<u>The Nature of twinkling black holes in the distant Universe</u>

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Description:
Compact radio sources, powered by supermassive black holes, are important but under-explored components of the radio galaxy population. They provide unique clues to radio galaxy life cycle. Understanding their changes across different stages of the Universe provides important insights into how galaxies change with cosmic time. While important, it is very challenging to identify these compact objects (<arcsecond in angular scale). The student working in this project will use a recently developed technique of implementing interplanetary scintillation (IPS) to the wide field of view of the Murchison Widefield Array (MWA) to identify such compact objects in large numbers efficiently. From this sample they will identify potential candidates at large distances (high redshift) and follow them up with optical and infrared telescopes in order to understand their properties and explore their contributions to galaxy evolution.

The technique of widefield IPS uses random fluctuations induced by variations in the solar wind on sub arcsecond scale objects to identify compact sources very efficiently across large parts of the sky. This technique, similar to using twinkling to distinguish compact stars from planets at night, effectively provides the 6-km wide MWA with the capability of a telescope that is a few hundred kilometres wide. This unique capability to identify survey large has been used to select approximately 7000 compact objects from more than 65000 objects over approximately one quarter of the sky. This sample size is expected to double once further data is processed in the near future.

As the PhD candidate, you will combine this dataset to find their counterparts in the catalogue made with the Widefield Infrared Survey Explorer (WISE) space telescope. All detection will inform us about the host properties of these objects, but when they are not detected in WISE they can potentially be from the very early Universe (redshifts >2). Additionally, you have the potential to identify objects at highest redshifts ever detected using this approach. You will measure the distances to these candidate objects to explore their properties during the term of your PhD.

To achieve this, you will combine the well-established techniques of using optical spectroscopy with large telescopes and the recently developed technique of using detecting emission lines at longer wavelengths with the Atacama Large Millimetre/submillimetre Array (ALMA). Further, you can follow up these objects with Very Long Baseline Interferometry (VLBI) techniques to image them. By following up a statistically significant number of objects, you will study how their spectral and morphological properties change with redshift and their environment.

This project will develop in you: *i)* an depth understanding of radio interferometry, *ii)* the process of scientific exploration from conceiving ideas, setting up experiments to test them to obtain results which you can publish, and *iii)* important insights into the properties of galaxies and their changing behaviour across different stages of the evolving Universe.