



SPANISHUVASTRONOMY.IAA.ES

Workshop for the **WSO** Working Group and Spanish UV Astronomy

Instituto de Astrofísica de Andalucía, IAA-CSIC
Granada, June 30 - July 1, 2014



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Science Drivers

Since the times of the International Ultraviolet Explorer (*IUE*), the Spanish Astronomy has been involved in UV observations, resulting in a strong UV community. To bring together the UV-based astrophysical research carried out in Spain and to discuss the present and future of the field, we plan a "*WSO* Working Group and Spanish UV Astronomy" workshop. The calibrations programs and science to be carried out with *ISSIS* on board the World Space Observatory-Ultraviolet (*WSO-UV*), a 170 cm UV space telescope to be launched soon, will be particularly examined.

Topics:

UV instrumentation.

- *WSO-UV* Project
- Space missions
- Ground based UV observations

Stellar physics and evolution.

- Star formation
- Young stars
- Massive stars
- Compact objects
- Close binaries

Milky Way and galaxies.

- Interstellar and intergalactic medium
- Galactic astronomy
- Galaxies
- Stellar populations
- Cosmology

Planetary atmospheres.

- Solar system
- Exoplanets

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Participants:

Blay, Pere	Universitat de València (UV)	Spain
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Vílchez, José M.	Instituto de Astrofísica de Andalucía (IAA-CSIC)	Spain

Session 1Chairman *Martín A. Guerrero***UV instrumentation***WSO-UV Project, space missions, ground based UV observations*

June 30

**Welcome message from the Science Organizing Committee chairman
Martín A. Guerrero**

10:30 – 10:40

**Estatus del proyecto *WSO-UV* y programa científico
Ana Inés Gómez de Castro**

10:40 – 11:30

Revisión del estado del proyecto *WSO-UV* y de la participación española en él. Descripción del caso científico para *WSO-UV* e *ISSIS*.

Invited talk

30 min

**The Imaging and Slitless Spectroscopy Instrument for Surveys (*ISSIS*) for the World
Space Observatory-Ultraviolet (*WSO-UV*)**

**Gracia Belén Perea Abarca, Ana I Gómez de Castro, Belén Perea G., Nestor Sanchez,
and Javier López-Santiago**

12:00 – 12:15

The *WSO-UV* is an international project developed to guarantee access to the ultraviolet (UV) range in the post Hubble Space Telescope era. This 170 cm space telescope has been conceived as a multipurpose observatory carrying instrumentation for astronomical imaging and spectroscopy.

Far UV coatings for astrophysics and solar physics applications

Juan Larruquert, Luis Rodríguez-de Marcos, José A. Méndez, and José A. Aznárez,

12:15 – 12:30

GOLD's research is devoted to the development of novel coatings for the far (100-200 nm, FUV) and the extreme (40-100 nm, EUV) ultraviolet, and it is mostly focused on applications for space optics. Developments include high reflectance mirrors, narrowband coatings, filters, and polarizers. GOLD covers all stages from multilayer design and material optical characterization to multilayer deposition and FUV-EUV optical measurements. These stages are completed with the capacity to coat relatively large substrates in clean-room conditions to meet space requirements. GOLD has been involved on filters for *WSO*'s imaging instrument for over a decade. In the presentation, an overview of GOLD's capacities to prepare and characterize FUV filters will be given, along with a summary of coatings that are relevant to space optics.

