Radiation-driven winds of hot luminous stars XVIII. The unreliability of stellar and wind parameter determinations from optical vs. UV spectral analysis of selected central stars of planetary nebulae and the possibility of some CSPNs as single-star supernova Ia progenitors

T. L. Hoffmann, A. W. A. Pauldrach, and C. B. Kaschinski

Institut fuer Astronomie und Astrophysik der Universitaet Muenchen, Scheinerstrasse 1, 81679 Muenchen, Germany

Context. The uncertainty in the degree to which radiation-driven winds of hot stars might be affected by small inhomogeneities in the density leads to a corresponding uncertainty in the determination of the atmospheric mass loss rates from the strength of optical recombination lines and â€“ since the mass loss rate is not a free parameter but a function of the stellar parameters mass, radius, luminosity, and abundances â€“ in principle also in the determination of these stellar parameters. Furthermore, the optical recombination lines also react sensitively to even small changes in the density structure resulting from the (often assumed instead of computed) velocity law of the outflow. This raises the question of how reliable the parameter determinations from such lines are.
Aims. The currently existing severe discrepancy between CSPN (central stars of planetary nebulae) stellar and wind parameters derived from model fits to the optical spectra and those derived using hydrodynamically consistent model fits to the UV spectra is to be reassessed via a simultaneous optical/UV analysis using a state-of-the-art model atmosphere code.
Methods. We have modified our hydrodynamically consistent model atmosphere code with an implementation of the usual ad-hoc treatment of clumping (small inhomogeneities in the density) in the wind. This allows us to re-evaluate, with respect to their influence on the appearance of the UV spectra and their compatibility with the observations, the parameters determined in an earlier study that had employed clumping in its models to achieve a fit to the observed optical spectra.
Results. The discrepancy between the optical and the UV analyses is confirmed to be the result of a missing consistency between stellar and wind parameters in the optical analysis. While clumping in the wind does significantly increase the emission in the optical hydrogen and helium recombination lines, the influence of the density (velocity field) is of the same order as that of moderate clumping factors.Moderate clumping factors leave the UV spectra mostly unaffected, indicating that the influence on the ionization balance, and thus on the radiative acceleration, is small. Instead of the erratic behavior of the clumping factors claimed fromthe optical analyses, our analysis based on the velocity field computed from radiative driving yields similar clumping factors for all CSPNs, with a typical value of f_cl = 4. With and without clumping, wind strengths and terminal velocities consistent with the stellar parameters from the optical analysis give spectra incompatible with both optical and UV observations, whereas a model that consistently implements the physics of radiation driven winds achieves a good fit to both the optical and UV observations with a proper choice of stellar parameters. The shock temperatures and the ratios of X-ray to bolometric luminosity required to reproduce the highly ionized Ovi line in the FUSE spectral range agree with those known from massive O stars (LX/Lbol ~ 10-7 . . . 10-6), again confirming the similarity of O-type CSPN and massive O star atmospheres and further strengthening the claim that both have identical wind driving mechanisms.
Conclusions. The similarity of the winds of O-type CSPNs and those of massive O stars justifies using the same methods based on the dynamics of radiation-driven winds in their analysis, thus supporting the earlier result that several of the CSPNs in the sample have near-Chandrasekhar-limit masses and may thus be possible single-star progenitors of type Ia supernovae.

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Email: uh10107@usm.uni-muenchen.de