Data Fusion and Deconvolution

Stephen Serjeant, 11 November 2021

Motivation

Wide-field submillimetre surveys have driven many major advances in galaxy evolution in the past decade, but without extensive follow-up observations the coarse angular resolution of these surveys limits the science exploitation. This has driven the development of various analytical deconvolution methods. In the last half a decade Generative Adversarial Networks have been used to attempt deconvolutions on optical data. We have developed an auto-encoder with a novel loss function to overcome this problem in the submillimeter wavelength range (Lauritsen+21 MNRAS, 507, 1546). This approach is successfully demonstrated on Herschel SPIRE 500 micron COSMOS data, with the superresolving target being the JCMT SCUBA-2 450 micron observations of the same field. We reproduce the JCMT SCUBA-2 images with high fidelity using this auto-encoder. We are now deconvolving much larger Herschel survey areas, with a view to identifying rare ultra-high-redshift systems to probe the demographics and mechanisms of star formation at the earliest epochs, strong gravitational lenses to enable follow-up observations of the resolved physical processes in the progenitors of present-day giant ellipticals, and foreground interlopers, all using multi-wavelength supplementary data.

Activities and Expected Outcomes

We would like funding for a visit from Dr Lucia Marchetti's UCT group (or Dr Marchetti herself) for furthering the analysis with the Herschel data fusion to facilitate this cross-correlation with our machine learning deconvolution outputs. We will seek additional UK funding from the visitors' line in our STFC Consolidated Grant and other sources.

Aims / Goals

- Cross-match the catalogues from our deconvolved Herschel maps with the Herschel data fusion products
- Search for rare systems in the cross-matched catalogues such as strong gravitational lenses (to facilitate follow-up work on the dark matter halo mass distributions and the resolved star formation in extreme starbursting galaxies at Cosmic Noon) and ultra-red ultra-high-redshift systems (to measure the demographics and physical processes driving extreme star formation at the highest available redshifts)
- Initiate work to incorporate other multi-wavelength data into the Herschel deconvolution with our denoising autoencoder