z~6 QSO, A&A accepted, arXiv:2207.03314. I supervised the dynamical modelling of the host-galaxy disk, including rotation and molecular outflow.
- Ramos Almeida, Bischetti, et al. (2022), The diverse cold molecular gas contents, morphologies and kinematics of type-2 quasars as seen by ALMA, A&A, 658, A155. I was responsible for the calibration, analysis and interpretation of ALMA data, including gas kinematic models and the identification of molecular outflows.
- Vietri et al. (2022), The WISSH quasars project X. Discovery of a powerful and variable ultra-fast outflow in a z=3.6 quasar. A&A accepted, arXiv:2205.06832. I provided feedback to optimise the modelling of the intrinsic quasar continuum emission and the identification of broad absorption line features.
- Laurenti et al. (2022), X-ray spectroscopic survey of highly accreting AGN, A&A, 657A, 57L. I contributed to the analysis of the UV and optical quasar spectra and to the derivation of quasar nuclear properties.
- Chen et al. (2021), Measuring the Density Fields around Bright Quasars at z~6 with XQR-30 Spectra, ApJ, 931, 29. I provided the properties of broad absorption line outflows in the XQR-30 quasar sample.
- Bosman et al. (2021), Hydrogen reionisation ends by z=5.3 : Lyman-α optical depth measured by the XQR-30 sample, MNRAS, 514, 55. I provided information about the presence and kinematic properties of broad absorption line outflows in the XQR-30 quasar sample.
- Zanchettin, Feruglio, Bischetti et al. (2021), The IBISCO survey: I. Multiphase discs and winds in the Seyfert galaxy Markarian 509. A&A, 655, A25. I contributed to the calibration and analysis of the ALMA continuum and line data. I was responsible for modelling and interpreting the molecular gas dynamics.
- Cicone et al. (2021), The first image of a molecular halo out to r~200 kpc (SUPER VI), A&A, 645L, 8C. I contributed to optimising uv-plane modelling of ALMA and ACA data and to imaging extended emission.
- Saturni et al. (2021) Catching dual AGN activity and kiloparsec-scale outflows in IRAS 20210+1121, A&A, 645A, 154S. I contributed to quantifying the uncertainties associated with the spectral measurements and to characterising the [OIII] outflow physical properties.
- Lamperti et al. (2021), SUPER V. ALMA continuum observations of z~2 AGN and the elusive evidence of outflows influencing star-formation. A&A, 645, A90. I contributed to improving quasar size measurements in the millimetre data (in the UV and image planes) and to modelling the IR SED.

- Circosta et al. (2021), SUPER. IV. CO(J = 3-2) properties of active galactic nucleus hosts at cosmic noon revealed by ALMA. A&A, 646, A96. I was largely involved in the calibration and analysis of ALMA data.

- Vietri et al. 2020, SUPER III. Broad Line Region properties of AGN at z~2, A&A, 644A, 175V. I provided help to improve the modelling of the C IV line in broad absorption line quasars and to homogenise methods and assumptions in the comparison of outflow properties among different samples.

- Travascio et al. 2020, Multiple AGN activity during the BCG assembly of XDCP0044.0-2033 at z~1.6, MNRAS, 498, 2719T. I was responsible for providing the ALMA- based SFR for the cluster members.

- Kakkad et al. 2020, SUPER II. Spatially resolved ionised gas kinematics and scaling relations in z~2 AGN host galaxies, A&A, 642A, 147K. I was involved in the calibration and in the realignment of sources in the SINFONI data. I provided feedback on the identification of ionised outflows.

- Zappacosta et al. 2020, The WISSH quasars project VII. The impact of extreme radiative field in the accretion disc and X-ray corona interplay, A&A, 635L, 5Z. I analysed the near-infrared quasar spectra and provided quasar properties such as redshift, luminosity, black hole mass.

- Travascio et al. 2020, The WISSH quasars project VIII. Outflows and metals in the circum-galactic medium around the hyper-luminous z~3.6 quasar J1538+08, A&A 635A, 157T. I was involved in determining and interpreting the ionised gas kinematics in the MUSE data.

- Rojas et al. 2020, BAT AGN Spectroscopic Survey - XIX. Type 1 versus type 2 AGN dichotomy from the point of view of ionized outflows, MNRAS, 491, 5867R. I co-supervised the spectral decomposition of the optical spectra and I was involved in the determination of the outflow energetics.

