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Strong (fast) shock waves can propagate through the atmospheres of cool pulsating evolved stars like RV Tauri or Mira stars. the medium in which they propagate is essentially made of hydrogen; it is dense (10(16) to 10(10) particles per cm3) and cool (500 to 5000K) The propagation velocity is fairly high (40-60 km/s) so that behind the shock front the temperature is so high that molecules and atoms are broken and ionization occurs. Then, at large distances from the hydrodynamic discontinuity (shock front), recombinations occur and produce Lyman photons that cross the discontinuity and alter the medium before it : a radiative precursor, coupled to the shock front and the wake , and the whole structure is strongly selfconsistent. In such shock waves, the effects of radiation cannot be considered as perturbations but must be taken into account accurately since the whole structure is highly sensitive to the corresponding parameters.

However, though very complicated, the modelization of strong shock waves propagation in circumstellar atmospheres must be performed with good input physics including the Lyman radiation (optically thick, not locally but throughout the overall structure), the Balmer radiation (optically thin out of the recombination zone where it is generated), etc... together with detailed chemistry (ionization, excitation, recombination of atoms and molecules) and physics (dynamics, thermodynamics). A major difficulty is that for most processes, the medium is out of local thermal equilibrium. In particular, when crossing the shock front, though the "heavy particles" (ions, atom, molecules) can be considered as still "thermalized" at the same temperature, these are heated to temperatures much higher than those reached by the electrons; the latter can be considered as coupled only dynamically to the heavy particles (by electric forces), but not coupled thermally : they are compressed adiabatically. A therma-lization zone follows, in which mutual collisions restore a unique temperature.

It is easy to imagine that the complete modelization of such structures (illustrated in Fig. 1) can be approached only progressively.

The first steps were concerned with the determination of the overall structure as described in the figure (paper 1). Then the

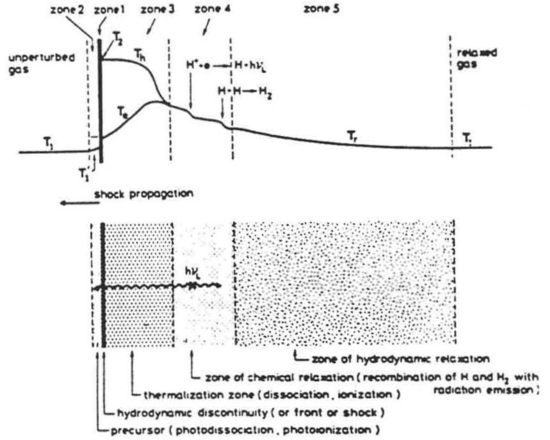


Fig. 1. Structure of a radiative shock (not to scale).

radiative precursor was modelled first for "cold" photons (just producing ionization) and for "hot" photons (including extra-heating) (papers 2 and 4); we have also built a self consistent model of the central part governed by the Lyman radiation, including the hydrodynamical discontinuity shrouded by the precursor and the regions where the temperatures are equalized and ions recombined (zones 1 to 4 in fig.1). For these models only the Lyman continuum radiation was taken into account.

Now, if we want to predict the optically thin (and so observable) Balmer fluxes, we have to introduce an additional level in our model of hydrogen atom. This is being done and a first paper (paper 5 of the series) describes what occurs within the radiative precursor if the two-level hydrogen atom is replaced by a three-level hydrogen atom.

For a mainly molecular medium, whereas, with a two-level atom, ions are produced only by direct photodissiociation of H2 followed by ionization of atoms, a significant part of the molecules are photodissociated and produce excited atoms which can be easily ionized by less energetic photons (Balmer); one can show that it results that any given ionization degree can be reached with less kinetic energy released in the gas so that the radiative precursor is less heated. Besides it seems that , for the expected Balmer fluxes, the Balmer continuum is optically thin and plays a minor rôle in the precursor structure as far as the Lyman alpha radiation has negligible effects, which is a reasonable assumption. Note that the temperature of the recombination zone of ions is an important parameter : above 15000K, direct photodissociation of molecules produces excited atoms and populate the addeed energy level of the atom, which does not occur below 15000K.

Incidentally we have also checked the sensitivity of the model structure to estimated parameters; in particular we discovered a very high sensitivity to the cross section of photoionization.

The work is now going on towards building a self consistent model of the Lyman dominated zone with a three-level hydrogen atom, including Lyman alpha radiation; this is the best way to determine which range of parameters is relevant in particular for the assumptions concerning radiation.

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