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DIVISION B WG **ULTRAVIOLET ASTRONOMY**

Div. B/ WG **Ultraviolet Astronomy**

TRIENNIAL REPORT 2015-2018

1. Introduction

The UV astronomy WG (WG-UV) was created following the IAU General Assembly in Hawaii in 2015 with the main aim at building a road map for the UV Astronomy for the next 2-3 decades. WG-UV built of the experience of the Network for Ultraviolet Astronomy (NUVA) created by European astronomers back in 2004. The NUVA organized international meetings every three years which attracted strong participation also from non-European countries (the US, Canada, Brazil, Russia, India, China, etc.) and coordinated the activity in the area world-wide. The WG-UV has implemented these activities at global scale within the IAU.

Prompted by the current status of UV astronomy, the UV community is deeply involved in the science working groups behind the large missions planning/development. Moreover, the community is becoming increasingly interested in the implementation of international partnerships for small, cubesat-size, missions that grant quick access to a broad diversity of UV projects.

2. Developments within the past triennium

During the 2015-2018 triennium, the WG activity has concentrated in two basic areas: identification of the science drivers and development of a road map. WG-UV members have actively participated in the identification of the key science areas requiring access to the UV range. These inputs have been transferred to the IAU Working Group on Global Coordination of Ground and Space Astrophysics to elaborate the Report of the Kavli IAU Workshop on Global Coordination: Future Space-Based Ultraviolet-Optical-Infrared Telescopes by Debra Elmegreen, Ewine van Dishoeck, David Spergel, and Roger Davies.

The road map proposed by the WG-UV contains inputs from astronomers and Space Agencies. The most ambitious project is being prepared by a NASA-funded Science and Technology Definition Team (STDT) to build and operate a 10/15 m class large UV-optical-infrared (LUVOIR) observatory. The high collecting capability, the small diffraction limit and the high dynamical contrast (10^{-10}) would enable direct imaging of the nearest Earth-like exoplanets and the measurement of their atmospheric signatures, including possible bio-signatures. If finally selected, LUVOIR will revolutionize all fields of astrophysics; a detailed accounting can be found at the LUVOIR site†.

The Russian-led mission WSO-UV will grant access to the UV range after Hubble epoch (Shustov et al. 2018) and a wealth of 2 m class UV missions being proposed to the Agencies: CETUS to NASA (Heap et al. 2017), Arago (Neiner et al. 2014) and MESSIER (Valls-Gabaud et al. 2017) to ESA, CASTOR (Coté et al. 2014) to CSA and a 2 m size surveyor mission to CNSA. Should they be successful, a new era of major discoveries would open for UV astronomy.

At the time of writing this report, UV observations can be obtained with Hubble, SWIFT, ASTROSAT/UVIT and XMM-Newton. An important advance will be the upcoming release of the data base of spectral observations obtained by the Galaxy Evolution Explorer (GALEX) survey (see Bianchi et al. 2018).

A major concern is the lack of an *all sky* survey at UV wavelengths. As shown in Fig. 1, radio-astronomy (21 cm line) and UV astronomy share this lacuna. The WG-UV believes that this relates to the limited capabilities of UV detectors, normally photon-counting, solar-blind devices that are damaged by high count rates. An action should be taken in this sense, in particular because the current census of nearby planetary systems includes many within the $b \in [-20^o, +20^o]$ Galactic latitude range.

In 1999 the California Polytechnic State University (Cal Poly) and Stanford University developed the CubeSat spefications to ease the design, manufacture, and testing of small satellites intended for low Earth orbits (LEO). The availability to interested experimenters of custom-off-the-shelf (COTS) products is changing space astronomy, in general and UV astronomy in particular. Small missions are competitive to study atmospheric photoevaporation of hot Jupiters (France et al. 2017), to survey the sky in the UV bands (Brosch et al. 2017) and to observe the Earth at UV wavelengths for subsequent investigations with large telescopes such as LUVOIR (Gómez de Castro et al. 2017).

The WG-UV has developed a web site (www.gnuva.net) and an interface to facilitate cooperation among the academia and research centres worldwide to elaborate small, cube-sat size proposals. Also, in July 2017, the WG-UV organized a workshop on UV surveys where the possibilities open by the cubesat technology and the easier access to space were analyzed.

2.1. *Participation/organization of activities*

The WG-UV has organized a major workshop during the 2015-2018 triennium entitled "Ultraviolet Sky Surveys. The needs and the means" held in Tel-Aviv in July 10-14, 2017 (http://www.astro.tau.ac.il/events/uss/).