- Feruglio, Bischetti et al. 2020, Multiphase Gas Flows in the Nearby Seyfert Galaxy ESO428-G014. Paper I, ApJ, 890, 29F. I was involved in the calibration, analysis and interpretation of the ALMA data for continuum and CO emission. I provided the gas dynamical models.

- Vietri, Piconcelli, Bischetti et al. (2018), The WISSH Quasars Project IV. BLR versus kpc-scale winds, A&A, 617, A81. I analysed the near-IR and provided the routines used to model the UV-optical quasar spectra.

- Saturni, Bischetti et al. (2018). The rest-frame UV-to-optical spectroscopy of APM08279+5255 - BAL classification and black hole mass estimates, A&A 617, A118. I was responsible for the analysis and interpretation of the quasar continuum and emission lines in the UV, optical and near-infrared spectrum.

- Feruglio et al. (2018), The dense molecular gas in the z~6 QSO SDSS J231038.88+185519.7 resolved by ALMA, MNRAS, 410, pp.1703-1724. I was involved in the data calibration, imaging, and in the determination of the gas kinematics.

- Circosta et al. (2018). SUPER I. Toward an unbiased study of ionized outflows in z~2 active galactic nuclei: survey overview and sample characterisation, A&A, 620, A82. I provided feedback on the SED, with focus on the IR and millimetre bands.

- Feruglio, Ferrara, Bischetti et al. (2017), On the discovery of the fast molecular gas in the UFO/BAL quasar APM08279+5255 at z=3.912, A&A 608, A30. I was responsible for the calibration and imaging of the NOEMA data. I was involved in the identification of emission lines in the mm spectrum.

- Fiore et al. (2017), AGN wind scaling relations and the co-evolution of black holes and galaxies, A&A 601, A143. I provided the ionised outflow velocity and energetics for the hyper-luminous quasars.

- Duras et al. (2017). The WISSH quasars project. II. Giant star nurseries in hyper-luminous quasars, A&A 604, A67. I provided feedback on the SED modelling, focusing on radiative transfer models to constrain the AGN contribution to sub-millimetre photometry.
- Martocchia et al. (2017). X-ray properties of hyper-luminous quasars, A&A, 608, A51. I provided redshift and black hole masses for quasars with near-IR spectroscopy.

PI-ship and COI-ship of observational proposals on a competitive basis

- **PI-ship of 6 successful proposals, optical-to-millimetre spectroscopy** and imaging **(total ~88 hours)**
  - Atacama Large Millimetre Array (**ALMA**), *Building the spatially resolved CO SLED of the most luminous QSO in the local Universe*, ID 2019.1.00590.S, **6 hours**
  - Karl G. Jansky Very Large Array (**JVLA**), *Molecular gas content and star-formation efficiency in hyper-luminous QSOs*, ID 18A-028, **21.5 hours**
  - Northern Extended Millimetre Array (**NOEMA**), *Building the CO SLED of the most luminous QSOs at Cosmic noon*, ID W21DG, **10 hours**
  - Large Binocular Telescope (**LBT**), *An atlas of stellar mass distributions and morphologies in an unbiased sample of local AGN hosts*, ID IT-2021B-031, **31.5 hours**
  - Telescopio Nazionale Galileo (**TNG**), *An atlas of optical stellar mass distributions and morphologies in an unbiased sample of local AGN hosts*, ID A44TAC_36, **12.5 hours**
  - ESO Rapid Eye Mount telescope (**REM**), *Near-IR SED of the hyper-luminous z=3.5 quasar J1555+1003*, DDT proposal, **7 hours**
- **COI-ship of 35 successful proposals (total ~450 hours)**
  ALMA, NOEMA, JVLA, Atacama Compact Array (ACA), Atacama Pathfinder EXperiment (APEX), IRAM 30-metre telescope, Multi Unit Spectroscopic Explorer (MUSE) at the Very Large Telescope (VLT), LBT Utility Camera in the Infrared (LUCI) and LUCI + Advanced Rayleigh guided Ground-layer adaptive Optics System (ARGOS), Device Optimised for the LOw RESolution (DOLORES) and Near Infrared Camera Spectrometer (NICS) at TNG, Low Frequency Array (LOFAR), Chandra, X-ray Multi-Mirror Mission (XMM-Newton).

