Modelling line emission in PDRs

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Emission lines formation in a diluted medium results from a large number of conspiring physical processes. When trying to compute a line intensity or (harder) a line profile from first principle, one has to take into account at least three different kind of processes:

- Atomic or molecular physics data. Accurate knowledge of radiative and collisional transition probabilities are required to determine the population of excited levels which leads to line formation. Thermodynamical equilibrium is almost never established, so that detailed balance equations need to be solved. Unfortunately many important datas are still badly known.
- Structure and dynamics of the emitting medium. Local emissivities at a specific point depend at least on the local temperature and density of the gas, but often also on other less accessible parameters such as the turbulence state of the gas, a magnetic field or the existence of rapidly evolving transients such as shocks. Self consistent models which would include all relevant processes are out of reach numerically, and choices must be made among the more relevant physical processes to include.
- Radiative transfer effects. A few relevant interstellar lines are thin enough so that the total emissivity is just the sum of all local emissivities along the line of sight. Unfortunately, most lines are not so easy to cope with and a minimal radiative transfer formalism must be included. Various degrees of sophistication are possible, from a simple escape probability theory to full wavelength dependant line transfer.

On the whole, line modelling is still more an art than a science. One should be well aware of the various asumptions made in a model before applying it to some particular observational result.