Session 2***Stellar physics and evolution***
Star formation and young stars**June 30****The size of stellar coronae from flaring events**
Javier López Santiago**12:30 – 13:00**

The extension of the corona of stars is under discussion in the Astrophysical community. For analogy with the Sun, some researchers argue that stellar coronae are compact and that they do not extend beyond one stellar radius. However, the comparison of flaring loop observational parameters in very active stars with MHD models suggests that some loops may exceed several stellar radius in length. The MHD approach involves a number of assumptions that are controversial. In particular, one needs to assume the event takes place in a single loop instead of an arcade, what is sometimes observed in the Sun. Therefore, at least for some cases, the MHD model may not be adequate for determining the loop's length. In those cases, using semi-empirical scaling laws seem to be a better approach. However, the use of scaling laws results in very strong magnetic fields inside the loops, what is difficult to justify from the Physics of the trapped plasma. By contrast, magnetic field strengths determined from MHD models are in agreement with those observed in the Sun. Thus, to study the extension of the stellar corona one may use MHD modeling and obtain long loops with magnetic field strength similar to the solar case, or semi-empirical scaling laws and obtain small loops as in the Sun but with very strong magnetic fields inside. To disentangle this controversy, new independent measurements of the loop length are needed. I present a different approach for determining the length of flaring loops based on the oscillating nature of the loops after strong flares.

Invited talk**Red and brown dwarfs in the ultraviolet**
José A. Caballero**13:00 – 13:30**

I will review what *ISSIS/WSO-UV* data will tell on early M- and ultracool dwarfs in the solar neighbourhood and young brown dwarfs in star-forming regions. The two main *ISSIS* outcomes on this topic may be the identification of bona fide substellar objects at the bottom of the IMF in clusters because of their UV excess emission and the selection of the least active M dwarfs for the search of habitable planets. Although not specifically designed for that, *ISSIS* will also provide information on multiplicity and the origin of activity in low-mass close, resolved binaries.

Invited talk

Session 2 (continuation)***Stellar physics and evolution***
Star formation and young stars

June 30

Young Stellar Object candidates toward the Orion region selected from *GALEX*
Néstor Sánchez

13:30 – 13:45

We analyze 359 ultraviolet tiles from the All Sky Survey (AIS) of the space mission *GALEX* covering roughly 400 square degrees toward the Orion star-forming region. There is a total of 1,555,174 ultraviolet sources that were cross-matched with the 2MASS, UCAC4 and *WISE* catalogs to produce a list of 290,717 reliable sources with a wide range of photometric information. Using different color selection criteria we identify 120 Young Stellar Object candidates having ultraviolet and infrared excesses, of which 85 are new. We discuss the spatial distribution, the Spectral Energy Distributions and other physical properties of these stars.

Reddening determination and model fitting of early type stars observed by *WSO*
Carmen Morales, F. Llorente de Andrés, and C. Rodrigo Blanco, E. Solano Márquez & Amelia Bayo

13:45 – 14:00

The interstellar extinction law presents in the UV a very strong feature at 2175 Å which can be used to estimate the $E(B-V)$ of any stellar object with a precision similar to the one obtained by traditional methods in the visible but without any previous knowledge of its spectral type. We show our results for B stars. With the observations from the World Space Observatory UV Spectrographs (WUVS) and the Imaging and Slitless Spectroscopy Instrument for Surveys (ISSIS), we will be able to estimate color excesses for all the stars observed by them. As well, with the VO SED Analyzer (VOSA) at the Spanish Virtual Observatory, we will be able to fit model stellar atmospheres to the dereddened stellar spectra observed by *WSO*, with a very long wavelength baseline, from the ultraviolet to the infrared. We show our results of VOSA model fitting to B stars observed by *IUE* and, in particular, to blue straggler stars.



90 min

Session 3

Chairman Ana Inés Gómez de Castro

Stellar physics and evolution***Massive stars, compact objects and close binaries***

June 30

Magnetospheric properties of T Tauri stars through CII], FeII] and SiII] ultraviolet emission lines
Fátima López Martínez

