EP 9: Exoplanets and Astrobiology

Time: Wednesday 16:15–18:15 Location: ZHG005

Invited Talk EP 9.1 Wed 16:15 ZHG005

A JWST View of Exoplanet Atmospheres: Everything We Dreamed Of, and More — •Laura Kreidberg — Königstuhl 17, 69117 Heidelberg

The recent launch of the James Webb Space Telescope (JWST) has revolutionized the field of exoplanet atmosphere characterization, thanks to its unprecedented sensitivity and broad wavelength coverage. In this talk, I will give a tour of the latest JWST results for transiting exoplanets, from gas giants down to rocky worlds. For the largest planets, I'll focus on the complex physical processes recently revealed in their atmospheres, including photochemistry, 3D effects, and cloud formation. Pushing down to smaller worlds, I'll share the first measurements of chemical composition for the elusive sub-Neptune population, and address the question of whether water worlds exist. In closing, I will give an update on the rapidly evolving topic of rocky planet characterization, including which (if any) rocky planets have atmospheres at all, and what their possible atmospheric compositions could be.

EP 9.2 Wed 16:45 ZHG005

How to improve the initial stellar characterisation of faint stars with transiting planets? — •Matthias Ammler-von Eiff[1], Daniel Sebastian[2], Jie Yu[3], Chen Jiang[1], and Eike W. Guenther[4] — [1]MPI for Solar System Research, Germany — [2]School of Physics and Astronomy, University of Birmingham — [3]School of Computing, Australian National University — [4]Thuringian State Observatory, Germany

The study of planetary systems in different Galactic environments is particularly interesting. These systems can be distant so that the host stars can be too faint for a precise characterisation with asteroseismology, interferometry, or ground-based spectroscopy. Also, extinction plays an important role.

An accurate determination of the host star parameters is essential to characterise planets in their orbit. In order to better understand the limitations for faint host stars and to identify possible solutions in preparation of PLATO, we reviewed the stellar parameters of all 36 CoRoT targets with planets detected.

We identified independent constraints, for instance from stellar density based on transit light curves and from distance from Gaia. We compared those to published estimates of extinction and effective temperature. This way, we can find out how accurate stellar parameters are and derive extinction more accurate than before. Eventually, we can derive the radii of the host stars in a homogeneous way. To our knowledge, this is the first time that the full set of CoRoT host stars is characterised with precise distances from Gaia.

EP 9.3 Wed 17:00 ZHG005

WASP-121 b's transmission spectrum observed with JWST/NIRSpec G395H reveals thermal dissociation and SiO in the atmosphere — •Cyril Gapp for the WASP-121 b JWST/NIRSpec transit-Collaboration — Max-Planck-Institut für Astronomie, Königstuhl 17, D-69117 Heidelberg, Germany

WASP-121 b has been established as a benchmark Ultra-Hot Jupiter, serving as a laboratory for the atmospheric chemistry and dynamics of strongly irradiated extrasolar gas giants. Here, we present and analyze WASP-121 b's transmission spectrum observed with NIRSpec G395H onboard the James Webb Space Telescope (JWST) and find evidence for the thermal dissociation of H_2O and H_2 on the planet's permanent day side. Additionally, we detect SiO at a statistical significance of $5.2\,\sigma$. Constraining the abundance of SiO and abundance ratios between Silicon and volatile atoms in WASP-121 b's atmosphere could help discriminate between possible migration histories of the planet. The three-dimensional nature of thermal dissociation on WASP-121 b's day side and recombination on its night side, however, poses a challenge to constrain molecular abundances and elemental abundance ratios from the transmission spectrum. To account for this, we implemented an atmospheric model in the `NEMESIS` framework that splits the planet's atmosphere into day side and night side. A retrieval applying our atmospheric model to WASP-121 b's transmission spectrum favors a higher H_2O abundance on the night side than on the day side, demonstrating the impact of hemispheric heterogeneity when attempting to constrain WASP-121 b's bulk H_2O inventory.