Commissions of trust and Organisation of events

- Co-chair of the SOC of Symposium *Properties and impact of large-scale multiphase AGN outflows* at the EAS Annual Meeting, 27th June - 1st July 2022 Valencia, https://eas.unige.ch/EAS2022/session.jsp?id=S6
- Member of the International Astronomical Union (IAU), Division C Education, Outreach and Heritage; Division H Interstellar Matter and Local Universe; Division J Galaxies and Cosmology; Executive Committee Working Group of Junior Members
- Referee for the peer-reviewed astronomical journals Astronomy & Astrophysics (A&A), Monthly Notice of the Royal Astronomical Society (MNRAS), Publications of the Astronomical Society of Australia (PASA)
- Expert reviewer in the TNG/REM proposal evaluation during AOT 42-AOT 46 cycles. I take part in the distributed peer review process for the proposal evaluation at ALMA and ESO telescopes
- Member of the LOC for Symposium The X-ray Universe 2017, 6-9 June 2017, Rome, https://www.cosmos.esa.int/web/xmm-newton/2017-symposium
- Responsible for the organisation of the *Cycle of Seminars of Postdocs and PhDs at INAF OATs* since April 2021 (http://www.oats.inaf.it/index.php/it/past_seminars.html)

Outreach

- *HACK100* - *La città di Trieste celebra Margherita Hack,* guide of tours of the "Specola" and astronomical observations, Trieste, June 2022

- *Ricercatori in Gioco by INAF, SISSA, ICTP, and INFN* at [SHARPER](#) Notte dei Ricercatori, Trieste 24 Sep 2021, responsible of activities with kids aged 6-11
- *Virtual Tour of The Universe* by INAF OATs at [*Trieste Next*](#), Trieste, 24-26 Sep 2021, outreach responsible during public event activities
- Showing [*Le Donne nella città della Conoscenza*](#), Trieste, Mar - May 2022, virtual presentation
- *Women in Science - La scienza è per tutte*, European Science Night 2019, INAF OAR, virtual lecture
- [Notte Europea dei Ricercatori](#) at INAF OAR, Monte Porzio Catone, 28 Sep 2018, guide of tours of the Observatory

Teaching

- I have won a position as a fixed term researcher (TD-A) at UniTs, Dipartimento di Fisica (prot. N. 76681 of 16/06/2022). Responsible for designing, teaching and evaluating students for the master degree course "Sub-millimetre and radio astronomy, principles and observations" (40 hours of frontal lectures)
- I am responsible for the training of PhD students from UniTs and Scuola Internazionale Superiore di Studi Avanzati (SISSA) R. Tripodi (Tripodi, Feruglio, Fiore, Bischetti et al. 2022) and M.V. Zanchettin (Zanchettin, Feruglio, Bischetti et al. 2021,A&A,655,A25), concerning the techniques of (sub-)millimetre interferometry, analysis of interferometric data and techniques of dynamical modelling.
- In 2019 at INAF OAR, I was responsible for the training of PhD student A. Travascio (Università di Roma La Sapienza, XXXII Cycle, supervisors F. Fiore, E. Piconcelli), concerning the ionised gas kinematics from UV, optical and near-IR spectra of high-z quasars and galaxies (Travascio et al. 2020,A&A,635A,157T, Travascio et al. 2020,MNRAS,498,2719T)

Press and Media coverage

- "Il Piccolo", "Rubrica Scienza Oltre il Giardino" column, *Manuela (INAF) studia i venti prodotti dai buchi neri*, 20/02/2022, interview by journalist M. B. Tolusso
- "Il Piccolo", "Rubrica Scienza Oltre il Giardino" column, *L'astrofisica Manuela si occupa all'INAF dei buchi neri attivi delle galassie*, 24/05/2021, interview by journalist M. B. Tolusso
- "Radio Rai FVG", "[RADAR](#)" broadcast, 24/05/2022, interview by journalist S. Regina about the discovery of BH-driven outflows in the 1 Gyr old Universe
- "Beckwith" radio , "[TALOS](#)" broadcast , 29/10/2020, interview by journalist A. Lerda about the early growth phases of massive galaxies and black-holes
- Web articles:
  - "Inverse" journal, "[Distant quasars reveal a surprising process that capped the first black holes' growth](#)", interview by journalist J. Nagle, 11/05/2022
  - "Vice" journal, "[Ancient Black Holes Have Revealed a Mystery at the Edge of Time and Space](#)", interview by B. Ferreira, 11/05/2022
- Press releases on Media INAF:
  - [Non ci sono più i vènti da buchi neri di una volta](#) (11/05/2022)
  - [Mezzogiorno di quasar](#) (23/10/2022)
  - [Venti di quasar nell'universo primordiale](#) (17/10/2019)
  - [Baby boom stellare nei quasar ultra luminosi](#) (08/08/2017)
- Press release on Scuola Normale Superiore newscast: [Venti cosmici primordiali più potenti di quelli delle galassie a noi vicine](#) (11/05/2022)
- Press release on KICC Cambridge University newscast: [Greedy black holes in the early Universe generate galactic storms](#) (27/09/2019)
- Other articles:
  - [Giant molecular outflow detected from the quasar PDS 456](#)

