Theory and experiments of accretion processes in cataclysmic variables

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Abstract

The accretion processes are among the most important phenomena in high-energy astrophysics since they are widely believed to provide the power supply in numerous astrophysical objects and are the

main source of radiation in binary systems containing compact objects. Among the different X-ray binary systems, the cataclysmic variable (CV) stars provide a unique insight in order to study the accretion processes in extreme astrophysical regimes. They are close binaries containing a white dwarf (WD) which accretes matter from its late-type low mass main sequence companion [1]. Their importance is due to the fact that they provide the best opportunity to study the accretion processes in isolation, since other sources of luminosity (mainly the WD and the secondary star luminosity) are relatively unimportant or well known. CVs are divided in two main classes. For the nonmagnetic CVs, the accretion occurs through an accretion disc and for the magnetic CVs (mCVs), the accreted plasma is directly guided by the magnetic field lines down to the magnetic poles of the white dwarf. During this talk, we will detail the accretion processes in the two classes of CVs and we will focus on the high-energy environment near the photosphere of the compact objects for mCVs. The understanding of the physics of this region is fundamental since it is at the basis of the determination of the WD properties [2]. In the standard model, the impact of the supersonic free-fall accreting matter with the WDs photosphere generates a shock (accretion shock) [3], which heats the infalling plasma up to 10-50 keV. This post-shock region cools by different radiative processes that lead to the formation of high-stratified structure in temperature and density [2]. Unfortunately, the size scales associated with these zones are on the order of the WD radius or smaller, which avoid their direct observations and the determination of the physics of the impact zone [4]. For this reason, every alternative approach that can provide a direct insight of these objects is of primary importance. Recently, exact scaling laws have been calculated for this accretion column scheme in different accretion regimes and demonstrated that we can reproduce these physical regimes with powerful lasers [5], [6], [7]. A review concerning these experimental results will be presented demonstrating the possibility to study efficiently the radiation hydrodynamics accretion processes in laboratory.

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