

## Section A: Overview of the Research Project

**TITLE:** Investigating Background Radio Sources in MeerLIRGs

**AREA OF RESEARCH:** Science

**ACADEMIC LEVEL:** Master

**ABSTRACT:** The MeerLIRGs project is a 1.28 GHz MeerKAT continuum survey of all the 298 Southern Luminous Infrared Galaxies - LIRGs ( $S(60\mu\text{m}) > 4.24 \text{ Jy}$ ) from the Revised Bright Galaxy Sample (RBGS; Sanders et al. 2003, Condon et al. 2021, Moloko et al. 2025 – MNRAS submitted) and of 43 galaxies part of the IRAS 12- $\mu\text{m}$  Galaxy Sample - 12MGS, Rush et al. 1993. This survey (observed as part of the MeerKAT OT projects PID: SCI-20210212-TJ-01, PI: Jarrett and PID: SCI-20220822-LM-01, PI: Marchetti) covers  $\sim 340$  square degrees across the entire Southern Sky with high sensitivity (rms noise  $\sigma \approx 20 \mu\text{Jy/beam}$ ) and 7.5" resolution. While the primary focus of MeerLIRGs has been on the LIRGs themselves, the wide MeerKAT fields also capture numerous background radio sources. This project aims to leverage the MeerLIRGs dataset to investigate the background radio sources detected in each field. By analyzing their spectral indices, luminosities, and potential AGN activity, we can contribute to broader studies of the cosmic radio source population and their role in galaxy evolution.

**PRIMARY SUPERVISOR:** Dr Lucia Marchetti, [lucia.marchetti@uct.ac.za](mailto:lucia.marchetti@uct.ac.za), University of Cape Town

**CO-SUPERVISOR:** Prof Mattia Vaccari, [mattia.vaccari@uct.ac.za](mailto:mattia.vaccari@uct.ac.za), University of Cape Town

Please note that all supervisors here indicated will be responsible for supervising the student's research.

## Section B: Details of Research Project

### SCIENTIFIC MERIT, METHODOLOGY & EXPECTED OUTCOME:

The key objectives of this research are:

1. Characterizing Background Radio Sources: Identify and classify non-LIRG radio sources in MeerLIRGs fields, measuring their flux densities and morphologies. Depending on the interest of the candidate a machine learning approach (e.g. Astronomy - Lochner et al. 2021) will be considered to identify sources with extended radio emission.
2. Cross-Matching with Multi-Wavelength Catalogs: Identify counterparts using infrared (WISE, Spitzer), optical (SDSS, DECam, DESI), and X-ray (eROSITA, Chandra, XMM-Newton) data.
3. AGN vs. Star Formation Activity: Use radio and multi-wavelength diagnostics (e.g., spectral index, brightness temperature, SED fitting) to distinguish AGN-powered radio sources from star-forming galaxies.
4. Statistical Analysis of Background Source Properties: Investigate trends in the luminosities, redshifts, and environments of the detected sources and compare the results with existing deep-field surveys (e.g., COSMOS, EDFS, FIRST, LOFAR).

Expected outcomes of this project are:

- A catalog of background radio sources detected in MeerLIRGs fields, classified by their radio and multi-wavelength properties.
- Insights into the nature of background radio sources, including the fraction of AGN versus star-forming galaxies.
- A comparative analysis of MeerKAT-detected background sources with previous radio surveys.
- A publishable research paper presenting the data products and the scientific findings.
- Potential in-depth studies of single objects of relevance (e.g. GRGs) identified in the commensal study, also with follow-up observations at different wavelengths.

- An effective pipeline to extract radio sources detected in MeerKAT images and characterize them via a multi-wavelength analysis, which will be helpful e.g. to make the most of the MeerKAT Data Archive in the era of LSST and 4HS.

#### **BROAD TIMELINE**

<b>Task</b>	<b>Duration</b>
Literature review	4 months
Data acquisition and reduction	4 months
Radio source extraction/classification	4 months
Multi-wavelength analysis/classification	4 months
Statistical analysis	4 months
Writing and thesis completion	4 months

#### **FEASIBILITY:**

The project relies on MeerKAT data that have already been collected. Continuum images have been produced, and radio mosaics will be made available to the students at the start of this project in 2026. PyBDSF is a robust tool for radio source extraction, and multi-wavelength data are publicly available in VO-compliant data archives, and the supervisors are experts in the production and analysis of multi-wavelength catalogues of radio sources. The student will be based at UCT and will thus have access to the direct technical and scientific support provided by the supervisors as well as UCT/IDIA researchers. The student will have access to the IDIA/ilifu cloud computing facility where we expect that most of the analysis will be carried out.

