Section A: Overview of the Research Project Proposal

1. Title of Research Project:	A MeerKAT HI and continuum survey of post-merger galaxies
2. Area of Research	Science
3. **Academic level:**	PhD

4. Abstract:

The primary objective of this PhD project is to perform an HI and continuum survey of SDSS-selected, visually-identified post-merger galaxies. This survey is motivated by the recent extraordinary MeerKAT results found in the NGC 6240 system - a prototypical post-merger and binary supermassive black hole system. The project will explore the radio-jet feedback mechanism through simultaneous HI and continuum mapping with MeerKAT of a large sample $z < 0.1$ systems. The size of this targeted MeerKAT survey in clearly disrupted host galaxies makes this a promising sample to find more spectacular systems like NGC 6240, or quantify how rare it may be.

5**. Primary Supervisor:**	Prof Roger P. Deane
6**. Institution:**	University of the Witwatersrand

Section B: Research Project Proposal

1. **Scientific merit:** *describe the objectives of the research project, placing them in the context of the current key questions and understanding of the field.*

The primary objective of this PhD project is to perform an HI and continuum survey of SDSS-selected, visually-identified post-merger galaxies. This survey is motivated by the recent extraordinary MeerKAT results found in the NGC 6240 system - a prototypical post-merger and binary supermassive black hole system. MeerKAT discovered the first HI emission in NGC6240, vital to constraining the gas dynamics and merger history and completing the picture as the already mapped molecular and ionised gas (e.g. Tacconi et al. 1999, Muller-Sanchez 2018). In addition, this MeerKAT observation also contains the entirely serendipitous discovery of what seems to be a ~300 kpc radio halo-like radio continuum component that surrounds the NGC 6240 system and another more distant galaxy neighbour. These results are the subject of two separate MSc theses, each of which will be a forthcoming student-led publication, all to be submitted by the end of 2021 (Magolego et al, Santana et al., in prep.).

This proposed PhD project will explore the radio-jet feedback mechanism through simultaneous HI and continuum mapping with MeerKAT of a large sample $z < 0.1$ systems. The size of this targeted MeerKAT survey in clearly disrupted host galaxies makes this a promising sample to find more spectacular systems like NGC 6240, or quantify how rare it may be. Insights gained from this nearby universe study may provide useful information in identifying comparable systems at higher redshifts as probed by MeerKAT Large Survey Projects coupled with future wide-field OIR spectroscopic surveys. Hydrodynamical simulations predict significant increases in the star formation rate and AGN accretion

rate as galaxies merge, as well as dual/binary` SMBH pair spiral in towards one another and disrupt the neutral and ionized gas angular momentum in the galactic nucleus. However, there are counter examples as well, such as NGC 6240 itself, which has shown comparable levels of positive and negative feedback (Muller-Sanchez et al. 2018).

Understanding the role of mechanical feedback is an important, often overlooked ingredient in confronting observations with semi-analytic and hydrodynamical models of galaxy evolution (e.g. Crain et al. 2015). This PhD project proposes to do exactly that through a previously unexploited window on dual SMBH effects: the neutral hydrogen distribution and dynamics.

Two important aspects are missing from the post-merger picture in a statistically significant sample, and this PhD project aims to provide both: (1) the neutral gas distribution and dynamics; and (2) mapping the radio continuum to determine if mechanical feedback is playing an important role in relation to the HI gas emission and/or absorption, and (3) if there are more examples like the spectacular ~300 kpc radio halo surrounding the prototypical NGC 6240 system, that MeerKAT is so well suited to discovering.

2. Feasibility: *outline the methods that will be used to achieve the objectives. Provide details on the availability of required data / access to required equipment / availability of research facilities and other resources required. Include any relevant expected intermediate milestones and associated timeframes towards attaining the overall objectives of the project.*

Calibration and imaging of MeerKAT datasets is a computationally expensive process, however, Wits University is extremely well equipped to perform this with purpose-installed compute servers running all necessary software. Calibration and imaging of datasets using the exact same correlation mode and field type have been successful, so no exception is expected here. The primary supervisor has a strong record of successful proposals on radio telescopes, and his students and postdocs with MeerKAT. The required data for this project will be secured in the next MeerKAT call, however, in the event of mis-matched timing with data availability, the student will train on a known source of similar properties as well as explore several that are already contained in the MeerKAT archive.

3. **Link the proposed project to one or more of the SARAO research priority areas for 2020** *(refer to Section 4 of the Application Guide), and explain in some detail how the proposed research will contribute to the priority area(s).*

This project of course relates directly to Science topics with MeerKAT, playing a complementary role to a number of MeerKAT Large Survey Projects that aim to decouple the relative importance of AGN activity and star formation in driving galaxy evolution, as well as the environmental impact on HI mass and morphology.

4. If relevant, describe any particular qualifications, academic abilities, skills and/or experience that a student should have in order to successfully deliver on the objectives of the research proposed.

Some experience with interferometric calibration and imaging will be beneficial but not essential.
Some programming experience, particularly with Python will be beneficial.