What could we know about the global structure of black hole spacetimes? — abstract for the general public

Black holes are unusual entities in many ways. One of them is that, under many characterizations, they are global entities: prima facie, an entire history of the universe needs to be surveyed in order to establish whether a black hole is in it. And yet, search for new physics centers around these entities. In recent years rapid progress has been made on observations of black holes, with many lines of evidence opening up. For scientifically informed philosophy it is an unusual and exciting opportunity.

However, global properties are troubling. Explicitly constructed examples of mathematical representations of space and time show that many global properties cannot be determined, in the following sense: the locally collected data are compatible with very different global properties, no matter how many observations about our immediate surroundings and our past we make. (Philosophers call these "observationally indistinguishable spacetimes".) A common view is that such examples justify a form of skepticism about global properties.

So far, the debate focused on cosmological examples. This project will answer whether (and if so in what ways) similar concerns arise for models of black holes. The project asks two types of questions.

First, what **can** be said about observationally indistinguishable spacetimes? This aims to address what can formally be shown to be true — do similar constructions arise in the context of black holes as well?

Second, what **should** be said about observationally indistinguishable spacetimes? That is, even if similar constructions arise, should they also be interpreted in similar ways? Do the global properties play the same representational and functional roles in this context as in cosmology?

By addressing these questions, the project opens a fresh avenue in philosophy of physics, providing a new context in which we will learn a lot about skepticism, notion of prediction, induction, idealizations in physics, conceptual foundations of general relativity, and deep questions in metaphysics of space and time.