Transactions IAU, Volume XXVIIB
Proc. XXVII IAU General Assembly, August 2009
Ian F. Corbett, ed.

doi:10.1017/S1743921310005028

DIVISION IV STARS
(Etoiles)

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DIVISION WORKING GROUPS

Massive Stars
Abundances in red giants

INTER DIVISION WORKING GROUPS

Division IV-V WG	**Active B stars**
Division IV-V WG	**Ap and related stars**
Division IV-V WG	**Standard stars**

SCIENCE AND BUSINESS MEETING, 7 August 2006

1. Introduction

During the General Assembly in Rio de Janeiro the Division IV meeting, and the meetings of the participating working groups and commissions, were held on thursday 6th (session 1 and 2) and friday 7th (sessions 1, 2, 3, 4).
The meeting of the Division IV took place in one 1.5 hour session during the afternoon of 7 August 2009 and was attended by about 50 participants. Most of this meeting was devoted to a scientific session "**The Solar Composition**".
This scientific session was followed by a short business meeting where the composition of the new board of the Division for the triennium 2009-2012 was announced.

2. The solar composition

The chemical composition of the Sun is one of the most important yardsticks in astronomy with implications for almost all fields from planetary science, helioseismology, to the high-redshift Universe. It is the reference for the determination of stellar abundances. Recently with the introduction of new 3D atmospheric models the chemical composition of the Sun has been revised and it is a good time to survey the new results, and the new problems, in this field of research.

The three following talks were given and are available (pdf format) on the WEB site of the Div IV:

http://www.iau.org/science/scientific_bodies/divisions/IV/ and click on "Division WEB page" (documents).

Marc Pinsonneault (Ohio State University, Department of Astronomy, USA)
Absolute Solar Abundances from Helioseismology

Helioseismology permits the study of internal solar structure in exquisite detail, and in particular the internal temperature gradient. The temperature gradient in the core in turn depends on the opacity, which also depends on the composition. This opens the possibility of using stellar interiors studies to constrain the absolute solar abundances. Scalar solar features (in particular, the solar surface helium abundance and convection zone depth) are also sensitive to the solar abundances; the former is strongly affected by iron group element abundances because they retain electrons to high temperatures, and the latter by both iron and lighter metals such as CNONe. A two parameter abundance solution can be inferred from the scalar properties, with the relative heavier element abundance set to the meteoritic values and the lighter one set by photospheric abundance ratios. The scalar constraints alone do not distinguish between C, N, O, and Ne as the opacity sources, but a solution with high Ne and low CNO can be ruled out by the strong imprint of the Ne/O ratio on the sound speed profile in the solar core. The seismic solution for the solar mixture is similar to that of Grevesse & Sauval 1998, with modestly enhanced Ne/O. The inferred oxygen is compatible with the recent Caffau *et al.* 2008 value but not with the lower Asplund *et al.* 2004 oxygen. Convective overshoot may reduce the inferred seismic oxygen by a small amount, but not enough to bring the values into agreement with the lower scale. Independent seismic tests of the bulk metal abundance in the convection zone, based upon the equation of state, also favor a higher absolute oxygen abundance consistent with that derived from opacity calculations. Experimental efforts in progress will provide valuable constraints on the theoretical opacities for solar interiors conditions.

Martin Asplund (Max-Planck-Institut für Astrophysik, D-85741 Garching, Germany)
New determination of the abundances in the solar atmosphere

The solar chemical composition is an important ingredient in our understanding of the formation, structure and evolution of both the Sun and our solar system. Furthermore, it is an essential reference standard against which the elemental contents of other astronomical objects are compared. In this talk I evaluate the current understanding of the solar photospheric composition. In particular, a re-determination of the abundances of nearly all available elements is presented (Asplund, Grevesse, Sauval & Scott, 2009, ARAA, 47, 481).

The results are based on a realistic new 3-dimensional (3D), time-dependent hydrodynamical model of the solar atmosphere, which fulfills all key observational tests. We have carefully considered the atomic input data and selection of spectral lines, and accounted for departures from LTE whenever possible. The end result is a comprehensive and homogeneous compilation of the solar elemental abundances.

Particularly noteworthy findings are significantly lower abundances of carbon, nitrogen, oxygen and neon compared with the widely-used values of a decade ago. The new solar chemical composition is supported by a high degree of internal consistency between available abundance indicators, and by agreement with values obtained in the solar neighborhood and from the most pristine meteorites. There is, however, a stark conflict with standard models of the solar interior according to helioseismology, a discrepancy that has yet to find a satisfactory resolution.

