Detection of high-velocity material from the wind-wind collision zone of Eta Carinae across the 2009.0 periastron passage

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We report near-IR spectroscopic observations of the Eta Carinae massive binary system during 2008-2009 using VLT/CRIRES. We detect a strong, broad absorption wing in He I 10833 extending up to -1900 km/s across the 2009.0 spectroscopic event. Archival HST/STIS ultraviolet and optical data shows a similar high-velocity absorption (up to -2100 km/s) in the UV resonance lines of Si IV 1394, 1403 across the 2003.5 event. UV lines from low-ionization species, such as Si II 1527, 1533 and C II 1334, 1335, show absorption up to -1200 km/s, indicating that the absorption with v from -1200 to -2100 km/s originates in a region markedly faster and more ionized than the nominal wind of the primary star. Observations obtained at the OPD/LNA during the last 4 spectroscopic cycles (1989-2009) also display high-velocity absorption in He I 10833 during periastron. Based on the OPD/LNA dataset, we determine that material with v < -900 km/s is present in the phase range 0.976 < phi < 1.023 of the spectroscopic cycle, but absent in spectra taken at phi < 0.947 and phi > 1.049. Therefore, we constrain the duration of the high-velocity absorption to be 95 to 206 days (or 0.047 to 0.102 in phase). We suggest that the high-velocity absorption originates from shocked gas in the wind-wind collision zone, at distances of 15 to 45 AU in the line-of-sight to the primary star. Using 3-D hydrodynamical simulations of the wind-wind collision zone, we find that the dense high-velocity gas is in the line-of-sight to the primary star only if the binary system is oriented in the sky so that the companion is behind the primary star during periastron, corresponding to a longitude of periastron of omega ~ 240 to 270 degrees. We study a possible tilt of the orbital plane relative to the Homunculus equatorial plane and conclude that our data are broadly consistent with orbital inclinations in the range i=40 to 60 degrees.

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