Division G Working Group: Ap and Related Stars

Annual Report 2022-23

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Introduction

The purpose of the Working Group on Ap and Related Stars (ApWG) is to promote and facilitate research about stars in the spectral type range from mid-B to early F that exhibit surface chemical peculiarities and related phenomena. To this effect, the ApWG publishes a newsletter and distributes it to its members and the more than 70 ApWG members actively contribute to the organization of international scientific meetings. The Ap and related stars represents an active field of research, which takes full advantage of the new opportunities opened by the unprecedented data delivered by the space- and ground-based instruments that came into operations in the past few years. Some of the resulting scientific highlights are presented in this report.

Scientific Highlights

Over the past year in excess of 50 research papers have been published by members of the ApWG. Here we present only a short selection of some of the scientific highlights during the past year.

Keszthelyi et al. (MNRAS, 517, 2028, 2022) published a systematic study of the effects of the magnetic fields on the stellar structure and evolution and provided grids of evolutionary tracks at three different metallicities. The magnetic fields influence the surface abundances via modified mixing and rotational velocities due to magnetic braking.

A paper by Owocki et al. (MNRAS, 513, 1449, 2022) studied the effect of centrifugal breakout as a mechanism of acceleration of electrons that power the radio emission of magnetic stars. The derived theoretical scaling matches well the empirical trends of observed radio luminosities of magnetic stars.

Members of the ApWG have obtained high-resolution and high SNR Stokes I and V spectra for more than 20 chemically peculiar stars (HgMn and roAp) have been obtained with ESPaDOnS at the CFHT during 2022 and this observational project will continue during the 2023. Mathys et al. (A&A, 670, A72, 2023) reported the results for HD213258 which has a very long stellar rotation period of 50 years, derived from the analysis of the mean longitudinal magnetic field values measured using the ESPaDOnS spectra and those found in previous publications. They confirmed that HD213258 is a roAp star with the pulsation periods found to be around 7.58 minutes. The mean radial velocity (in absolute value) of this object is extremely high and shows low amplitude variations. This means that the star is a single-line spectroscopic binary with most probably a brown dwarf as the secondary. It is known to be an astrometric binary as well. Considering the aforementioned properties, HD213258 is one of the most interesting candidates for detailed study of extremely slow rotation and abundance peculiarities in Ap stars.

During the period 2022/23 members of the ApWG have continued a series of detailed studies of the surface structure of magnetic chemically peculiar stars using techniques of

Doppler and Zeeman-Doppler imaging. These methods allow one to reconstruct surface maps of chemical spots and magnetic field vector from high-resolution time series spectropolarimetric observations. Among targets recently studied by Kochukhov et al. (2022, MNRAS, 510, 5821), with this approach was the bright Ap star φ Dra, which was also observed by the space-based TESS experiment nearly continuously for one year. Analysis of the space photometry (light time travel effect) and ground-based spectroscopy (radial velocities) revealed φ Dra to be a long-period single-lined spectroscopic binary. Its chemical maps showed an enhancement of Cr, Fe and Si in a series of spots encircling intersections of the magnetic and rotational equators. Another recent ZDI study of the star 45 Her (Kochukhov et al. 2023, MNRAS, 521, 3480) mapped one of the weakest surface magnetic fields known in an Ap star. Despite sub-100 G average field strength, this star features well-developed surface chemical inhomogeneities with contrasts of several dex. The existence of such weak magnetic field is at odds with the predictions of field (in)stability by several theoretical studies.

A peculiar Newsletter

A peculiar Newsletter (ApN), the electronic newsletter of the ApWG, is the product of this group that is most valued by its members. Its contents include lists of recent publications in the field of Ap and related stars and announcements of interest for the scientific community working in that field (including conference announcements, job ads, and obituaries). It also serves as a forum for discussions among members of this community. In summary, since its foundation in 1978 (on paper, at the time), it has been an essential channel of communication and of reference for the scientists interested in Ap and related stars. The ApN is hosted on a server at the Leibniz Institute for Astrophysics Potsdam (https://apn.aip.de/), under the lead of the Editor, Dr Silva Järvinen.

Scientific meetings

In October 2022, members of the ApWG organised an on-line meeting of the *Eastern Association for Stellar Astrophysics* (EASA), where phenomenon of CP stars was discussed in many presentations. The next, in-person, meeting of EASA is planned for April 24-25, 2023 at the Mt. Allison University, Canada.

Members of the ApWG have had proposals accepted for scientific meetings at the forthcoming EAS 2023 meeting in Kraków, Poland, 10-14 July 2023; Symposium *S5 From stellar variability to stellar structure and evolution* and Special Session SS21 *Unveiling the secrets of chemically peculiar stars.*

There also continues to be regular meetings of the MOBSTER (Magnetic OB[A] Stars with TESS: probing their Evolutionary and Rotational properties) Collaboration (https://mobster-collab.com/) who are using TESS photometry and ground-based facilities to improve our understanding of magnetic stars.