THE CHEMICAL COMPOSITION OF PROCYON

A.V. Yushchenko, V.F. Gopka
Astronomical Observatory, Odessa State University,
T.G.Shevchenko Park, Odessa, 270014, Ukraine,
e-mail: yua@lens.tenet.odessa.ua

ABSTRACT. The review of last studies on the chemical composition of Procyon showed that the abundances of 55 elements were investigated in the atmosphere of Procyon. The abundances of majority of elements are near Solar systems values. The exceptions are Li, Be, B, Se, Te. The possible explanation of tellurium overabundance is proposed.

Key words: $r-, s-$process elements – stellar abundances.

Procyon is one of the brightest F-stars. The chemical composition of Procyon was investigated repeatedly. The review of elemental abundances in the atmosphere of Procyon A (Procyon B is a white dwarf) were made by Lyubimkov (1995) and Drake & Laming (1995). The present study will review the latest investigations of Procyon and propose the possible explanation of tellurium overabundance in the atmosphere of this star.

The abundances of Li, Be, B were investigated by Lemke et al. (1993) using GHRS spectra. They found that Procyon is highly depleted in Li and Be, and depleted in B by a factor at least 3. The lithium abundance in Procyon was investigated by Ferluga et al. (1995). These authors used spectra with high signal to noise ratio (500) and resolving power 110,000 but were not able to detect lithium lines near λ 6708 Å. The Li abundance in Procyon was investigated by Gerbaldi et al. (1995). A NLTE studies of elemental abundances in Procyon were published by Kiselman (1994) for boron, Takeda (1994) for CNO, Takeda & Takeda-Hiday (1994) for sodium, Takeda et al. (1996) for potassium, and Mashonkina et al. (1995) for Na, Mg, K, Ba.

The abundances of Th, Te, Re in Procyon were determined by Yushchenko & Gopka (1994), Gopka et al. (1995a), Yushchenko & Gopka (1996a). The abundance of Er in the Procyon atmosphere was redetermined by Gopka & Yushchenko (1995). The determination of abundances of Ge, Mo, Ag, Cd, Te, Ho, Hf, Os, Ir in Procyon and a review of abundances of 34 *r*-, *s*-process elements was made by Yushchenko & Gopka (1996b).

The abundance pattern in Procyon consist of Li, Be, B, C, N, O, Na, Mg, Al, Si, S, K, Ca, Sc, Ti, V, Cr, Mn, Fe, Co, Ni and 34 *r*-, *s*-process elements. The abundances of 55 elements in the atmosphere of Procyon A are known and it is one of the highest level of completeness of stellar elemental abundance distributions (Sun - 72 elements).

The detailed abundance pattern in Procyon can help to answer Steffen's (1985) question: whether the white dwarf companion has contaminated the atmosphere of Procyon A with nuclear processed matter when loosing (explosively ?) a great fraction of it's mass. The elemental abundance distribution for Procyon show that the abundances of majority of the heavy elements are near Solar system values ($\pm$0.1 dex).

We must to mention that all but few abundance determinations for Procyon were made with Kurucz (1979) models. Yushchenko & Gopka (1996b) showed that new grid of Kurucz (1992) models may led to small overabundance (near +0.1 dex) of heavy elements in the atmosphere of Procyon A, but new investigation of atmospheric parameters is necessary.

Only two of the heavy elements show large discrepancies from Solar system values. These are Se, Te. The underabundance of Se (-2.4 dex) were found by Farragiana et al. (1986) from 1 line in IUE spectrum of Procyon and must be confirmed by high signal to noise observations and determinations of $\log gf$ for this line.

The overabundance of Te (+0.8 dex) in the atmosphere of Procyon A with respect to the meteoritic value was found by Gopka et al. (1995) using weak line λ 3175.147 Å. Second line of Te λ 2142.822 Å confirmed this result (Yushchenko & Gopka, 1996b).

The location of tellurium (Z=52) on the plot of relative abundances of *r*-, *s*-, *p*-process nuclei as a function of their mass number at the maximum of r-process can partly explain it's overabundance. But second r-process element, thorium show solar abundance.

The structure of above mentioned plot of relative abundances was explained by Burbidge et al. (1957). Another explanation of maximum of the plot of relative abundances near Te and Xe was proposed by Selinov & Frenkel (1950), Selinov (1958, 1964): the decay of superheavy nuclei. Kramarovskij & Chechev (1987) pointed that Selinov's prediction was confirmed by Lougheed et al. (1985). Lougheed et al. (1985) found decay $^{260}_{101}Md = ^{132}_{50}Sn + ^{128}_{51}Sb$. If nucleosynthesis in r-process can reach the region of superheavy β-stable nuclei with Z=100-114, the results of decay of these nuclei can strongly influence on the structure of the plot of relative abundances in the region near mass number A=130.

New measurements of oscillator strengths and observations of Procyon with better signal to noise ratio and high spectral resolution in the UV spectral region are desired to obtain a more precise result.

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