The Evolution of Black Holes Across Cosmic Time

Research Field
Radio Astronomy

Project Suitability
PhD
Masters/Honours

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The formation and evolution of the super-massive black holes which reside in the centres of most galaxies remains one of the principle mysteries of astrophysics. We know that they evolve via two processes: merging (along with their host galaxies) and accretion. Their merging history would have to be consistent with models and observations of galaxy evolution, as well as future gravitational wave results (e.g. from LISA). Their accretion history can be constrained by X-ray and mid-IR surveys (for high accretion rates) and by radio surveys probing the relativistic jets emitted at low accretions rates. Hence it is possible to determine how the distribution of black holes masses evolves from the present day to the early Universe.

This project aims to:

(i) develop models to relate accretion rates and the states of the accretion disk with observables such as X-ray, mid-IR and radio luminosities from surveys. In particular, this work would focus on using multi-frequency radio surveys (e.g. the Murchison Widefield Array and the Australian SKA Pathfinder) to constrain the power of radio jets and therefore the accretion related to the radio emission. This work would also build upon our knowledge of galactic black holes,

(ii) use these models to determine the backward evolution of the black hole mass function consistent with observables,

(iii) examine the processes which could lead to the rapid formation of black holes in the early Universe and the effect they have on their environment,

(iv) make predictions of observables from accreting black holes at high redshift taking into account factors such as inverse Compton scattering of the CMB by relativistic electrons from the radio jets and the increased density of the interstellar, circum-galactic and intergalactic media.

This project will uniquely exploit the broad frequency coverage of many Australian radio telescopes such to constraint the evolution of super-massive black holes across cosmic time.

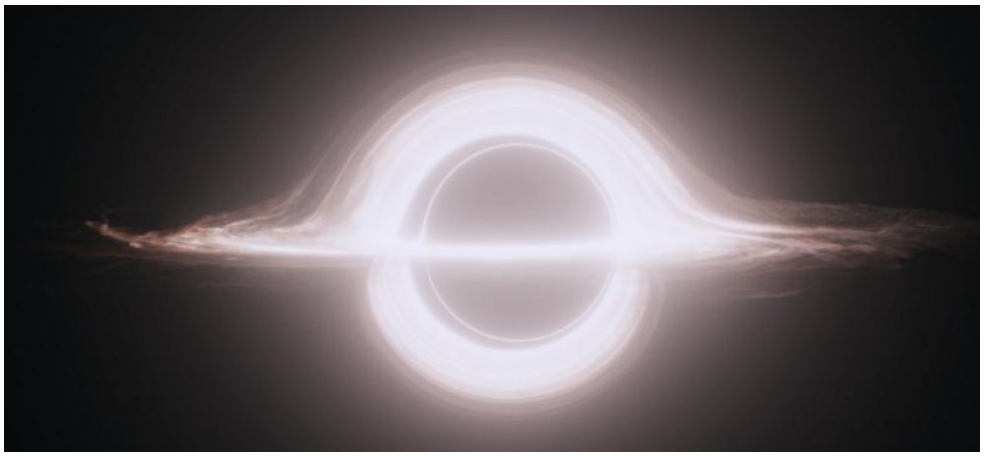

Fig 1: Model of the distortion of an accretion disk by a black hole as used in the film Interstellar (James et al. 2015).