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A radiative transfer model for hydrogen recombination line masers

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Astronomical masers occur when radiation is amplified by the process of stimulated emission over long path lengths, producing line emission that is much brighter than spectral lines produced by spontaneous transitions. Molecular astronomical masers have proven to be a useful tool to probe conditions in a wide variety of astronomical sources. Masers are also produced by atomic hydrogen formed by recombination in sufficiently dense H II regions. These hydrogen recombination line (HRL) masers have been observed in a handful of objects to date and the analysis of the atomic physics involved have been rudimentary. In this work a new model of HRL masers is presented which uses an nl-method model to describe the atomic populations interacting with free-free radiation from the plasma, and an escape probability framework to deal with radiative transfer effects. The importance of including the collisions between angular momentum quantum states and the free-free emission in models of HRL masers are demonstrated. The model is used to describe the general behaviour of radiative transfer of HRLs and to investigate the conditions under which HRL masers form. The model results show good agreement with observations collected over a broad range of frequencies.

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Yes

Level for award
 (Hons, MSc,
   PhD, N/A)?

PhD

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