Descriptive report of research activity

My research activity, since my PhD, has mainly focused on the evolution of galaxies and of the supermassive black-holes hosted at their centres. I have aimed to investigate the nuclear, host-galaxy and environment properties via complementary observations, to assess the role played by black-hole feedback in the framework of black-hole and galaxy common evolution. Accordingly, I have specialised in millimetre and radio interferometers, which have the unique capability that they can be adapted to sample the whole range of spatial scales over which black-hole feedback is known to occur, from the inner regions of galaxies to the circum-galactic scales, and they can sample the cold neutral and molecular phase of the interstellar medium at all redshifts, from the nearby Universe back to the epoch of the first quasars (z~6-7). I have also specialised in near-IR and optical spectroscopy, which can either probe nuclear properties of AGN and quasars, and reveal the presence of black-hole driven outflows in the ionised gas phase from absorption/emission lines.

Expertise in (sub-)millimetre and radio astronomy

- Specialist knowledge of state of the art (sub-)millimetre and millimetre telescopes, including both interferometric (ALMA, NOEMA, JVLA) data, and single-dish data (IRAM 30-metre) of both the radio continuum and spectral lines.
  - Expert of millimetre interferometry and aperture synthesis techniques, (self-)calibration, UV plane and image plane analysis, UV plane analysis in the cm-wave domain, multi- frequency source modelling. I am a specialist of high-resolution observations of local galaxies and deep fields of high-redshift quasars and galaxies, including low and very high signal-to-noise observations.
  - I have been awarded observing time with ALMA (project 2019.1.00590.S), NOEMA (project W21DG), and JVLA (project 18A-028).
  - I have personally carried out mm observations at the IRAM 30-metre telescope in 2017 and in 2018 (Pico Veleta, Spain) for a total of 70 hours.
  - I am an expert of dynamical modelling techniques for spectral line observations of local and high-redshift sources, using specific galaxies such as 3D-BAROLO and Kinemetry.
- Deep expertise in the analysis of data from Square Kilometre Array (SKA) precursors such as LOFAR.
  - I am specialist of preprocessing techniques of wide-field, radio images, such as the Preprocessing for Facet Calibration for LOFAR (preFactor), direction-dependent calibration and imaging techniques, including the Facet Calibration for LOFAR (Factor) tool and the Direction-Dependent spectral deconvolution framework based on image plane Faceting (DDFacet), either applied to low-frequency (200 MHz) and to very low frequency (50 MHz) observational data.
  - I am co-P.I. and responsible for the data analysis and scientific exploitation of two LOFAR projects in the framework of LOFAR Key Science Projects and LOFAR Two-metre Sky Survey (LoTSS) (P.I. C. Feruglio, E. Piconcelli).

Expertise in multi-wavelength study of galaxy evolution

- Expert in the analysis of multi-wavelength spectroscopic and imaging data of local AGN and of high-redshift quasars and galaxies, especially in the near-infrared and optical bands. This includes long-slit spectra and datacubes from Integral Field Unit spectrographs, data acquired in

seeing-limited or in Adaptive Optics AO-assisted mode, such as VLT/X-shooter, LBT/LUCI, LBT/ARGOS, VLT/MUSE, VLT/SINFONI, TNG/DOLORES, TNG/NICS).

- Expert in the reduction techniques of spectroscopic and imaging data in the optical and near-infrared, using different specific softwares and packages such as the ESO Recipe Execution Tool (EsoRex), Astrocook, CubEx, and dedicated IDL, IRAF and MIDAS routines.