15:30 – 15:45

The CII], FeII] and SiII] semiforbidden lines are in the range 2320-2340 Å. These emission lines provide a reliable optically thin tracer for measurement of the plasma properties in the magnetosphere of T Tauri stars (TTSs). In this work these lines are analyzed in a sample of 20 TTSs using 30 medium resolution spectra from the Hubble Space Telescope (HST) data archive. We developed an algorithm in IDL making use of theoretical values of emission line ratios to fit the observed spectra. The procedure provides the properties of the emission region, such as electron density, temperature and line broadening. For most of the stars in the sample we obtain temperatures from 104.1 to 104.5 K and densities from 108 to 1012 cm⁻³. These stars have suprathermal line broadening (between 35 and 165 km s⁻¹), except TW Hya and CY Tau with thermal line broadening. Both C II] line luminosity and broadening are found to correlate with the accretion rate. Line emission seems to be produced in the magnetospheric accretion flow, close to the disk. Three stars (DG Tau, RY Tau and FU Ori) display blueshifted line centroids indicating that the line emission in these stars could be dominated by the outflow.

Winds of metal-poor OB stars: prospects for the *WSO* and *ISSIS*
Miriam García García

15:45 – 16:15

Until the past decade, the SMC stood a frontier both as maximum distance and metallicity lower-limit for systematic studies of OB-stars. In the current race to break this frontier and reach metallicity conditions closer to the First Stars the information from UV spectroscopy is usually overlooked, mostly because of feasibility issues. We present new results from *HST*-COS UV spectroscopy in IC1613 (~1/10 Z_⊙) that have proved once again the important role of UV spectroscopy to characterize blue massive stars and their winds. We will also discuss the important role that the *WSO* instrumentation can play in characterizing the physics of metal-poor massive stars, key to the high redshift Universe.

[Invited talk](#)

OB stars models: the role of the UV region
Artemio Herrero

16:15 – 16:45

We present a review of how stellar parameters of OB stars are determined, and the primary role that the UV plays in this determination. We emphasize why the UV wavelength region is crucial for the proper modelling of these stars, and for the solution of some present-day problems.

[Invited talk](#)

Session 3 (continuation)***Stellar physics and evolution***
Massive stars, compact objects and close binaries**June 30****Revisiting the UV-optical-IR extinction law**
Jesús Maíz**17:15 – 17:45**

Twenty five years after its publication, the Cardelli et al. (1989) family of extinction laws is still widely used. Nevertheless, it has outlived its usefulness, especially if one is interested in using it with precision (spectro) photometry: its NIR exponent does not agree with recent works, the functional form in the optical is wrong, the UV-to-IR correlation with a single parameter is in question, and its application in the UV outside the Galaxy is limited. I will discuss recent and future improvements on the extinction laws across the IR-to-UV range, paying special attention to the information that new UV data can provide that is not already buried in the IUE archive.

*Invited talk***Tracking mass-transfer processes: the case of High Mass X-Ray Binary Systems**
Pere Blay**17:45 – 18:00**

The physical process leading to the intense X-ray emission seen in High Mass X-ray Binary Systems was only understood as a mass transfer process with the advent of modern UV astrophysics. Only a multiwaveband approach helps to disentangle the properties of these sources and the UV range plays a crucial role in this task. The UV observational footprints left by the mass transfer and accretion processes in the spectra from HMXRBs will be reviewed. The important contribution that we expect from *WSO-UV* to this field will be discussed.

Gaia data is coming
Jordi Torra**18:00 – 18:30***Invited talk*

Session 4

Chairman Jesús Maíz

Milky Way and galaxies*Interstellar and intergalactic medium, Galactic astronomy and galaxies*

July 1

Fullerenes, PAHs, Amino Acids and High Energy Astrophysics
Susana Iglesias-Groth

09:00 – 09:30

Theoretical, observational and laboratory work on the new form of carbon known as fullerenes and its hydrogenated forms (fulleranes) are reviewed. These molecules can be responsible of diffuse interstellar bands, the UV bump, a major feature in the extinction curves measured in many lines of sight in our Galaxy and other galaxies and the anomalous microwave emission detected in several regions of star formation in molecular clouds and HII regions.