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## Education & Professional Qualifications

### Academic Qualifications

- 2006 **BSc in Astronomy**, University of Padova, Italy.
- 2008 **MSc in Astronomy**, University of Padova, Italy, 110/110 Cum Laude.
- 2012 **PhD in Astronomy**, University of Padova, Italy.

### Professional Qualifications

- 2016 **Postgraduate Course in Science Communication - Science Communication: an introduction to theory, best practice and practical skills**, Centre for Research on Evaluation, Science and Technology (CREST), University of Stellenbosch, South Africa, NQF level 8, Credits 15.
- 2022-2027 **NRF Rated Researcher**.

## Research & Academic Experience

- Extensive knowledge of multi-wavelength astronomy observing principles and of the scientific applications and exploitations of multi-wavelength observations.
- Extensive knowledge of studies of the statistical probes for Observational Cosmology Studies such as luminosity/mass functions, star formation rate estimators and strong lensing search and multi-wavelength characterisation.
- Extensive experience as PI or co-PI of observing proposals with a number of international observing facilities
- Extensive experience in image processing and source extraction techniques.
- Extensive experience with 2D and 3D visualisation software (VR and digital planetaria) for astronomical and multi-disciplinary research.
- Extensive experience in creating and managing large astronomical databases, including the production and public release of multi-wavelength source catalogues and related documentation
- Extensive experience interfacing with Community Support Groups, Mission Planning and Data Processing Teams.
- Experience designing and working with both ESA-led space missions (Herschel, Euclid) and international space missions (Hubble, Spitzer, Akari).
- Extensive experience supervising PhD students, Masters, Honours and Bachelor students (6 Honours, 1 Bachelors, 4 MSc, 3 PhD students (co)supervised in the period 2017-2023).
- Extensive experience in undergraduate teaching, tutoring and mentoring.
- Extensive experience in giving contributed and invited talks at scientific conferences/meetings and technical workshops.
- Extensive experience liaising with academic and University management boards at the highest levels.

## Project Management & Engagement Experience

- Extensive project management experience within both academic research projects, international scientific collaboration and University/public facilities (e.g. laboratory and Planetaria)
- Extensive experience in managing big collaborations and working as part of a team either as a team member or as (an elected) board/exec member, working group chair of international consortia/professional bodies
- Broad experience in writing funding requests to National and European funding agencies (e.g., the *European Commission*, the *Science and Technology Facilities Council* - STFC in the UK, the DSI/NRF in SA and the Italian Ministry of Foreign Affairs and International Cooperation ).
- Project management experience within both academic projects and National (SA, UK, IT) or International science communication & education projects.
- Experience in administrative and financial management of national/international projects.
- Experience in creating and maintaining a website as well as in creating contents for media releases.
- Experience liaising with policymakers and stakeholders at the National (SA and UK) and International level.
- Knowledge of impact evaluation strategies for both National (SA, UK and Italy) and International projects.
- Extensive experience in planning, organising and hosting international workshops and conferences.

