Chandra spectroscopy of the hot star beta Crucis and the discovery of a pre-main-sequence companion

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In order to test the O star wind-shock scenario for X-ray production in less luminous stars with weaker winds, we made a pointed 74 ks observation of the nearby early B giant, beta Cru (B0.5 III), with the Chandra High Energy Transmission Grating Spectrometer. We find that the X-ray spectrum is quite soft, with a dominant thermal component near 3 million K, and that the emission lines are resolved but quite narrow, with half-widths of 150 km/s. The forbidden-to-intercombination line ratios of Ne IX and Mg XI indicate that the hot plasma is distributed in the wind, rather than confined near the photosphere. It is difficult to understand the X-ray data in the context of the standard wind-shock paradigm for OB stars, primarily because of the narrow lines, but also because of the high X-ray production efficiency. A scenario in which the bulk of the outer wind is shock heated is broadly consistent with the data, but not very well motivated theoretically. It is possible that magnetic channeling could explain the X-ray properties, although no field has been detected on beta Cru. We detected periodic variability in the hard (hnu > 1 keV) X-rays, modulated on the known optical period of 4.58 hours, which is the period of the primary beta Cep pulsation mode for this star. We also have detected, for the first time, an apparent companion to beta Cru at a projected separation of 4 arcsec. This companion was likely never seen in optical images because of the presumed very high contrast between it and beta Cru in the optical. However, the brightness contrast in the X-ray is only 3:1, which is consistent with the companion being an X-ray active low-mass pre-main-sequence star. The companion's X-ray spectrum is relatively hard and variable, as would be expected from a post T Tauri star. The age of the beta Cru system (between 8 and 10 Myr) is consistent with this interpretation which, if correct, would add beta Cru to the roster of Lindroos binaries -- B stars with low-mass pre-main-sequence companions.

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