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CORONAL ELEMENT ABUNDANCES OF THE POST-COMMON ENVELOPE BINARY V471 TAURI

Martin Still[1,2] and Gaitee Hussain[3]

Evolutionary calculations indicate that there should be no peculiar abundances on the companion star resulting from the common envelope epoch if accretion efficiencies are low. Indeed, we find no evidence for peculiar abundances from archival ASCA data, although uncertainties are high. We find that a single-temperature plasma model does not fit the data. Two-temperature models with decoupled elemental abundances suggest that Fe is underabundant compared to the Hyades photospheric mean. In the absence of a measurement of photospheric Ne abundance in the cluster, we find Ne is overabundant compared to the solar photospheric value. This is indicative of the inverse first ionization potential effect. Differences between coronal and photospheric abundances are believed to result from the fractionation of ionized and neutral material in the upper atmosphere of the star. Care must be taken to include this effect when inferring photospheric abundances from X-ray data (e.g., Sarna 2004).

V471 Tau is a 12.5 hour eclipsing binary with a white dwarf and tidally-locked K2 companion. At a distance of 47 pc, it is the closest object which has been through a recent common envelope phase of evolution. During the red giant phase of the white dwarf progenitor's life, the envelope of the giant was large enough to contain the orbit of the K star companion. While the two stars shared a common envelope, tides, friction and mass loss created a significantly smaller binary, with a short orbital period. The envelope of the giant has since been ejected, but the binary still loses angular momentum through wind braking and gravitational radiation. V471 Tau is therefore one of the best candidates for a pre-cataclysmic variable (pre-CV). CVs occur when the orbital period of a white dwarf–red dwarf binary becomes short enough for the main-sequence companion to fill it's Roche lobe. Quasi-persistent accretion will then occur through Roche lobe overflow. These objects are the sources of dwarf nova outbursts and classical nova eruptions that enrich the galactic ISM.

V471 Tau is a member of the Hyades open cluster. Photospheric abundances of the Hyades members have been measured by Cayrel et al. (1985) and Varenne & Monier (1999). Accepting model assumptions we show in Still & Hussain (2003) that coronal Fe is under-abundant relative to the mean photospheric Hyades content and coronal Ne is over-abundant, at least relative to the solar photosphere. The Ne/Fe ratio in V471 Tau is suggestive of an inverse-FIP (First Ionization Potential) effect.

The coronal, energetic particle and cosmic ray abundances in the sun are all different from the solar photospheric content. Mounting evidence indicates that this is equally true for active stars (e.g. Brinkman et al. 2001). While in most cases the photospheric abundances remain uncertain, there is at least one strong piece of evidence for fractionation regions in between stellar photospheres and coronae. It derives from the fact that coronal abundances are correlated with elemental FIP. In the solar atmosphere the ratio of coronal to photospheric abundances decreases with FIP. When comparing stellar coronal abundances to the solar photosphere some sources follow this trend while others show the "inverse FIP effect", i.e. an increasing ratio with increasing FIP.

FIP effects are thought to be directly associated with the process of element fractionation in stellar atmospheres (Hénoux 1995). The ionized fraction of each element will depend on the plasma temperature in the fractionation region. Some process is required to decouple the ionized and neutral plasmas. Possibly the charged particles are accelerated along field lines in loops above the stellar photosphere. Flare ejection provides another mechanism to propel material into the corona.

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[1]NASA/Goddard Space Flight Center, Greenbelt, MD 20771, USA(Martin.Still@gsfc.nasa.gov).
[2]Universities Space Research Association.
[3]ESTEC, ESA, 2200 AG, Noordwijk, The Netherlands.