Project Title: Interpreting Galactic and Extra-galactic Molecular Observations Through Statistical Methods

Project description:

Molecules pervade the cooler, denser parts of the Universe. These gas components of galaxies, such as the Giant Molecular Clouds where stars form, contain a significant fraction of the non-stellar baryonic matter. Observing molecular gas is important for our understanding of how galaxies and stars form and evolve, since this denser, cooler gas is the only reservoir of matter for future star formation. Astronomers routinely observe the universe at sub-mm wavelengths at which many molecular species emit. Indeed, a wide variety of objects, from pre-stellar cores to extragalactic AGNs, are observable in the emission from hundreds of molecules.

A major motivation for these observations is the fact that unravelling the chemical and physical conditions that produce the emission allow us to understand the physical and energetic processes occurring in the observed gas. However, deriving physical properties from these observations involves complex chemical and radiative transfer models. Further, it is not always clear which molecules should be observed if one wishes to constrain specific physical parameters.

Throughout this PhD project the student will use statistical methods and machine learning to create tools that better facilitate this process. The student will use our chemical model and a popular radiative transfer model to produce datasets of molecules and their emission under different physical conditions, from those resembling the molecular clouds where stars form, to those in starburst galaxies and surrounding AGNs.

Combining these datasets with regression models and dimensionality reduction techniques, the student will produce recommendations for which molecular transitions should be observed by the astronomer who wishes to constrain a particular physical parameter. Further, they will develop emulators and invertible neural networks that allow observers to derive physical parameters from observations without running the complex chemical models that were used to produce our statistical models.

The models and initial methods that the student will develop are prepared so the project can start immediately. Once underway, the student will have ample opportunity to redirect the project according to their particular interests or ideas they develop.

Supervisor: Prof Serena Viti and Dr Jon Holdship

Selection criteria: An interest in statistics and ML techniques is desirable

Applications:

To apply for this vacancy, please send an email to _____. Please ensure that you upload the following additional documents quoting the project title:

- Curriculum vitae;
- Bachelor's and master's transcripts;
- (Draft of) MSc thesis.

Deadline: June 1st 2021