



Seminar

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The Big Picture: From Cosmic Origins to Life on Exoplanets

Tuesday, 12 January 2021, 2:15 p.m.

Due to the precautions imposed by the current Corona pandemic, the Thunberg Hall will be closed to the public until further notice.

You are therefore invited to join the seminar via Zoom instead:

<https://uu-se.zoom.us/j/67151906433>

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ABOUT MARTIN SAHLÉN

Martin Sahlén received his PhD in Astronomy from the University of Sussex in 2009. He has held postdoctoral fellowships at the Wellcome Sanger Institute, Stockholm University, and the University of Oxford. He was a Fulbright Fellow at Johns Hopkins University in 2016. He participates in the Euclid satellite project, the telescopes 4MOST and the Square Kilometre Array.

Sahlén's main field of research concerns the physical processes involved in the formation and evolution of large-scale structure in the Universe. He has shown that statistical samples of clusters and voids in the galaxy distribution of the late-time Universe are powerful tools for measuring the properties of dark energy, dark matter and neutrinos, and for testing whether General Relativity holds on cosmological scales (*Phys. Rev. Lett.* 2013, *Phys. Rev. D* 2018, 2019). He produced the first-ever measurements of cosmological model parameters based on voids, showing that the existence of the largest known cluster and void is sufficient to infer the existence of dark energy (*Astrop. J. Lett.* 2016). In the early Universe, large-scale structure is tightly linked to the emergence of the first galaxies. This epoch is a unique testbed for primordial galaxy formation and possible non-standard dark matter and dark energy. Sahlén is developing the advanced state-of-the-art software GalaxyMC to model and analyse galaxy samples in the early Universe.

Sahlén also works on machine learning and inference methods, as well as the philosophy of cosmology. He has argued that explanations of the geometrical flatness of the Universe or the expected value for the cosmological constant based on the standard paradigm of cosmic inflation, or multiverse scenarios, are empirically untestable. Therefore, he proposed a generalization of Bayesian probability that extends inference to meta-empirical domains (in *The Philosophy of Cosmology*, Cambridge University Press 2017; selected in *The Best Writing on Mathematics 2018*, M. Pitici [Ed]., Princeton University Press 2019).

During his time as a Fellow, Sahlén will focus on a project investigating which environments in galaxies are the best habitats for life on exoplanets and on how common such environments are.

ABSTRACT

Since the early 20th century, astronomical observations and physical models have revolutionised our understanding of the cosmos. A unified physical description of the first moments and subsequent evolution of the Universe at different length scales has been established, alongside a description of its basic constituents. A key feature is that the Universe is not static but evolves in time, and goes through several distinct cosmic epochs. The initial matter distribution is acted upon by the fundamental laws of physics, which gradually leads to the formation of yet larger and more complex structures as the Universe cools and expands. Arguably, the most complex of known structures is life - in particular intelligent life. While our best models of the Universe do allow for complex life to form, it also seems that if the laws of physics were only slightly different, then complex life could not exist. Furthermore, the local environmental conditions of a solar system within a galaxy, and of a planet within a solar system, need to be fairly special to allow for life as we know it to exist over long periods of time. Here, I will describe some of the key ingredients in our recipe for forming a Universe like ours, and how different mixtures of the ingredients are related to the prospects for life to exist and persist on exoplanets - and ultimately, to how common life may be at different cosmic locations and epochs.