The WG-UV will also organize a Special Session on "Ultraviolet Astronomy and the Quest for the Origin of Life" to be held during COSPAR Assembly during July 2018 in Pasadena. Understanding planetary system formation, the evolution of the young planetary disks, the interaction of stars with planetary atmospheres and the generation of complex, life precursor molecules requires observations in the ultraviolet range. During this event, the current status of research in this field will be addressed.

† https://asd.gsfc.nasa.gov/luvoir/science/

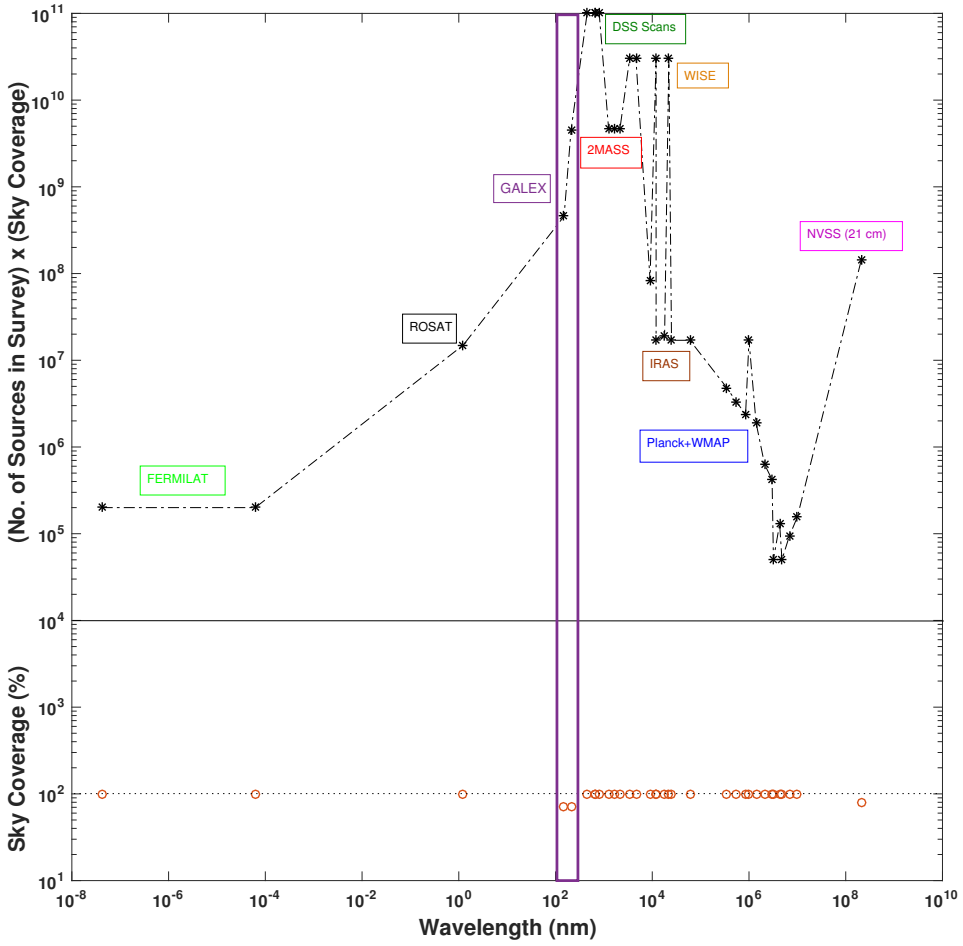

Figure 1. Sky surveys accross the electromagnetic spectrum (from Gómez de Castro et al. 2018). In the top panel the total number of sources detected by the survey is multiplied by the sky coverage (100% for a full sky survey). In the bottom panel, just the percent of the sky coverage at any given wavelength is indicated.

Moreover, the WG-UV has presented the road-map and participated in road-map discussions in two conferences: "Lifecycle of metals throughout the Universe" held in Baltimore, April 2017 and in the Kavli IAU workshop on "Global coordination of ground and space astrophysics: Future space based optical/UV/IR telescopes" in Leiden, July 2017.

3. Closing remarks

The future of UV astronomy depends crucially on decisions to be made by the space agencies in the next few years. The advent of COTS technologies and cheap launches for

cubesat size space probes may revolutionize the field and guarantee that the knowledge achieved with great effort on UV spectral tracers is kept alive in the community.

The WG-UV has also identified the need to define reference UV spectral windows for photometric studies. The windows defined by the GALEX mission are set by the response curve of the photocathods used in GALEX detectors and not on astrophysical interests. Future cubesat-size missions will most likely run photometric surveys given their small effective area and a common framework needs to be defined.

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Chair of the Working Group

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