EP 2: Astrophysics / Exoplanets and Astrobiology

Time: Monday 16:15–18:45 Location: EP-H1

EP 2.1 Mon 16:15 EP-H1

Cross-matching Low Frequency Array (LOFAR) Sources — •Lukas Böhme — Fakultät für Physik, Universität Bielefeld, Deutschland

Multi-frequency studies of the radio sky provide insight into the nature of the observed objects. To do so, I cross-match resolved and unresolved radio sources at different frequencies and angular resolutions.

The combination of several radio bands from the Low Frequency Array (LOFAR) and other radio telescopes with multi-frequency optical and infrared data allows for photometric redshift estimates, not only for LOFAR Two-metre Sky Survey (LoTSS) sources, but also for lower resolution LOFAR LBA Sky Survey (LoLSS) and NRAO VLA Sky Survey (NVSS) sources.

I present a new cross-matching algorithm incorporating the radio source extensions and apply it to the catalogues from LoLSS-PR, LoTSS-DR1, LoTSS-DR2 (LOFAR) and NVSS (VLA).

I study the number of components of LoLSS radio sources and their spectral properties. I find an average spectral index of $\alpha = -0.77 \pm 0.17$ for sources matched in all surveys. This spectral index is flux density independent above $S_{1400} = 30$ mJy and appears to be redshift independent.

EP 2.2 Mon 16:30 EP-H1

2-Kanal - Kohonenkarten zur Klassifizierung von Radioquellen und Identifizierung von optischen Host-Galaxien — •Schwarz Kilian[1], Stevens Simon[1], Mah Zhee Kein Jeremy[1], El-Beit Shawish Sara[1], Farjoud Masouleh Negar[1], Imhof Dennis[1], Rapp Stefan[1] und Hoeft Matthias[2] — [1]Hochschule Darmstadt, Haardtring 100, 64295 Darmstadt — [2]Thüringer Landessternwarte, Sternwarte 5, 07778 Tautenburg

Aufgrund der großen Datenmengen durch aktuelle Himmelsdurchmusterungen gewinnt die Klassifikation mit Hilfe von Methoden des maschinellen Lernens an Bedeutung. Für die ausgedehnten Quellen in der ersten Veröffentlichung von Daten des LOFAR Two-Metre Sky Survey (LoTSS) hat sich die automatische Gruppierung der Quellmorphologien mit Hilfe der Self-Organising-Maps (SOMs) als sehr leistungsvoll erwiesen [Mostert et. al 2020, Astronomy & Astrophysics]. In diesem Beitrag wird gezeigt, wie diese Methode weiterentwickelt werden kann, um die morphologische Klassifikation von Radioquellen zu verbessern und die zugehörigen Wirtsgalaxien in optischen Karten [Chambers et. al 2019, arXiv] zu identifizieren. Hierzu werden 2-Kanal-Kohonenkarten mit Hilfe der PINK-Software [Polsterer et. al 2016, 24th European Symposium on Artificial Neural Networks] trainiert und anschließend analysiert. Durch das Setzen eines Begrenzungsrahmens wird die Anzahl der möglichen zugehörigen Wirtsgalaxien erheblich eingeschränkt. In weiteren Schritten werden andere Eigenschaften der Quellen, z.B. Rotverschiebung, zusätzlich in dem Lernverfahren berücksichtigt. Die aktuellen Ergebnisse werden präsentiert.

Invited Talk EP 2.3 Mon 16:45 EP-H1

Cloudy with a hint of magnetic fields — •Ludmila Carone — St Andrews University, St Andrews, UK — Max Planck Institute for Astronomy, Heidelberg, D

In this review talk, I will present the state of the art of numerical models of exoplanet atmospheres. I will show why it is important to consider that exoplanets are three dimensional objects that can change their local observed atmosperic gas phase composition (C/O ratio) via cloud formation and disequilibrium chemistry. Since C/O ratios are used as proxies for exoplanet formation it is important that 3D processes are incorporated in the interpretation of upcoming detailed observations with next generation space telescopes: i.e. the James Webb Space Telescope, ARIEL and also PLATO. Last but not least, tackling magnetic fields interaction and how they impact observable properties in exoplanet atmospheres is an ongoing numerical challenge.