Invited talk

Molecular UV spectroscopy in the Diffuse Interstellar Medium: from H₂ to PAHs
José Cernicharo

09:30 – 10:00

The UV domain of the electromagnetic spectrum is particularly well adapted to study the diffuse interstellar medium and photodissociation regions associated to illuminated molecular clouds edges. I will discuss the science that the WSO instruments could address in the context of the study of small molecules such as H₂, CO, C₂H₂, HCN, etc, and of very large complex molecules, PAH, fullerenes, and carbon clusters. The comparison and complementarity of these observations with those provided by other instruments at other wavelengths will be also addressed.

Invited talk

HST STIS UV spectroscopy of NGC 6543
Xuan Fang

10:00 – 10:15

I will present some results from the HST STIS UV spectroscopy of planetary nebula NGC 6543.

Clumpy stellar winds of central stars of planetary nebulae
Martín A. Guerrero

10:15 – 10:30

The central stars of planetary nebulae (CSPNe) exhibit fast stellar winds that have been typically studied through the P-Cygni profiles of high-excitation ions observed in the UV domain. Indeed, the discovery of these stellar winds, and the development of the present paradigm of planetary nebula formation and evolution, resulted from UV observations carried out by IUE. Alike the stellar winds of OB stars, those of CSPNe are clumpy and highly variable. Here I describe the properties of these variable winds, as derived mostly from multi-epoch FUSE high-dispersion spectroscopic observations. The new phenomena observed in stellar winds of CSPNe offer an alternative explanation for the enigmatic hard X-ray emission observed in CSPNe.

Session 5*Milky Way and galaxies
Stellar populations and cosmology*

July 1

Gravitationally lensed AGN: FUV-EUV emission as will be seen from WSO-UV/ISSIS
Luis J. Goicoechea

11:00 – 11:30

Follow-up programmes of gravitationally lensed (multiply imaged) AGN with WSO-UV/ISSIS will allow us to discuss the structure and variability of the FUV-EUV emission of these distant sources ($1 < z < 3$). In particular, monitoring campaigns will play a key role to unveil accretion flows in the vicinity of supermassive black holes, as well as mass distributions and compositions of lensing galaxies. We use the Crowded-field Image Simulator (CIS_v1.0) for WSO-UV/ISSIS to produce frames of a “typical” lensed AGN and check the potential of the future facility.

*Invited talk***UV Spectroscopy and the Discovery of Quasars**
Jack Sulentic

11:30 – 11:45

Last year marked the 50th anniversary of the discovery of quasars. From the beginning quasar studies have involved most of the electromagnetic spectrum. While discovered from radio observations, it was soon realized that most quasars are radio quiet. Within two years of their discovery we were seeing UV spectral features like Mg II 2800 and C IV 1549 for the first time in extragalactic sources--thanks to the large redshifts. This talk considers the importance of these UV lines in studying the physical properties of these high luminosity sources.

Interpretation of quasar UV spectra: the "4D eigenvector-1" approach
Paola Marziani

11:45 – 12:15

The rest-frame UV spectral range contains the strongest resonance lines observed in active galactic nuclei and quasars. Analysis of their intensity ratios and line profiles provides diagnostics on the physical and dynamical conditions of the line emitting regions. This talk discusses UV line properties in the framework of the 4D "eigenvector-1" correlations aimed at estimating ionizing photon flux, chemical abundances, emitting region distance radius, and central black hole mass.

Invited talk

Session 6***Planetary atmospheres
Solar system and exoplanets*****July 1**

**A panorama of the Solar System at UV wavelengths
Agustín Sánchez Lavega****12:15 – 12:45**

I summarize in this talk the main subjects of interest in the study of solar system bodies at UV wavelengths. These include planetary and cometary atmospheres (neutral and ionized layers), the surfaces of Mercury and Mars, asteroids and other minor bodies, and planetary rings.

