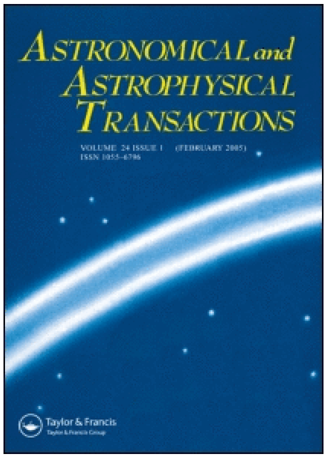

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ABUNDANCES OF RHENIUM AND TELLURIUM IN PROCYON

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A comparison between the synthetic spectrum of the Procyon photosphere and a high quality observed spectrum (Griffin's Atlas) permitted us to identify one line of rhenium and one line of tellurium in the blue part of the observed spectrum. The abundances of these elements in the solar atmosphere are unknown. The abundances of rhenium and tellurium in the photosphere of Procyon were found using the spectrum synthesis method: log $A(Re)$ = 0.40, log $A(Te)$ = 3.04 (in the scale log $A(H)$ = 12.00).

KEY WORDS **r-, s-process elements – stellar abundances**

1 INTRODUCTION

The investigations of abundances of r-, s-process elements in the atmospheres of stars of different types are important for solving a number of astrophysical problems. The present study is aimed at the determination of the abundance of rhenium and tellurium in the photosphere of Procyon. Procyon (α CMi), one of the brightest F-type stars, is exceptionally well studied. A high resolution spectrum, from 3140 to 7470Å, was published by Griffin & Griffin (1979). A brief review of papers dealing with chemical abundances in the photosphere of Procyon can be found in Yushchenko & Gopka (1994) and in Gopka & Yushchenko (1995).

Abundances of rhenium and tellurium are unknown even for the solar photosphere (Grevesse & Noels, 1993). We are not aware of papers dealing with rhenium and tellurium lines in stellar spectra. The last version of the compilation of published oscillator strengths for heavy elements, the file BELLHEAVY (Kurucz, 1992, 1993), contain 11 lines of Te I, 772 lines of Re I, and 47 lines of Re II with known oscillator strengths. The majority of these oscillator strengths were measured by Corliss & Bozman (1962).

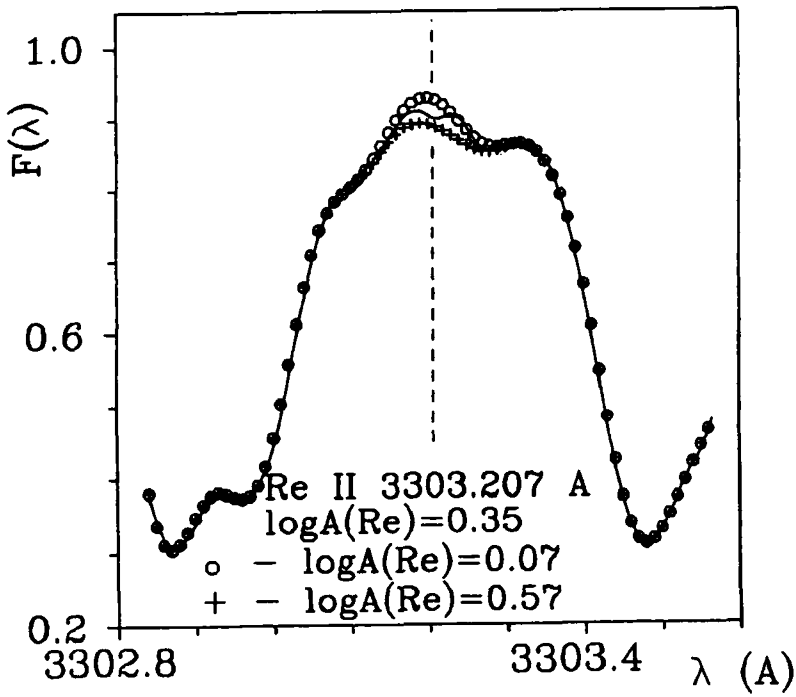

Figure 1 The spectrum of Procyon near the Re II λ3303.207Å line. The solid line is observed spectrum; circles, the synthetic spectrum calculated for log $A(Re)$ = 0.07; crosses, the synthetic spectrum calculated for log $A(Re)$ = 0.57.

2 THE METHOD

We used digitized version of the spectral atlas of Procyon (Griffin & Griffin, 1979). The synthetic spectra were calculated for a Procyon type star within the wavelength range of 3140–7470Å with 0.025Å intervals. Software developed by Tsymbal (1992) and Gadun & Sheminova (1988) was used.