EP 2.4 Mon 17:15 EP-H1

Gap in Solar System's Proto Planetary Disk Likely Confirm Features in the Distribution of Exoplanet Semi-Major Axes — •Stuart F. Taylor — SETI Affiliate, Mountain View, CA USA — Participation Worldscope, Hong Kong

The recent discovery of a gap dividing the solar system's protoplanetary disk (SS's PPD) may be a confirmation of the peak-gap-peak (PGP) feature in the distribution of semi-major axes of exoplanets hosted by stars most like the sun. This PGP feature was published before the SS PPD gap was presented. It has long been thought that PPDs form with separate inner and outer disks separated by a gap, but seeing this structure in the distribution of exoplanet semi-major axes is unexpected due to how it is thought that primordial features are erased by subsequent planet migration. The solar system gap is reported to be closer than 3 AU, while the PGP feature's gap extends from 1.5 to 1.9 AU for planets of solar mass stars. The two results taken together suggest that planets of stars that are similar to the sun or with higher metallicity may generally start their evolution with a gap in this range, likely associated with a snow line. We are now finding that the semi-major axis of this feature appears to scale with the square root of stellar mass. We also propose that the study of planetary system architectures and demographics be organized in the form of a new additional section of an exoplanet catalog, which would include results on exoplanet occurrence distributions and findings of features and correlations among exoplanet parameters.

EP 2.5 Mon 17:30 EP-H1

Composition of super-Earths, super-Mercuries, and their host stars — •Vardan Adibekyan — nstituto de Astrofísica e Ciências do Espaço (IA)

Because of their common origin, it is expected (or assumed) that the composition of planet building blocks should (to a first order) correlate with stellar atmospheric composition, especially for refractory elements. In fact, information on the relative abundance of refractory and major rock-forming elements such as Fe, Mg, Si are commonly used to improve interior estimates for terrestrial planets (e.g. Dorn et al. 2015; Unterborn et al. 2016) and has even been used to estimate planet composition in different galactic populations (Santos et al. 2017). However, there is no direct observational evidence for the aforementioned expectation/assumption and was even recently questioned by Plotnykov & Valencia (2020). By using the largest possible sample of precisely characterized low-mass planets and their host stars, we show that the composition of the planet building blocks indeed correlates with the properties of the rocky planets. We also find that on average the iron-mass fraction of planets is higher than that of the primordial values, owing to the disk-chemistry and planet formation processes. This result can bring important implications for the future modeling of exoplanet composition.

EP 2.6 Mon 17:45 EP-H1

Planetary interiors via Love-number determined from radial velocities — •Lia Marta Bernabò and Szilárd Csizmadia — DLR Berlin, Institut für Planetenforschung (Deutsches Zentrum für Luft- und Raumfahrt) - Rutherfordstr. 2, 12489 Berlin

We study the inner structure of planets by determining the Love numbers kn and hn (Love, 1911), which describes the susceptibility of their shape to change in response to a tidal and rotational potential. The second degree Love number k2 is highly sensitive to the thickness of the interior layers and rheology of the planet and it is proportional to the concentration of mass towards the centre of the planet, therefore it is used to infer the internal structure of the body. We will present the method how to analyze the radial velocity curve in presence of apsidal motion caused by tidal interaction between the star and the planet, and by general relativity. The former one can be linked to the Love-number k2 (Kopal, 1959) which constrains the planetary interior as a third measurable parameter beyond the mass and radius (Baumeister et al., 2020). We also study the effect of the rotationally and tidally distorted stellar shape on the radial velocity curves. This causes a distortion on the RV-shape as well, and leads to the presence of an apparent eccentric orbit in the RV-curve. We show that the correct estimate of this effect must be taken into account and some other studies overestimated its amplitude and significance. Finally, we show our first results when we applied our method to real systems.

