Clumping in Hot Star Winds
W.-R. Hamann, A. Feldmeier & L.M. Oskinova, eds.
Potsdam: Univ.-Verl., 2008
URN: http://nbn-resolving.de/urn:nbn:de:kobv:517-opus-13981

Radiative transfer in CV disk winds

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Mass accretion onto compact objects through accretion disks is a common phenomenon in the universe. It is seen in all energy domains from active galactic nuclei through cataclysmic variables (CVs) to young stellar objects. Because CVs are fairly easy to observe, they provide an ideal opportunity to study accretion disks in great detail and thus help us to understand accretion also in other energy ranges. Mass accretion in these objects is often accompanied by mass outflow from the disks. This accretion disk wind, at least in CVs, is thought to be radiatively driven, similar to O star winds. WOMPAT, a 3-D Monte Carlo radiative transfer code for accretion disk winds of CVs is presented.

The first detection of outflows in CVs dates back to the late 1970ies and early 1980ies when blueshifted absorption troughs and P Cygni profiles in ultraviolet (UV) resonance lines were discovered (Heap et al. 1978). Such signatures of outflows are mainly seen during outbursts and high states of CVs, as the disk is hotter and creates more radiation pressure for driving a wind. The observational evidence is such that detailed models of CVs, at least in outburst, have to include outflows.
Within the Tübingen group a code for modeling NLTE accretion disk atmospheres was developed and successfully used to model spectra of CVs and ultracompact X-ray binaries (Nagel et al. 2004, Werner et al. 2006). Our goal is to develop a whole package with which we are able to model a complete CV including the accretion disk, the white dwarf and the outflow.
At the moment we implemented a kinematical biconical wind model by Shlosman & Vitello (1993) for the outflow structure. To contrast the kinematical model a hydrodynamical approach is taken by implementing a wind structure based on CAK theory following Feldmeier & Shlosman (1999). Monte Carlo techniques are used to do the radiative transfer in this three-dimensional wind structure. Photon packets, which represent a monochromatic family of photons, are created on the disk or the WD and are then followed through the wind. All parts of a photon packet's life, the creation, interaction points and -processes, new directions of flight, etc. are determined via probabilities. Optical depths are acquired by numerical integration of local opacities along the photon's line of flight. Thus no Sobolev approximation is needed. Furthermore line opacities can be calculated with either Doppler or Stark broadening. The spectra are determined by detecting escaping parts of photon packets in a virtual detector located at infinity.
Typical P Cygni wind lines, such as the C IV 1550 Å resonance line, (Fig. 1) are reproduced by our model. One interesting point to note is, using the same parameters the assumption of Doppler broadening yields much stronger lines compared to the use of Stark broadening. In order to get the P Cygni profile for Stark broadening one could assume a higher abundance of C in the wind as compared to the standard solar value. Other possible solutions currently probed for this problem are different temperatures and higher accretion rates. Even clumping like in O-star winds might prove useful.

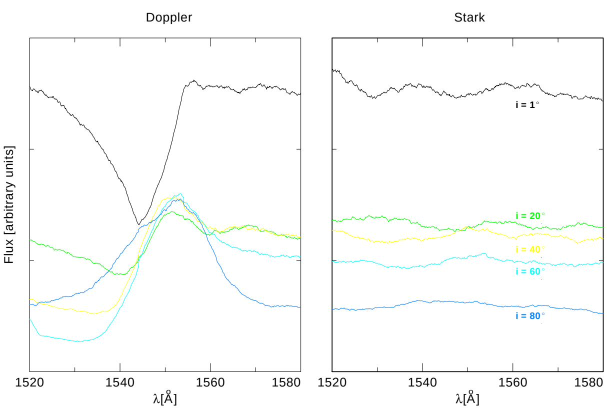

Figure 1: Calculated C IV 1550 Å resonance line for different inclination angles.

References

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