UNIVERSITY of TASMANIA

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"If a galaxy was shrunk down to the size of a major city, the black hole would only be the size of a letterbox. Yet … these black holes shoot out incredibly powerful jets, which in this analogy would be the size of the continent of Australia."

- Dr Stas Shabala

Supercomputer team to explore how black holes are changing our universe

Three current or former University of Tasmania astrophysicists are members of a team which has been awarded more than 20 million hours of supercomputing time to study the influence of supermassive black holes on their host galaxies.

The team, which also includes astrophysicists from WA and the UK, have been granted the time on Australia's largest research supercomputing facility, the National Computational Infrastructure (NCI) in Canberra.

They will use it to combine computer models of black holes - and the jets that shoot out of them - with large-scale cosmological simulations of the Universe.

The three UTAS-linked investigators are Senior Lecturer Stas Shabala and PhD candidate Patrick Yates, and former staff member Associate Professor Martin Krause, now at the Hertfordshire Centre for Astrophysics Research in the UK.

Associate Professor Chris Power, from the University of Western Australia node of the International Centre for Radio Astronomy Research, is leading the research. He was a University of Tasmania Visiting Scholar in 2018.

"Black holes produce very powerful jets and winds," Associate Professor Power said. "We know they can stop stars forming, and create the different kinds of galaxies we see in the Universe today.

"But the problem is that we have a very cartoonish understanding of how this process works."

Development of the techniques necessary to run these supercomputer jet simulations is a core aspect of Patrick Yates' PhD work, which began just over three

years ago. He has been using the kunanyi supercomputer run by the Tasmanian Partnership for Advanced Computing to develop and test the jet simulations.

The project's aim, Dr Shabala said, is to produce the most realistic predictions to date of black hole jets and their interaction with galaxies.

"We can then directly compare these predictions to observations by telescopes, including the Square Kilometre Array, which will be partially hosted by Australia."

Black holes are tiny by cosmic standards, Dr Shabala explained. "If a galaxy was shrunk down to the size of a major city, the black hole would only be the size of a letterbox. Yet now and then these black holes shoot out incredibly powerful jets, which in this analogy would be the size of the continent of Australia.

"Travelling at almost the speed of light, these jets impart huge amounts of energy to their surroundings as they burrow through cosmic gas."

Telescopes such as the Square Kilometre Array will observe many millions of galaxies and black hole jets in the years to come.

"Our NCI project will provide a theoretical framework for understanding those telescope measurements," Dr Shabala said. "We are combining our knowledge of the physics of galaxies and of black hole jets to form a single picture of how these cosmic ecosystems evolve.

"The novelty of our approach is combining state-of-the-art jet models, developed at the University of Tasmania and the University of Hertfordshire, with equally sophisticated galaxy formation models, developed at the University of Western Australia."

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