The line list consisted of one of the versions of Kurucz's computations for iron group elements (1991) and of the files BELLLIGHT, BELLHEAVY (Kurucz, 1992, 1993). Lines of some atoms and ions are absent in the files BELLLIGHT, BELLHEAVY (for example, those of He, C I, C II). The lines of these species were selected from Kurucz (1989).

We adopted the parameters of Procyon's model atmosphere derived by Steffen (1985): $T_{\rm eff}$ = 6750 K, log g = 4.04, $v_{\rm turb}$ = 2.1 km/s. The synthetic spectrum in the wide spectral region was used only for identification: the unblended and slightly blended absorption lines of rhenium and tellurium were selected from calculations. Each line selected from the computed list was investigated in the observed spectrum. For these purposes we developed software for displaying observed and synthetic spectra simultaneously on the screen of an IBM PC, in any

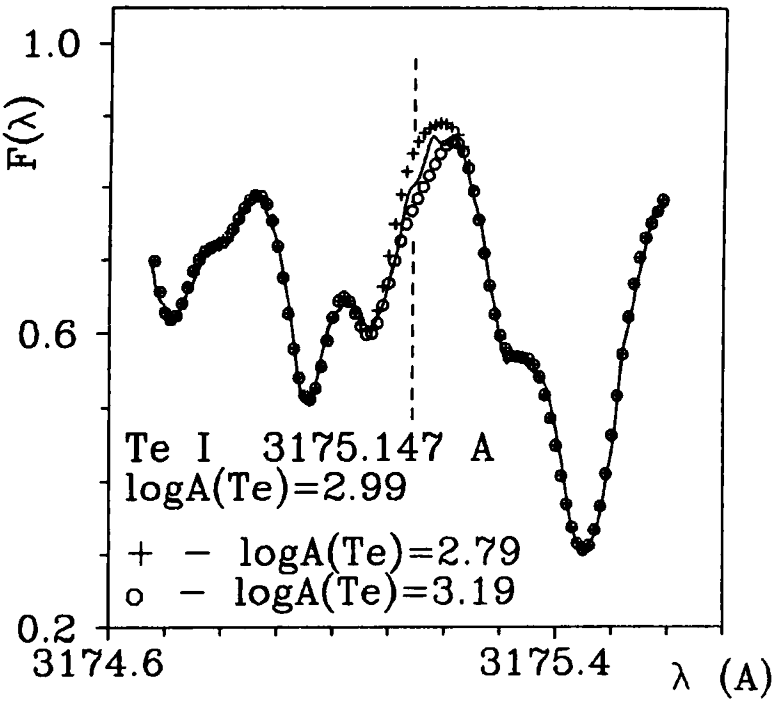

Figure 2 The spectrum of Procyon near the Te I λ3175.147Å line. The solid line is observed spectrum; circles, the synthetic spectrum calculated for log $A(Te)$ = 3.19; crosses, the synthetic spectrum calculated for log $A(Te)$ = 2.79.

desired scale. In such a way, the possibility of erroneous identification was excluded.

The selected lines were analyzed by the method of spectrum synthesis. Unidentified lines were replaced by artificial lines of iron. The observed spectra were smoothed by the Gauss filter with 0.015Å width. The synthetic spectra were broadened by Gaussian type macroturbulence with 3.5 km/s velocity. The instrumental profile was assumed to be Gaussian, with 0.02Å width. Effects of rotation were not completely accounted for. The possible errors of the fitting procedure can be estimated from Figures 1 and 2, where the synthesized profiles are shown for two cases (over- and under-abundant by 0.2–0.25 dex with respect to the adopted value of abundance).

3 RESULTS AND CONCLUSIONS

One line of rhenium and one line of tellurium were found in the observed spectrum of Procyon. Figures 1 and 2 show the observed lines of rhenium and tellurium in the Procyon spectrum and their fitting by synthetic spectra.

The value of rhenium abundance in the photosphere of Procyon is log $A(Re) = 0.35$. The value of tellurium abundance in the photosphere of Procyon is log $A(Te) = 2.99$.

Steffen (1985) found that a correction of about +10% in necessary for equivalent widths of weak lines obtained from the Procyon Atlas. If we take this correction into account, larger log A values (by about +0.05 dex) will be obtained. The final abundances in the Procyon atmosphere are 0.40 for rhenium and 3.04 for tellurium.

The meteoritic abundance of rhenium is 0.27 (Anders & Grevesse, 1989). The over-abundance of rhenium in Procyon's atmosphere with respect to the meteoric value is +0.13 dex.

The meteoritic abundance of tellurium is 2.24 (Anders & Grevesse, 1989). The over-abundance of tellurium in Procyon's atmosphere with respect to the meteoritic value is +0.80 dex.

New measurements of oscillator strengths and observations of Procyon with better signal-to-noise ratio are desired to obtain a more accurate result.

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