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## Employment History

### Academic & Research appointments

- Nov 2012 – **STFC Post-Doctoral Research Associate in Astronomy**, the Open University, Milton Keynes, UK.
- March 2017 • Develop statistical studies of galaxy formation and evolution processes combining multi-wavelength observations  
• Leadership within the Herschel/ATLAS and Herschel/HerMES Consortia in the identification, follow-up observations and physical classification of strong gravitational lensing candidates exploiting all the Herschel Extragalactic Surveys ( $\sim 1000 \text{ deg}^2$ ) and multi-wavelength observing programs.
- April 2017 – **SARChI Post-Doctoral Research Fellow in Astronomy**, the University of Cape Town & the University of the Western Cape (joint position), Cape Town, SA.  
Feb 2020 • Galaxy formation and evolution research from a multi-wavelength perspective • Teaching Assistant and Course Coordinator for the course *Introduction to Galaxies and Cosmology* (PHY327) • PI of the multi-cycle (cycle-25, cycle-26) HST snapshot proposal: "SNAPshot observations of the largest sample of lensed candidates in the Equatorial and Southern Sky identified with Herschel". • PI of 2 observing programs with the South African Large Telescope (SALT) • Student supervision
- March 2020 – **Senior Lecturer in Astronomy**, University of Cape Town, SA.  
present • Lecturer of the second year undergraduate course *Astrophysics* (AST2002H) <http://www.ast.uct.ac.za/ast/undergraduate/ast2002h> • Galaxy formation and evolution research from a multi-wavelength perspective • SA co-I in the EU funded project *SKilled, Innovative & Entrepreneurial Scientists*, SKIES (Call: EC-H2020-SwafS-2020-1; Grant Agreement: 101006212), devoted to create and deliver training for astronomy PhD students and early career researchers on innovation and entrepreneurship • Co-PI of the NRF ISARP 2023-2025 Italy-SA Bilateral program RADIOMAP+ aimed at foster the collaboration of the two countries in the SKA era • 4MOST Hemisphere Survey of the Nearby Universe (4HS) Survey exec member as Data Management Unit/Catalogue/Database Manager. • Students supervision at different academic levels. • Board member of the UCT Science Faculty Research Committee, a committee that oversee the faculty's research strategy, postgraduate and funding matters. • Exec member of the International Astronomical Union (IAU) Division J *Galaxies & Cosmology*, the international representative body for professional astronomers. • I am one of the 10 selected SA PI for the LSST international project.
- September 2023 – **IDIA Visualisation Lab Director**, University of Cape Town, Cape Town, SA.  
present • Managing the development of the VR software iDaVIE • Manage the operations and maintenance of the lab • Menage a team of software developers • Develop the new strategy of the lab integrating multi-disciplinary aspects and collaborations • Manage the international collaborations of the lab • Supervise students working on data visualisation projects
- Vocational - Science Communication, Public engagement and Project Manager Roles**
- Jan 2014 – **Chair of the Education & Outreach UK National working group for the *International Year of Light* 2015 (IYL2015) UNESCO initiative.**  
March 2016
- Jan 2014 – **Project manager of the Open University participation as gold international sponsor in the *International Year of Light* 2015 (IYL2015) UNESCO initiative.**  
Oct 2016
- Jan 2017 – **Project Manager & Scientific Advisor of the "Hemelliggaam, or the Attempt to be here now" art project.**, <https://www.hemelliggaam.com>.  
2020
- Jan 2019 – **Coordinator of the Soapbox Science Cape Town initiative**, <http://soapboxscience.org>, An outreach project to promote women in science.  
present
- Jan 2019 – **Past president/advisor of the African Planetarium Association**, <https://africanplanetarium.org/>.  
present

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### Student supervision

Since 2016 I have supervised **10 honours NASSP (National Astrophysics and Space Science Programme)** students all affiliated at the University of Cape Town, and co-supervised **3 honours students in computer science at UCT** in collaboration with Prof. James Gain. All students successfully completed their honours and continued with their Masters at the University of Cape Town and at the University of the Western Cape.

Since 2020 to date, when my position changed to academic, I supervised **1 international Bachelor, 2 international MSc, 1 national MSc, 1 international PhD and 1 national PhD students** that successfully completed their degrees. In 2025 I am currently supervising **4 national MSc and 1 national PhD** students.

More in details, in 2020 I have co-supervised a **Masters student (Mr Edoardo Borsato)** and a **Bachelor student (Miss Cecilia Giorgi)** at the **University of Padova** in collaboration with Prof. Enrico Maria Corsini (University of Padua, IT) and Dr Mattia Negrello (University of Cardiff, UK). Mr Borsato successfully obtained his Masters with distinction in October 2020 and Miss Giorgi successfully completed her Bachelor degree in Astronomy both at the University of Padua. Mr Borsato has then continued with a **PhD under my co-supervision** that he successfully completed in 2023.

In 2020 I have also supervised **Miss Valentine Nyirahafashimana**, a **Master's student at the University of Rwanda**, East African Institute for Fundamental Research (ICTP- EAFIR). She obtained her degree in February 2021. In 2020 I have also started to serve as co-supervisor for **Mr Alex Sivitilli**, a **PhD student at the University of Cape Town** who successfully graduated in 2023.