EP 9.4 Wed 17:15 ZHG005

Modeling the astrosphere of LHS 1140 — •Klaus Scherer[1], Konstantin Herbst[2], Eugene Engelbrecht[3], Stefan Ferreira[3], Jens Kleimann[1], and Juandre Light[3] — [1]Institut für Theoretische Physik IV, Ruhr-Universität Bochum, — [2]nstitut für Experimentelle and Angewandte Physik, Christian-Albrechts-Universität zu Kiel, Germany — [3]Centre for Space Research, North-West University, 2520, Potchefstroom, South Africa

We have studied the 3D multifluid MHD structure of the LHS 1140 astrospheres. We discuss the shock structure of the stellar wind of LHS 1140 using four different models: HD and MHD single-fluid models, as well as multifluid models for both cases, including a neutral hydrogen flow from the interstellar medium. It is shown that the 3D multifluid positions of the termination shock differ remarkably from those found in the 3D ideal-single fluid hydrodynamic case. Here, we discuss especially the problems in choosing the stellar wind as well as the interstellar medium parameters. We present and discuss models with different initial parameter..

EP 9.5 Wed 17:30 ZHG005

Venus as an Exoplanet: Effect of varying stellar, orbital, planetary and atmospheric properties upon composition, habitability and detectability — •John Lee Grenfell[1], Jörn Helbert[1], Gabriele Arnold[1], Konstantin Herbst[2], Miriam Sinnhuber[3], and Heike Rauer[1,4] — [1]Department of Extrasolar Planets and Atmospheres (EPA), German Aerospace Centre, Berlin — [2]Centre for Planetary Habitability, University of Oslo — [3]Institute for Meteorology and Climate Research, Karlsruhe Institute of Technologie (KIT) — [4]Institute for Geological Sciences, Free University of Berlin

The newly selected Venus missions EnVISION and VERITAS (Venus Emissivity, Radio Science, InSAR, Topography, and Spectroscopy) offer new opportunities for studying Venus but will also contribute to furthering our knowledge of Venus as an exoplanet. Hot rocky planets are favored targets due to generally more frequent transits than cooler Earth-like objects. In this work we simulate Venus as an exoplanet varying stellar, orbital, planetary and atmospheric parameters and study the effect upon atmospheric composition, climate and spectral detectability with the LIFE (Large Interferometer For Exoplanets) telescope.

EP 9.6 Wed 17:45 ZHG005

The Influence of Stellar Energetic Particles (SEPs) on the Atmosphere of Rocky Explanets — •Andreas Bartenschlager[1], M. Sinnhuber[1], J. L. Grenfell[2], N. Iro[2], B. Taysum[2], and K. Herbst[2] — [1]KIT, Karlsruhe — [2]DLR, Berlin

New instruments (JWST) open up the possibility of studying the composition of exoplanetary atmospheres in habitable zones. On explanets around active and quite M-stars like TRAPPIST-1 and LHS1140, the impact of SEPs and GCRs on the atmosphere plays an important role and is investigated with the ion chemistry model ExoTIC (Herbst et al. 2022). We perform model experiments with different N_2- or CO_2-dominated atmospheres, depending on the initial CO2 partial pressure, as well as humid and dry conditions (Wunderlich et al. 2020). A further specification is the distinction between dead and alive atmospheres, whose composition is characterized by initial lower/higher O_2 fractions. New modules give the possibility to simulate the ion chemistry's impact on the atmospheric composition of multiple ionization events with different strengths and frequencies, based on the observed flaring frequency of TRAPPIST-1 and the permanent GCR impact on LHS1140b. Preliminary results show a significant impact of SEP events on the chemical composition of the atmospheres, including biosignatures such as O_3 and N_2O, especially in the recovery of the ozone layer after multiple SEP events. These changes have an impact on the observed transmission spectra. The strength and structure of these impacts depend on the initial composition, in particular on the availability of O_2, N_2 and H_2O.

EP 9.7 Wed 18:00 ZHG005

Extraterretrial life? — •Karin Moelling — Institute of Medical Microbiology (IMM), Gloriatr 30, 8006 Zürich

Life on Earth is the only one we now of. Could there be life on one

of the stars or exoplanets in the Universe? The main elements for life on Earth are "CHNOPS", which are universal and can give rise to nucleic acids, lipids and aminoacids, the essential macromolecules of terrestrial life. Life is characteized by repliction and evolution in response to environmental conditions.The simplest biomolecule for life om Earth is RNA,ribozymes or viroids. Also all metabolic processes in all species are very similar,and suggest a single origin, based on water, carbon and oxygen - are they also biomarkers for extraterrestrial life? On Earth life created its own living conditions, such as cyanobacteria which produced the toxic oxygen, now a biomarker of life. However, unaerobia live without oxygen. In meteorites 80 AA can be detected while we are only using 20. Our genetic code would not allow coding for them. Could there be different metabolism, genetic codes, biomarkers which lead to other forms of life. Could they be designed by alphaFold and AI, which may help us find unknown forms of life? Extremophiles and unique Earth properties will be discussed.