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Fine Analysis of Pulsating CP Stars

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Abstract. We present fine analysis results for roAp and λ Boo stars.

1. Introduction: goals and methods

Temperature and pressure structure of cool pulsating CP stars have an important role as boundary conditions for pulsation models. We perform a fine analysis of pulsating CP stars in order to determine the atmospheric structure with special respect to the differences between pulsating and *non* pulsating stars. In addition, possibly existing characteristic abundance patterns, which could be used as a discrimination between pulsating and *non* pulsating stars, are studied.

To achieve these goals we first perform a fine analysis for various cool CP2 stars based on line profile fitting of synthetic spectra with the codes SYNTH and ROTATE and on equivalent width calculations using WIDTH9 (Kurucz 1993, modified by V. Tsymbal). The results obtained are basic stellar parameters, abundance patterns, and estimations of the magnetic surface fields. These results will be compared with 'similar' stars which do *not pulsate* according to state-of-the-art observing techniques. As a first step towards self consistency, the initial fine analysis, which is based on model atmospheres from ATLAS9 (Kurucz 1993) with scaled solar abundances, will be repeated based on specific opacity distribution functions and model atmospheres for these stars.

2. Observations and results

We use high resolution spectra for wavelength regions in the visual and near infrared. Details will be given in publications related to the particular objects.

Up to now we have been working on the fine analysis of four roAp stars based on solar scaled model atmospheres. The analysis of α Cir and BI Mic has been finished. For γ Equ and the line variable DO Eri we have preliminary results. Table 1 gives the relative abundance for the investigated elements. Note the characteristic under-abundance for CNO, the over-abundance of rare earth elements (REE, La to Lu), and the complex pattern for iron peak elements. The most interesting results are the indication from surface gravity that BI Mic is still on the ZAMS and the pronounced over-abundance of Co for all roAp stars. For DO Eri, Co joins the REE in their variation in phase with the magnetic field,

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whereas Mg, Fe, and Ni show an anti-phase variation. The strikingly different abundance pattern of the pulsating λ Boo star 29 Cyg is not very surprising. For comparison the solar abundances according to Anders & Grevesse (1989) are also given in the table.

Table 1. Element abundances $\log(N_x/N_{tot})$ and basic parameters

	roAp BI Mic HD 203932	roAp α Cir HD 128898	roAp γ Equ HD 201601	roAp DO Eri HD 24712	roAp DO Eri HD 24712	λ Boo 29 Cyg HD 192640	Sun -
C	-4.09	-4.00	-4.40	-	-	-3.48	-3.48
N	-4.60	-4.40	-4.50	-	-	-	-3.99
O	-3.81	-3.80	-3.80	-	-	-	-3.11
Na	-5.76	-5.90	-5.90	-	-	-	-5.71
Mg	-4.18	-4.46	-	-4.50	-5.60	-6.26	-4.46
Al	-5.28	-	-	-	-	-	-5.57
Si	-4.37	-4.20	-4.05	-4.70	-4.70	-	-4.49
Ca	-5.09	-5.15	-5.40	-5.39	-5.13	-6.98	-5.68
Sc	-9.40	-9.80	-9.80	-	-	-10.74	-8.94
Ti	-6.71	-6.87	-6.80	-7.06	-7.29	-8.60	-7.05
V	-7.24	-7.65	-7.65	-	-	-	-8.04
Cr	-5.45	-5.55	-5.75	-5.85	-5.70	-8.27	-6.37
Mn	-6.18	-6.00	-6.25	-6.69	-7.11	-6.65	-6.65
Fe	-4.23	-4.50	-4.50	-4.86	-5.07	-6.37	-4.37
Co	-5.83	-5.50	-6.00	-5.94	-5.58	-	-7.12
Ni	-5.73	-6.15	-6.15	-6.24	-6.57	-	-5.79
Sr	-7.47	-7.25	-7.25	-	-	-10.84	-9.14
Y	-8.04	-8.50	-8.33	-8.23	-8.06	-	-9.80
Zr	-8.90	-9.00	-9.10	-	-	-	-9.44
Ba	-9.20	-10.30	-9.10	-9.13	-9.27	-11.41	-9.91
La	-9.72	-10.32	-	-10.14	-9.55	-	-10.82
Ce	-9.13	-9.40	-9.40	-9.15	-8.82	-	-10.49
Pr	-11.20	-10.40	-10.50	-10.04	-9.51	-	-11.33
Nd	-9.24	-9.30	-9.22	-9.21	-8.59	-	-10.54
Sm	-9.52	-9.50	-9.70	-9.65	-8.98	-	-11.04
Eu	-8.92	-9.40	-9.20	-9.80	-9.20	-	-11.53
Gd	-9.28	-9.45	-9.25	-9.26	-8.80	-	-10.92
Dy	-	-10.00	-9.65	-9.59	-9.13	-	-10.94
Er	-9.70	-	-	-9.84	-9.71	-	-11.11
$T_{\rm eff}$ [K]	7750	7900	7750	7250	7250	7800	5777
log(g)	4.6	4.2	< 4.5	4.3	4.3	4.0	4.44
B [kG]	-	~ 1.5	-	+0.4*min*	+1.5*max*	-	-
$v \sin(i)$	12.5	12.5	< 4.5	< 5	< 5	80	-
v_{micro}	< 0.5	1.5	~ 1	1.0	1.0	3.0	1.5

The typical intrinsic errors of the abundances range from 0.1 to 0.3, in some cases to 0.5 (depending on the number of lines). Errors for $T_{\rm eff}$ are less than 200 K, for $\log(g)$ less than 0.15. Velocities are given in [km s^{-1}] with relative errors of about 10% .

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