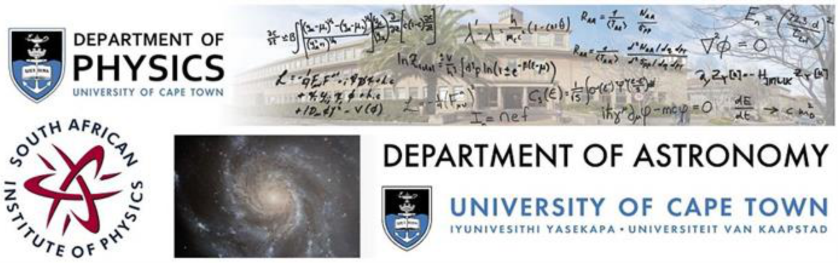

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Modelling Radiative Line Transfer in Maser Environments

Wednesday, 6 July 2016 11:30 (20 minutes)

Abstract content
   (Max 300 words)
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An astrophysical maser is a naturally occurring source of stimulated spectral line emission. To generate maser radiation, a molecular population inversion is required. This non-equilibrium inversion can be created by various pumping mechanisms, most typically infrared radiation and collisions. Spectral line emission from masers is stimulated (or seeded) and monochromatic, meaning the emitted photons have the same frequency and direction as the original photon, resulting in great amplification.

In order to understand the pumping mechanisms and physical characteristics of masers, suitable models for the molecular excitation and radiative transfer must be developed.

Complete solutions involve a multi-level system and requires a simultaneous solution for the level populations well as the transfer of radiation in all the lines that couple them. However, the escape probability method is an approximation that can be used to decouple the equations, thus enabling analysis in terms of level populations independent of radiative transfer.

From a mathematical point of view, this decoupling allows the solution to be expressed as a matrix of coefficients acting on a vector of populations. In this form, the level populations can be obtained by a number of standard numerical methods, with the only prerequisite for a successful solution being a reasonable initial guess.

The "masers" package was developed in Python and solves the matrix equation using molecular data and parameters describing the physical environment. It extends existing radiative transfer software by providing a reasonably fast, stable algorithm that deals with the solution method's inherent sensitivity to oscillations and multiple valid outcomes; allows different maser geometries for calculation; includes the contribution of interacting background radiation fields, as well as other sources of opacity such as line overlap.

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Main supervisor (name and email)
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