Invited talk

**A new look for Venus's UV major cloud feature
Javier Peralta Calvillo****12:45 – 13:00**

The superrotation present in the cyclostrophic atmospheres of slowly rotating bodies is a long-standing problem yet unsolved in atmospheric dynamics. Venus is the most extreme case known since its atmosphere can rotate 60 times faster than the solid planet, with this superrotation being accompanied and probably influenced by a quasi-permanent planetary-scale cloud structure known as the Y-feature which can be seen only in ultraviolet images. Here we present the analytical model for a new type of wave that, for the first time, offers an explanation for the Y-feature morphology and its 30-day evolution.

**Exoplanets in UV
Enric Pallé****13:00 – 13:15**

In this talk I will summary the attempts to characterize transiting exoplanets at UV wavelengths, and how this information can be used to gain knowledge into the atmospheric composition and evolution of their atmospheres.

**Concluding remarks & open discussion
Ana Inés Gómez de Castro****13:15 – 14:00**

Block program

Monday, June 30th

10:30-10:40	Welcome message from the Science Organizing Committee Martín A. Guerrero	
10:40-11:30	Estatus del proyecto WSO-UV y programa científico Ana Inés Gómez de Castro	Session 1 Instrumentation
11:30-12:00	Coffee Break	
12:00-12:15	The Imaging and Slitless Spectroscopy Instrument for Surveys (ISSIS) for the World Space Observatory-Ultraviolet (WSO-UV) Gracia Perea	
12:15-12:30	Far UV coatings for astrophysics and solar physics applications Juan Larruquert	Session 2 Stellar physics and evolution
12:30-13:00	The size of stellar coronae from flaring events Javier López Santiago	
13:00-13:30	Red and brown dwarfs in the ultraviolet Jose A. Caballero	
13:30-13:45	Young Stellar Object candidates toward the Orion region selected from GALEX Néstor Sánchez	
13:45-14:00	Reddening determination and model fitting of early type stars observed by WSO Carmen Morales	
14:00-15:30	Lunch	
15:30-15:45	Magnetospheric properties of T Tauri stars through CII], FeII] and SiII] ultraviolet emission lines Fátima López Martínez	Session 3 Stellar physics and evolution
15:45-16:15	Winds of metal-poor OB stars: prospects for the WSO and ISSIS Miriam García García	
16:15-16:45	OB stars models: the role of the UV region Artemio Herrero	
16:45-17:15	Coffee Break	
17:15-17:45	Revisiting the UV-optical-IR extinction law Jesús Maíz	
17:45-18:00	Tracking mass transfer processes: the case of High Mass X-Ray Binary Systems Pere Blay	
18:00-18:30	Gaia data in coming Jordi Torra	

Tuesday, July 1st

Session 4 Milky Way and galaxies	Fullerenes, PAHs, Amino Acids and High Energy Astrophysics Susana Iglesias-Groth	9:00-9:30
	Molecular UV spectroscopy in the Diffuse Interstellar Medium: from H ₂ to PAHs José Cernicharo	9:30-10:00
	HST STIS UV spectroscopy of NGC 6543 Xuan Fang	10:00-10:15
	Clumpy stellar winds of central stars of planetary nebulae Martín A. Guerrero	10:15-10:30
Coffee Break		10:30-11:00
Session 5 Milky Way and galaxies	Gravitationally lensed AGN: FUV-EUV emission as will be seen from WSO-UV/ISSIS Luis J. Goicoechea	11:00-11:30
	UV Spectroscopy and the Discovery of Quasars Jack Sulentic	11:30-11:45
Session 6 Planetary atmospheres	Interpretation of quasar UV spectra: the "4D eigenvector-1" approach Paola Marziani	11:45-12:15
	A panorama of the Solar System at UV wavelengths Agustín Sánchez Lavega	12:15-12:45
	A new look for Venus's UV major cloud feature Javier Peralta Calvillo	12:45-13:00
	Exoplanets in UV Enric Pallé	13:00-13:15
Concluding remarks & open discussion Ana Inés Gómez de Castro		13:15-14:00

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