MASS TRANSFER IN CLOSE BINARIES

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In the recent years, several attempts have been made to calculate mathematical models of the mass exchange in close binaries . Generally, there are are two possibilities how to do it : or to solve the hydrodynamical equations of the cicumstellar gas between the components of the binary or to compute the trajectories of the gas particles in the system . The first approach is well demonstrated in the investigations made by Prendergast and his collaboraters (Prendergast 1964, Prendergast and Tamm 1974), the second one in the pioneer work by Plavec et all. (1964) . Since 1964 many authors took interest for the problems connected with the modelling of the mass exchange in close binaries. Some results of their analysises are collected in the references given below . Even though they all have done much work for the structure and the motion of the circumstellar matter in close binaries to be explained, the the problem remains still open for further investigations.

The indisputable fact is that the hydrodynamical approach to the solution of the mass transfer in close binaries is the most realistic one . Due to a relatively short free path of the particles in a circumstellar gas envelope (centimetres or metres according to the density of the matter) the trajectories of the particles are strongly affected with particle encounters and the approach based on computations of the particle orbits seems to be inacceptable. On the other hand, the hydrodynamics of a circumstellar gas cloud is also very hard problem and its application to close binaries is strongly limited because we do not know exactly which initial conditions are to be substituted when integrating the hydrodynamical equations . And there are also lot of difficulties connected with the fact that the hydrodynamics itself does not take into account the thermodynamical conditions like the temperature and the radiation of the gas.

In the present investigation , we have made an attempt to unify both the approaches mentioned above in a simple procedure capable to analyze the main features of the gas structures and the gas motion in close binaries. Our idea was as follows : we should have first derive the distribution of the circumstellar matter in the system in form of the density and the velocity fields of the gas by computing the equations of the motion of the individual particles ejected from the surface of the component filling the Roche lobe and then, in the second step, to treate these data in a hydrodynamical manner taking into account possible particle encounters as well as the temperature , the pressure, and the radiation of the whole circumstellar gas structure . At the present time, we have fulfiled the first stage of our plan for a model of a binary system containing about two milions gas particles and the results are prepared to be discussed.

The computations were carried out by integrating the equations of motion for the particles ejected with thermal velocities from the surface of the component filling the Roche lobe . Following forces were taken into account : the gravity force corresponding to the bipolar gravitational potential of the binary, the centrifugal force and, of course , the Corriolis force corresponding to the relative motion of the particles in a co-rotating rectangular coordinate system . The ejected particles were supposed to be homogeneously spread over the surface of the component, and were ejected isotropically with different velocities in different directions.

By analyzing the density and the velocity distributions of the particles in the orbital plane, we can state the following general conclusions:

1) The particles ejected with the low velocities form a thin stream resourcing in the Lagrangean point L_1 and falling onto the smaller component. This stream may be responsible for the bright spot observed in the light curves of some close interacting binaries.

2) The particles ejected with high velocities form a disk around the smaller component . The structure of the disk is strongly affected with the size of this component.

3) With increasing velocities of the ejections , the atmospherical envelope of the more evolved component gets stronger and stronger, and, finally , it forms, together with the disk of the smaller component, a dumb-bell-shaped common envelope around the whole system.

4) The particles around the smaller component produce a circular motion with the velocities corresponding to Keplerian orbits . A similar motions can be detected also in some of the atmospherical layers of the component filling the Roche lobe.

A strenge situation arises when supposing the ejected gas to be fully ionized and in a thermodynamical equilibrium . In that case, the less massive free electrons move with the velocities by two ordres greater than massive protons and , in correspondence with the conclusion 2 , have to forme a disk around the primary component . As, for the same reason , the protons have to forme the stream connecting the secondary and the primary component , the bipolar gravitational field shoul act a role of a powerfull separator of the the charged electrons and protons and should give arise an appearance of magnetic and electric fields in the binary system . Even though one can prove that the fields cannot influence on the motion of particles in the system, the effect signalizes that there is something wrong in our considerations. The explanation of the paradox should be probably looked for in the mutuel interactions of the charged particles soon after they have been ejected from the surroundings of the point L_1 .

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