- Specialist in the analysis of spectroscopic and imaging, optical and near-infrared data and I have developed a set of coding skills necessary to perform this task. I have developed custom procedures to fit multi-wavelength quasar and galaxy spectra taking into account the continuum, line emission and absorption features. I have created automatic procedures to detect faint sources in all kinds of datacubes.

- Specialist in the analysis of gas kinematics and dynamical modelling in optical and near-infrared datacubes, using specific softwares such 3D-BAROLO and Kinemetry, and custom procedures to perform a pixel by pixel spectral decomposition of different kinematic components.

- I am first-author and second/third author of several publications exploiting multi-wavelength data, identifying feedback from AGN and quasars and quantifying its impact on the host-galaxy evolution: Bischetti et al. 2022, Nature, 605,244; Bischetti et al. 2017, A&A, 598, A122; Saturni, Bischetti et al. 2018, A&A, 617, A118; Vietri, Piconcelli, Bischetti et al. 2018, A&A, 617, A81; Feruglio, Bischetti et al. 2020; Zanchettin, Feruglio, Bischetti et al. 2021 (details in Bibliography)

Leadership and participation to international collaborations

I am either leader or collaborator in the international projects and collaborations outlined below, in which I coordinate teams of colleagues, define work schedules, organise regular meetings to identify work strategies, best practises, and to validate achievements. During the past years, I designed new and innovative research projects aimed at enhancing the scientific impact and at maximising the data exploitation within these collaborations.

- **XQR-30**, "The Ultimate X-shooter legacy survey of Quasars at the Reionization epoch", based on a 248 hours ESO VLT/X-shooter Large Program (P.I. V. D'Odorico, INAF OATs).

  ○ I lead project *Characterisation of black-hole driven outflows at Cosmic dawn* within Working Package 3 *Quasars and their environment*. I am the first author in Bischetti et al. 2022, Nature, 605, 244.

  ○ I lead project *Properties of UV-optical emission line outflows in the first quasars* within WP3 *Quasars and their environment.* I am the first author of the publication Bischetti et al. in prep., and second author in Mazzucchelli, Bischetti et al. in prep.

  ○ I contribute to the data calibration and analysis of ALMA follow-up programs (2021.1.01018.S P.I. S. Bosman, 2019.1.00111.S, P.I. B. Venemans).

- **PRIN MIUR 2017 BLACKOUT**, "Black hole Outflows and the Baryon Life Cycle of Galaxies" (P.I. F. Fiore, INAF OATs).

  ○ I lead WP1 BH f*eedback at the epoch of the formation of the largest BHs*, Task 1.1. I lead the data reduction and analysis of optical, near-IR and (sub-)millimetre data of quasars in the WISE-SDSS Selected Hyperluminous (WISSH) sample. I am the first author of Bischetti et al. 2018,A&A,617,A82 and Bischetti et al. 2021,A&A,645,A33.

  ○ I lead WP3 *Local laboratories for ISM and BH wind/jet physics*, Task 2.2. I am leading the reduction, calibration and analysis of high-resolution ALMA data of gas and dust in statistical samples of local AGN and in the host-galaxies of nearby luminous quasars. I am P.I. of ALMA project 2019.1.00590.S. I am first author of publication Bischetti et al. 2019a, A&A,628,A118,

second author in Feruglio et al. 2020,ApJ,890,29F and third author in Zanchettin et al. 2021,A&A,655,A25.

- ○ WP3, Task 3.5. I contribute to the reduction, calibration and analysis of NOEMA millimetre observations for a statistical sample of X-ray selected nearby quasars from the XMM-Newton Large Program SUBWAYS (P.I. M. Brusa, INAF OAS Bologna).

- **XMM Multy-year Heritage Program HYPERION**, (P.I. L. Zappacosta, INAF OAR).
  I am responsible for the follow-up observations of HYPERION quasars in the (sub-)millimetre with ALMA (project 2021.2.00151.S), NOEMA (project W21ED) and at radio wavelengths with JVLA.

- **SUPER**, based on an ESO Large Program with VLT/SINFONI (P.I. V. Mainieri, ESO Garching). I have been extensively involved in the calibration and analysis of ALMA data (projects 2017.1.00893.S, 2016.1.00798.S). I am co-author of three publications: Cicone et al. 2021,A&A,645L,8C, Circosta et al. 2021,A&A,646,A96, and Lamperti et al. 2021,A&A,645,A90.

