Strip-mining the Coronal Graveyard

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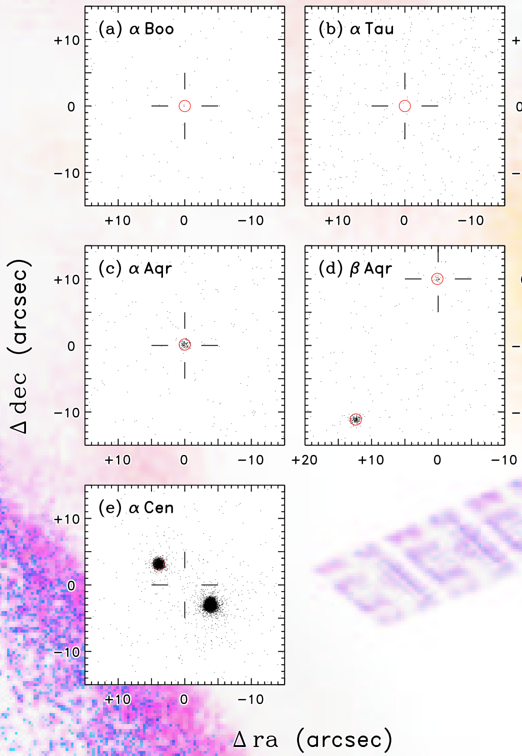
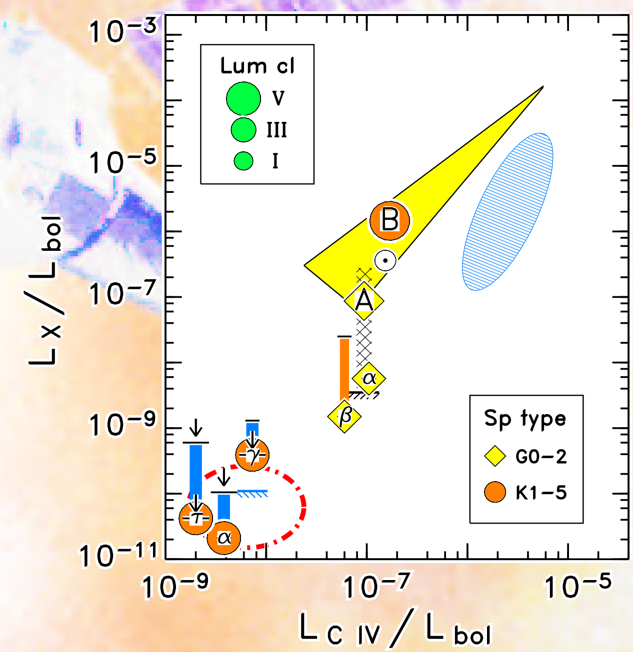
Abstract

We describe *Chandra* HRC-I pointings on optically bright, but X-ray faint, red giants and yellow supergiants in the so-called Coronal Graveyard. These stars display a conspicuous "X-ray deficiency" similar to Hertzsprung gap giants. We also obtained a DDT observation of the nearby α Centauri system, finding that the "fainted" sun-like primary, diagnosed by *XMM* last February, has recovered.



In a series of *Chandra* programs, we have conducted High Resolution Camera (HRC-I) pointings—typically 20 ks—on optically bright, but coronally dead, late-type giants and supergiants. So far, we have observed red giants α Bootis (Arcturus: K2 III) and α Tauri (Aldebaran: K5 III), obtaining a positive detection of the former, but not the latter; and (with more significant detections) yellow supergiants α Aquarii (G2 Ib) and β Aquarii (G0 Ib), members of the so-called "hybrid chromosphere" class. Previous *ROSAT* observations had been inconclusive: in the cases of α Boo and α Tau owing to lack of sensitivity; in the case of α Aqr due to a 38′ mispointing; and for β Aqr, because of a small but significant positional discrepancy. The *Chandra* HRC-I, with its superior spatial resolution, sensitivity, and—most importantly—freedom from CCD "red leak," recorded positive detections of Arcturus (albeit only 3 counts) and α Aqr; and recovered faint emission at the location of β Aqr, now well separated from the stronger source to the SE that dominated the earlier *ROSAT* image (Fig. 1, above). The coronal $L_X/L_{C\,IV}$ luminosity ratios (or upper limit for Aldebaran) of all four stars (Fig. 2, right) are extremely depressed relative to solar-type dwarfs, continuing the puzzling "X-ray deficiency syndrome" originally identified in fast-rotating, newly convective yellow giants of the Hertzsprung gap.

We also obtained, thanks to Director's Discretionary Time, a pointing on the nearby α Centauri binary (G2 V + K1 V), which was observed regularly during the *ROSAT* era, and more recently by Robrade & Schmitt with *XMM*–Newton, but now the orbital separation has closed below EPIC–*pn* resolution. The latter study caught an unprecedented decline in the coronal luminosity of the solar-like primary star ("A"), 'fainting' to only about 1 % its normal L_X in February 2005. The more recent HRC-I image, taken in late-October 2005, finds that α Cen A has recovered to its X-ray level of March 2003, at the beginning of the *XMM*–Newton program, but still significantly weaker than its historic L_X of the 1990's.



The X-ray/C IV flux–flux diagram above summarizes the results: α Boo ("α") and α Tau ("τ") in lower left hand corner; α Aqr ("α") and β Aqr ("β") in lower middle; and α Cen A ("A") and α Cen B ("B") in upper middle. The yellow wedge depicts the relation followed by dwarf stars of widely different activity; the blue oval traces out that for X-ray deficient F–G0 Hertzsprung gap giants. The yellow supergiants are weak coronal sources, apparently lying on a downward extension of the X-ray deficient track. This behavior might be linked to the extreme cases of Arcturus and Aldebaran, where *HST* UV spectra indicated that the hot C IV regions are buried beneath extended chromospheric envelopes, at least partly smothering any associated X-ray emission. An additional target—γ Draconis (K5 III)—remains to be observed in the Cycle 6 part of the program.

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