Hunting the Elusive Black Holes in Star Clusters

Globular star clusters are old, dense clusters of stars, containing up to millions of stars within a volume of space only a few light years across. Because of their old age, these clusters are expected to harbour thousands of black holes formed from the very first stars that were born, evolved, and turned into black holes in the cluster. As the cluster is extremely dense, some of these black holes then might entrap other stars in the cluster and form a binary star system. We would see them as they release energy by pulling matter from the trapped star. However, there have been very few black holes actually found in globular clusters so far, making it a puzzle as to what happens to the black holes formed in clusters. Do they get ejected from the cluster? Or are they hiding in the cluster but just difficult to observe?

Research Field
Accretion physics

Project Suitability
PhD

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We have been conducting a survey of Galactic globular clusters, hunting black holes – among other unusual systems that can be formed in clusters as a result of encounters between stars in these dense environments. With this survey, we have so far been able to discover new black hole candidates in several clusters in the Milky Way. We are now following up on some of these candidates to estimate their properties (e.g., how massive is the black hole? How much matter is the black hole pulling from the trapped star?), and also focusing on finding new black holes. Furthermore, our survey has allowed us to discover and study other unusual types of binary systems in clusters like neutron stars that are pulling matter from a trapped star, some of which are able to launch powerful radio jets. This has provided a unique opportunity for us to study how neutron stars can pull matter from a trapped star in a dense star cluster and produce energetic jets.

The aims of this projects are:

- Search for new candidate black holes or neutron star binary star systems in archival and new data (Radio + X-rays).
- Reduction and analysis of archival and new multi-wavelength data (radio, infrared, optical, X-rays) on candidates in globular clusters to determine their nature.
- Determine the population of black holes/neutron stars in globular clusters based on results.

With this project, we hope to achieve a better understanding of what happens to black holes in star clusters.

Left: Globular cluster 47 Tuc, one of the largest clusters in our Galaxy. We recently discovered a black hole in this cluster that is in a very tight orbit with a white dwarf. **Right**: Artist's impression of a binary stellar system in which a black hole has trapped another star and feeds off the material from the star.