In 2021 I have started to supervise **Miss Malebo Ella Moloko**, a **PhD student at the University of Cape Town**, together with Prof. T. H. Jarrett. She is due to complete her PhD in 2025. Between 2021 and 2023 I have supervised (together with Prof. Julien Larena and Dr Pierre Fleury), **MSc students Mr Daniel Johnson**, who has graduated with Distinction in 2023.

Between 2023 and 2024 I have co-supervised **Mr Boaz Keren Gil** in his **MSc in Computer Science at the University of Cape Town**. He has successfully obtained his Master in 2024 and he is now collaborating with the IDIA vislab as external consultant. In 2024 I have started to **supervise Miss Ansofi Pretorius (Astronomy NASSP MSc with coursework and minor dissertation)** and to **co-supervise Miss Kyra Kummer (Astronomy MSc via dissertation only)** together with Prof. D.J. Pisano at UCT, they are both due to finish in 2025. Starting in 2025 I am supervising **Miss Carys Gilbert** a SARA0 funded MSc student and co-supervising **Mr Maurice Bossekota Gbaya**, an MSc student in Computer Science at UCT.

## Publications, Talks and Grants

### Publications

2010 - present Published **173 publications of which 113 are papers on refereed journals** (the rest are proceedings and other publications/products), 18 of which have received more than 100 citations each. The number of citations generated by refereed papers is 6001, leading to an Hirsch impact factor with an **h index of 42**. A complete list of my publications is attached, but it is also available online through the SAO/NASA Astrophysics Data System (<https://bit.ly/30vTgKa>) or Scopus.

### Talks

2009 - present >30 Astronomical public conferences/discourses/posters and workshop with general public, students, teachers and amateur astronomers. An **average of 2 public talks a year**.

2009 - present >40 scientific talks at international conferences/workshops. An **average of 3 contributed talks a year** at international conferences/workshops.

2012 - present **12 invited contributions at international conferences, workshops or events**.

### Grants

- 2014 - 2015 Open University internal grant to manage the Open University IYL2015 initiatives (10 kGBP).
- 2015 Royal Astronomical Society grant to co-produce an animation for the International Year of Light 2015 (1.5 kGBP).
- 2015 SEPnet grant to co-produce an animation for IYL2015 (1.5 kGBP).
- 2015 SEPnet grant sponsorship to participate to "Soapbox Science 2015 - Bringing science to the public" ([soapboxscience.org](http://soapboxscience.org)).
- 2015 Merit Award from the Faculty of Science and the Open University in recognition of the work done for the International Year of Light 2015 (1.5 kGBP).
- 2016 South African DST-NRF visiting fellowship for young researchers from the UK (220 kZAR).
- 2017-2020 3-years long SA National Research Foundation grant to develop/manage the *Hemelliggaam* project as part of the NRF History of Astronomy Roadmap (1 MZAR), <https://www.hemelliggaam.com>.
- 2019 SA National Research Foundation and Department of Innovation grant to coordinate the Soapbox Science project in Cape Town (60 kZAR), <http://soapboxscience.org>
- 2020-2021 SA National Research Foundation and Department of Innovation grant to coordinate the Soapbox Science project in Cape Town (40 kZAR), <http://soapboxscience.org>
- 2021-2022 EU Horizon Grant - EC-H2020-SwafS-2020-1 - in support of the 2 years SKIES project (20 kEUR were given to UCT, of the 300 kEUR granted to the entire consortium made of 7 partner Institutions)
- 2021 UCT Enabling Grant Seeker Excellence Awards to support the SKIES project (20 kZAR)
- 2022 UCT Seed Research Grant in support of Rated Researcher (20 kZAR)
- 2022 NRF grant in support of Rated Researcher (50 kZAR)
- 2023-2025 NRF Incentive Research Grant in support of rated researchers (720kZAR over three years)
- 2023-2025 NRF ISARP 2023-2025 Italy-SA Bilateral program RADIOMAP+ (co-PI; 1.5 MZAR over 3 years)
- 2024 Africa grant to cover for my fee registration to attend the IAU GA2024 hosted in Cape Town, SA, 6-15 August 2024.
- 2024 Gerald Merton Fund to cover my membership in the Royal Astronomical Society in 2024 (155 GBP (~ 3.5 kZAR)).