To be submitted to the Astrophysical Journal C and N abundances in Algol B Drake document From the Heart of The Ghoul: C and N Abundances in the Corona of Algol B Jeremy J. Drake 1 Smithsonian Astrophysical Observatory, MS-3.

abstract

Chandra Low Energy Transmission Grating Spectrograph observations of Algol have been used to determine the abundances of C and N in the secondary star for the first time. In order to minimise errors arising from an uncertain coronal differential emission measure as a function of temperature, the analysis was performed relative to similar observations of an adopted “standard” star HR 1099. It is demonstrated HR 1099 and Algol are coronal twins in many respects and that their X-ray spectra are very similar in nearly all details, except for the observed strengths of C and N lines. The H-like 2p $^2P_{3/2,1/2}$ → 1s $^2S_{1/2}$ transitions of C and N in the coronae of Algol and HR 1099 demonstrate that the surface abundances of Algol B have been strongly modified by CN-processing, as demonstrated earlier by Schmitt & Ness (2002). It is found that N is enhanced in Algol B by a factor of 3 compared to HR 1099. No C lines are detected in the Algol spectrum, indicating a C depletion relative to HR 1099 by a factor of 10 or more. These C and N abundances indicate that Algol B must have lost at least half of its initial mass, and are consistent with predictions of evolutionary models that include non-conservative mass transfer and angular momentum loss through magnetic activity. Based on H-like and He-like transitions in O and Ne, it is estimated that Algol is slightly metal-poor by 0.2 dex in terms of the coronal abundances of light elements relative to HR 1099, while the Fe XVII 2p$^5$3d $^1P_1 → 2p^6$ $^1S_0$ transition indicates a very similar Fe abundance. In reviewing coronal abundance results for active stars in the literature, and drawing on an earlier Chandra study of the coronal abundances of HR 1099, it is concluded that Fe is very likely depleted in the coronae of both Algol and HR 1099 by 0.5 dex relative to their photospheric compositions, but that Ne is enhanced by a similar magnitude. Light elements such as C, N and O are likely depleted in both stars by of order 0.3 dex. The similarities in these large abundance anomalies in HR 1099 and Algol is notable. Despite such compositional fractionation in these coronae, the relative C and N abundances in HR 1099, determined by comparing observed line strengths to theoretical C/N line ratios, are consistent with recent solar values, indicating that differential fractionation between these elements is not significant and that little or no dredge-up of material subjected to CN-processing has occurred on the subgiant component.