- **ERC Advanced Grant 695671 QUENCH** (P.I. R. Maiolino, KICC). I am involved in the WP *Galactic Outflows - Ejective mode* and responsible for the reduction, calibration and analysis of ALMA data of quasar host-galaxies in the z~6 Universe. I am the first author of Bischetti et al. 2019b,A&A,630,A59.

- **ERDF Project QSOFEED** (P.I. C. Ramos Almeida, IAC). I am leader of the analysis and interpretation of high-resolution, multi-configuration ALMA data of nearby quasars (project 2018.1.00870.S) and I am second author of publication Ramos Almeida, Bischetti et al. 2022, A&A, 658, A155.

- **PRIN-RIC INAF 2019 n.115** (P.I. F. Nicastro, INAF OAR), Objective B *Gaining insights on the building of massive Circum-Galactic Medium at high redshifts*, Task B1. I am leading the characterisation of the cold molecular and neutral gas phases in the CGM of high-redshift quasars and galaxies, by using ALMA data.

- Vera C. Rubin Observatory **LSST Corporation, AGN Science Collaboration (SC), In-kind Contribution ITA-INA-2** (lead A. Bongiorno, INAF OAR). I have been awarded LSST data rights and I am responsible for creating mock AGN catalogues for the optimisation of the LSST survey and for the LSST synergy with ESA Euclid mission.

Expertise in software and coding

- Specialist of software for the reduction, calibration and analysis of (sub-)millimetre data: Common Astronomy Software Applications package (CASA), Grenoble Image and Line Data Analysis System (GILDAS), Continuum and Line Analysis Single-dish Software (CLASS).

- Expert user of pipelines and software analysis tools for data from SKA precursors such as FACTOR, preFACTOR, DDfacet.

- Expert user of softwares for the reduction and analysis of astronomical imaging data and spectroscopic data from single-slit or IFU spectrographs: ESO/MUSE, ESO/SINFONI, ESO/X-Shooter reduction pipelines, Astrocook, CubEx, QFitsView, SAOImageDS9, HEASARC FV, SExtractor, IRAF, MIDAS, 3DBAROLO, Kinemetry.

- Experienced programmer in Python 2.7-3.9, including scientific, statics and astronomy packages (e.g. Numpy, Scipy, Matplotlib, Ipython, Pandas, Statsmodels, Astropy, Pyfits, CosmoPy) and Numba compiler. Experienced programmer in IDL, good handling of Fortran 90, C++, Mathematica.

- I have developed suites of custom procedures to optimise the analysis of astronomical data: this includes procedures for fitting single-slit spectra of individual sources and large source catalogues; procedures for the pixel-by-pixel spectral decomposition of multi-wavelength

datacubes; procedures for the blind scan of datacubes for source detection; procedures for stacking spectra, datacubes, and UV-plane data.

- I am an expert user of macOS, Linux and Windows operating systems. I am experienced in remotisation tools and protocols (e.g. ssh, sshfs, vnc, X2go), to be used directly from command line or through a Graphic User Interface. I am familiar with using cluster systems to exploit computational resources on complex data analysis pipelines and large datasets

Attendance to schools and training events

I have attended high-level schools to specialise in single-dish and interferometric, (sub-)millimetre and radio data, and to exploit the newest telescopes such as the James Webb Space Telescope (JWST):

- ALMA Data Handling Workshop (Italian ARC, Bologna), Feb 2016
- 9th IRAM millimetre interferometry school (IRAM, Grenoble), Oct 2016
- 5th LOFAR school (Netherlands Institute for Radio Astronomy, ASTRON, Dwingeloo), Sep 2018
- LOFAR DATA Working Group: Data Reduction Hands On (INAF OATs, Trieste, chair: Annalisa Bonafede), Jan 2019
- The first italian LOFAR school 2019 (INAF-Istituto di Radio Astronomia IRA, Bologna), Jun 2019
- ALMA I-TRAIN with the European ARC Network (11 remote training sessions), Dec 2020 - Feb 2022
- JWST Workshop (European Space Astronomy Centre ESAC, Madrid), Oct 2017
- I have attended several dedicated training session in IRAM and Institut de Planétologie et d'Astrophysique (IPAG) Grenoble headquarters on the subject of aperture synthesis and millimetre interferometry, led by Dr. Roberto Neri (IRAM) and Prof. Cecilia Ceccarelli (IPAG)