MSc/PhD Project 2023

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Multi-wavelength study of SFGs and AGNs detected in the Radio

Problem statement. IR/submm bright galaxies dominate the star formation rate density of the Universe at redshift z=1-3. Both star formation and AGN activity are contributing to the high infrared/submm luminosities of these objects, but the underlying physics of such emission is still under debate. In this project, we aim to contribute to the understanding of the nature of IR/submm galaxies by exploiting Radio and multi-wavelength datasets.

Aims & Objectives. Herschel enabled the observations of the "obscured" side of galaxy evolution, finding that the peak of the SF rate density, SFRD, is dominated by objects defined as SF-AGN (Gruppioni et al. 2013, 2015), showing both SF and AGN activity in their broad-band spectral energy distribution (SEDs, from UV to far-IR). Interestingly, these Herschel high-z objects, which are more difficult to observe, appear to show the same SEDs of local IR galaxies such as the IRAS Revised bright galaxy sample - RBGS, Sanders et al. 2003 or the IRAS 12-μm Galaxy Sample - 12MGS, Rush et al. 1993. These IR local galaxies can thus be exploited as a gateway to understanding the physics at play not only in the low-z regime but also in their high-z analogues. With this in mind, we have started coordinated observing campaigns with MeerKAT and SALT to study these sources in great detail. In particular, we have already obtained MeerKAT snapshot observations (MeerLIRGs, PI: Jarrett) of ALL the 298 RBGS ($S(60\mu m) > 4.24$ Jy) distributed across the Southern sky (Condon et al. 2021). A wealth of multiwavelength data are already available for these sources including new spectroscopic data from SALT (Optical). This combined with the Radio data and spectral models makes it possible to strongly constrain the AGN and the SF activities in these galaxies. In particular we want to exploit the spectroscopic data to disentangle between SFGs and AGNs using the well-known BPT diagram and line profile fitting of typical AGN emission lines such as Hβ(4961 $\AA$) , [O III](4959, 5007 $\AA$), [O I](6300 $\AA$), Hα(6563 $\AA$) , [N II](6583 $\AA$), [S II](6716, 6731 $\AA$).

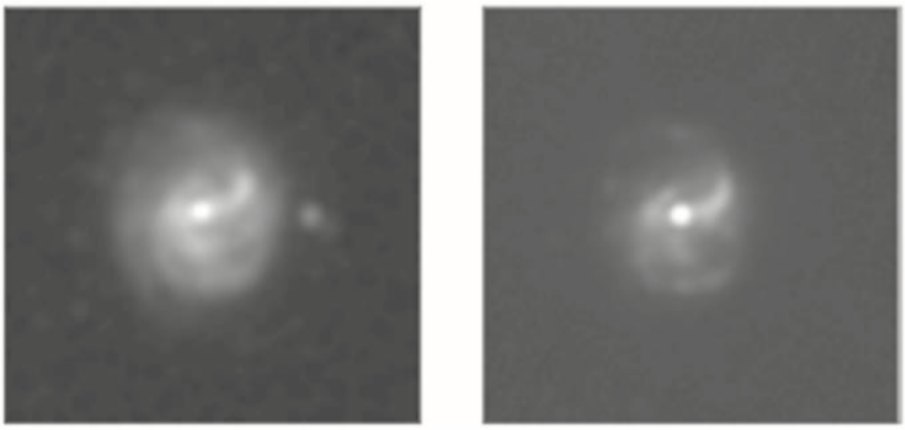

Figure 1: Comparison of NGC6156 from MeerKAT (left) and from Herschel (right) from Condon et al. 2021.

The envisaged work in this context could involve (and not be limited to) any of the followings and it can be tuned at MSc and PhD level:

1. MeerKAT continuum data reduction using the IDIA pipeline on ilifu;
2. SALT spectroscopic data reduction;
3. The construction and analysis of the multi-wavelength integrated and "resolved" SED of the observed objects using SED fitting codes such as e.g. LePhare (Arnouts et al. 1999 and Ilbert et al. 2006), CIGALE (Burgarella et al. 2005), AGN-fitter (Calistro Rivera et al. 2016) and SED3FIT (Berta et al. 2013a). All these are already available on ilifu through the HIPPO project.
4. Polarisation analysis of MeerKAT observations.

Although this project focuses primarily on the MeerLIRGs survey, similar analysis can be extended and conducted on the MeerKAT MIGHTEE and ASKAP surveys. This can be taken into consideration according to the interest of the candidates and level (MSc vs PhD) of the project undertaken.

Background requirements:
Some background in python scripting, programming and astronomical observations/data reduction is desireable.

Supervision team:
The student will be supervised by Dr Lucia Marchetti, Prof. D.J. Pisano and Prof. Tom H. Jarrett at the University of Cape Town, but will have an opportunity to engage with colleagues such as J.J. Condon at NRAO, C. Gruppioni and A. Feltre from INAF-Bologna (Italy).

Alignment with National Imperatives
This project aligns with the following national imperatives:

1. NRF Broad Category:
   (a) Environmental, Material, Physical and Technology. Our research aims to exploit observations of the sky at various wavelengths to better understand the physical processes at play in the Universe.
2. National Priorities:
   (a) Job creation: Graduate training in astronomy will contribute to nurturing a new generation of professional Astronomers and data scientists.
   (b) Transformation: the scientific goals of this project aim to promote transformation in science by nurturing a new generation of researchers with the skills that are the basis for South Africa's development in science and technology.
3. National Strategies:
   (a) Grand Challenge – Astronomy: this project addresses SA's parallel needs to promote research excellence and innovation and drive human capital development and transformation identified as part of DSI/NRF's national strategy for multi-wavelength astronomy.
4. Sustainability Development Goal:
   (a) Quality Education: Graduate training in astronomy and STEM subjects will contribute to increasing the offer of quality education for all.

National Infrastructure Platforms
This project will make use of MeerKAT, SALT and the IDIA/Ilifu cloud facility.

References :
James J. Condon, William B. Cotton, Thomas Jarrett, Lucia Marchetti, Allison Matthews, Thomas Mauch, Malebo Moloko (2021): *A MeerKAT 1.28 GHz Atlas of Southern Sources in the IRAS Revised Bright Galaxy Sample*, `https://doi.org/10.48479/dnt7-6q05`