Hans-Günter Ludwig (CIFIST, GEPI, Observatoire de Paris, 92195 Meudon Cedex, France)
Solar abundances from spectroscopy: what we know and what we need

We determined solar photospheric abundances from optical and near-infrared spectroscopy. The work was conducted in the broader context of spectroscopic studies in the CIFIST (Cosmological Impact of the FIrst STars) team hosted by Paris Observatory. The project constitutes a determination independent of other work applying several "self-made" tools: the 3D radiation

https://doi.org/10.1017/S1743921310005028 Published online by Cambridge University Press

hydrodynamics code CO^{5}BOLD, the 3D spectral synthesis code Linfor3D, the 3D NLTE code NLTE3D, and a 1D stellar atmosphere code called LHD sharing the micro-physics and in part numerics with CO^{5}BOLD. Also the standard 1D codes ATLAS, MARCS, and the Kiel NLTE code were applied. We completed the work on 12 elements (Li, C, N, O, P, S, Eu, Hf, Th, K, Fe, Os) using lines of atomic species. At the moment 14 people are involved in the project headed by E. Caffau bringing in all necessary expertise to handle code developments and the data analysis.

The main result might be summarized by the overall solar mass fraction of metals of $Z = 0.0154$; for the important CNO elements we obtained A(C)=8.50 ± 0.11, A(N)=7.86 ± 0.12, and A(O)=8.76 ± 0.07 on the usual spectroscopic scale A(H)=12. We took a rather conservative stand when estimating the uncertainties; in the case of N and C we quote the dispersion among abundances from individual lines, in the case of O it is a combination of individual errors and systematics due to NLTE effects. Our findings may be contrasted with the results of Asplund and collaborators who also applied 3D hydrodynamical model atmospheres in the abundance determination. While by standards of stellar spectroscopy the differences are modest (about 15%) they appear surprising when considering that all groups are basically using the same observational material and apply the same atomic parameters. What are the reasons for the sizable systematic differences?

Sources of systematic errors are related to i) line selection and blending problems; ii) the accuracy to which equivalent widths can be measured, here in particular the continuum placement and line profile shapes fitted to observations; iii) the accuracy of the 3D atmosphere models and spectral synthesis codes; iv) for NLTE calculations the efficiency of collisions with neutral hydrogen atoms; v) not-understood differences among high-quality solar atlases.

3D models atmosphere now provide an excellent match to the observed center-to-limb variation (including line blocking) of the solar radiation field. This indicates that the model's thermal structure closely resembles the actual solar conditions. This remains to be also shown for higher photospheric layers. Future analysis work would greatly benefit from a highest quality (signal-to-noise, correction for telluric absorption, wavelength calibration) solar atlas for several limb angles. Moreover, there remains a need for accurate atomic data: wavelength, oscillator strength, and particularly collisional cross sections needed in NLTE calculations.

3. The new Organising Committee members for the triennium 2009-2012

The election of a new Vice President for the Division had been organised before the General Assembly.
To chose the candidates we proceeded as it had been done last time: the candidates were the five current Presidents of the participating commissions (each was contacted with an invitation to be a candidate). In the case where the current President declined, the past president was invited to be candidate.
The electorate was defined as all members of the Division. More than 1000 e-mails were sent to those members (about 60 "could not been delivered"). 246 votes were received and Francesca d'Antona was elected as the new Vice President. (She will becomes President of the Division after the next General Assembly in China.)
The new board is formed by the President, the Vice President, the Past President of the Division and the five new Presidents of the participating Commissions. The new organising Committee of the Division IV for the triennium 2009-2012 is thus:
Christopher Corbally (President, Vatican), F. d'Antona (Vice President, Italy), M. Spite (Past President, France), J.A. Durantez Docobo (Comm 26, Spain), N.E. Piskunov (Comm 29, Sweden), C. Charbonnel (Comm 35, Switzerland), M. Asplund (Comm 36, Germany), R.O. Gray (Comm 45, USA)

The President of the division congratulates the new Vice President and the new SOC members on their election and she thanks the members of the current Organizing Committee of the Div IV for their very active work in ranking a large number of Symposia proposals, during the past triennium...

Monique Spite
President of the Division