EP 2.7 Mon 18:00 EP-H1

Stellar Flares and Habitable(?) Worlds from the TESS Primary Mission — •Maximilian N. Günther — European Space Agency (ESA), European Space Research and Technology Centre (ESTEC), Keplerlaan 1, 2201 AZ Noordwijk, Netherlands

On our search for habitable worlds, we have to account for explosive stellar flaring and coronal mass ejections (CMEs) impacting exoplanets. These stellar outbursts are a double-edged sword. On the one hand, flares and CMEs are capable of stripping off atmospheres and extinguishing existing biology. On the other hand, flares might be the (only) means to deliver the trigger energy for prebiotic chemistry and initiate life. This talk will highlight our study of all stellar flares from the TESS primary mission, driven by a convolutional neural network. I will discuss our new insights on flaring as a function of stellar type, age, rotation, spot coverage, and other factors. Most importantly, I will link our findings to prebiotic chemistry and ozone sterilisation, identifying which worlds might lie in the sweet spot between too much and too little flaring. With future extended missions and increased coverage, flare studies and new exoplanet discoveries will ultimately aid in defining criteria for habitability.

EP 2.8 Mon 18:15 EP-H1

INCREASE - An updated model suite to study the INfluence of Cosmic Rays on Exoplanetary AtmoSpherEs — •Konstantin Herbst[1], J. Lee Grenfell[2], Miriam Sinnhuber[3], and Fabian Wunderlich[2] — [1]Institut für Experimentelle and Angewandte Physik, Christian-Albrechts-Universität zu Kiel, 24118 Kiel — [2]Institut für Planetenforschung, Deutsches Zentrum für Luft- und Raumfahrt, 12489 Berlin — [3]Institut für Meteorologie und Klimaforschung, Karlsruher Institut für Technologie, 77344 Eggenstein-Leopoldshafen

Much remains to be explored when it comes to the diversity of exoplanetary atmospheres, much remains to be explored. For a few selected objects such as Proxima Centauri b, first observations of the atmosphere have already been achieved. At the same time, much more information is expected soon with the help of JWST launched in December 2021. However, to interpret existing and upcoming observations, model studies of planetary atmospheres that account for various processes - e.g., atmospheric escape, outgassing, climate, photochemistry, and the physics of air showers - are necessary. Here, we present our unique model suite INCREASE investigating the impact of cosmic rays on diverse exoplanetary atmospheres and their habitability.

EP 2.9 Mon 18:30 EP-H1

Viruses first? — •Karin Moelling — Inst. med. Mikrobiologie, Universität Zürich, Gloriastr 30, 8006 Zürich, Schweiz — Max Planck Institut Mol.Gen. Ihnestr 73 14195 berlin Deutschland

The discovery of exoplanets within putative habitable zones and spaceships to Mars and Eraly Earth raise interest in the origin of life. Could viruses play a role at the beginning of life on Earth and elsewhere? Viruses are the most successful species on Earth in every habitat. Contemporary viruses reflect evolution ranging from the early RNA world to the present DNA-protein world. Earliest replicating and evolving entities are enzymatic non-coding RNA molecules, ribozymes or viroids, fulfilling criteria of life. RNA is till today a dominating molecule in almost all aspects of life, generating novel information as driver of evolution. The whole Universe contains essential building blocks of life H,O,C,N,P. Water may be essential. Meteorites teach us about aminoaicds. The diversity of survival mechanism are demonstrated by extremophilic archaea, which developed indivdual survival metabolisms depending on extreme living conditonas as extrempohils. Autonomy of early life forms may have been given up by energy-saving parasitic life forms today.(Moelling and Breocker,2019, doi: 10.3389/fmicb.2019.0052310.3389/fmicb.2019.00523)