Modeling Forbidden Line Emission Profiles from Colliding Wind Binaries

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This paper presents calculations for forbidden emission line profile shapes arising from colliding wind binaries. The main application is for systems involving a Wolf-Rayet (WR) star and an OB star companion. The WR wind is assumed to dominate the forbidden line emission. The colliding wind interaction is treated as an archimedean spiral with an inner boundary. Under the assumptions of the model, the major findings are as follows. (a) The redistribution of the WR~wind as a result of the wind collision is not flux conservative but typically produces an excess of line emission; however, this excess is modest at around the 10% level. (b) Deviations from a flat-top profile shape for a spherical wind are greatest for viewing inclinations that are more nearly face-on to the orbital plane. At intermediate viewing inclinations, profiles display only mild deviations from a flat-top shape. (c) The profile shape can be used to constrain the colliding wind bow shock opening angle. (d) Structure in the line profile tends to be suppressed in binaries of shorter periods. (e) Obtaining data for multiple forbidden lines is important since different lines probe different characteristic radial scales. Our models are discussed in relation to {em Infrared Space Observatory} data for WR~147 and $gamma$~Vel (WR~11). The lines for WR~147 are probably not accurate enough to draw firm conclusions. For $gamma$~Vel, individual line morphologies are broadly reproducible but not simultaneously so for the claimed wind and orbital parameters. Overall, the effort demonstrates how lines that are sensitive to the large-scale wind can help to deduce binary system properties and provide new tests of numerical simulations.

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