

# Mario Damiano

*Ph.D. in Astrophysics*

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## Professional Objectives

- Characterization of exoplanetary atmospheres.
- Spectroscopic data interpretation from observations gathered via space- and ground-based facilities.
- Implementation of inverse information extraction techniques via Bayesian statistics.
- Automation of data evaluation processes leveraging Machine Learning (ML) algorithms.
- Formulation of comprehensive pipelines for streamlined data analysis.
- Technical and scientific interpretation of data patterns and model predictions.

## Professional experience

**2022 - Today** **Scientist & Data Scientist**, National Aeronautics and Space Administration (NASA) – Jet Propulsion Laboratory (JPL) – California Institute of Technology, CA, United States.

- Augmenting the capabilities of EXOREL<sup>®</sup> for interpreting exoplanetary reflection spectroscopic data. This are specific upgrades aimed at helping the development of the Habitable World Observatory (HWO)
- Augmenting the capabilities of EXOSIMS, a sophisticated yield model analysis tool used to simulate telescope performances. This endeavor is aimed at enhancing HWO.
- Developed a novel pipeline, EXOTR, for interpreting exoplanetary transmission spectroscopic data. Implemented Bayesian statistics utilizing the MultiNest sampling algorithm.
- Formulating proposals for planning observations using Hubble Space Telescope (HST) and James Webb Space Telescope (JWST).

**2018 - 2022** **Postdoctoral Research Fellow**, National Aeronautics and Space Administration (NASA) – Jet Propulsion Laboratory (JPL) – California Institute of Technology, CA, United States.

- Developed a novel pipeline, EXOREL<sup>®</sup>, for interpreting exoplanetary reflection spectroscopic data. Implemented Bayesian statistics utilizing the MultiNest sampling algorithm.
- Engineered a Neural Network model to expedite the retrieval process within EXOREL<sup>®</sup>. Created training, validation, and test datasets, and evaluated model performance post-training.
- Participated in organizing a data challenge event. Assisted in data simulation and validation of participant results.
- Undertook data analysis and scientific interpretation of HST data.
- Formulated proposals for planning observations using HST and/or JWST.

## Education

2019

**Ph.D. in Astrophysics**, *University College London (UCL), London, England, UK*,  
Advisors: Prof. Giovanna Tinetti, Dr. Giuseppina Micela, and Dr. Ingo Waldmann.  
Thesis title: *Data analysis of space and ground observations of exoplanetary atmosphere using Machine Learning algorithms.*

2015

**MSc Physics (Astrophysics)**, *University of Palermo (UNIPA), Palermo, Italy.*,  
Advisors: Prof. Giovanni Peres and Dr. Giuseppina Micela.

Thesis title: *Exoplanetary atmosphere: high-resolution spectrum with instruments iLocater and HIRES.*

## Awards, honors, grants, and fellowships

- JPL Voyager Bonus Awards (2024);
- Multiple awarded STScI grants for HST and JWST observations (see “Competitively awarded proposals and observing time” section), 2020-present;
- JPL Postdoctoral Fellowship, NASA/JPL, 2018;
- “Tessera Preziosa del mosaico di Palermo”, recognition for citizens of Palermo, Italy, 2018;
- Ph.D. studentship, European Research Council (ERC) and National Institute for Astrophysics (INAF), 2015.

## IT Skills

- Extensive knowledge of the Python language, including packages used for data analysis (i.e. NumPy, SciPy, PyAstronomy, Pandas, mcee, PyMultinest, dynesty), data visualization (i.e. Matplotlib), server parallelization through MPI (i.e. mpi4py) and ML libraries (i.e. Scikit-learn, Tensorflow, Keras);
- Knowledge of the C language (simple scripting for physics calculations);
- Knowledge of the Matlab language (data visualization and statistics);
- Extensive knowledge of text editing tools (i.e. L<sup>A</sup>T<sub>E</sub>X, Microsoft Office, Apple Keynote, Overleaf);
- Daily usage of server resources (knowledge of bash scripting, PBS and SLURM commands) for intensive computation.

## Invited colloquia and seminar talks

- 2023** ‘ATMOSPHERIC CHARACTERIZATION OF TEMPERATE ROCKY PLANETS THROUGH REFLECTION SPECTROSCOPY’, Jet Propulsion Laboratory, CA, US.
- 2022** ‘EXOPLANETARY ATMOSPHERES REVEALED THROUGH MACHINE LEARNING APPROACHES’, Jet Propulsion Laboratory, CA, US.
- 2022** ‘ATMOSPHERIC CHARACTERIZATION OF TEMPERATE ROCKY PLANETS THROUGH REFLECTION SPECTROSCOPY’, ExoSS workshop, Jet Propulsion Laboratory, CA, US.
- 2021** ‘UNRAVEL THE NATURE OF EXOPLANETARY ATMOSPHERES THROUGH SPECTROSCOPIC CHARACTERIZATION’, IPAC, California Institute of Technology, CA, US.
- 2020** ‘EXOPLANETARY CHARACTERIZATION THROUGH REFLECTION SPECTROSCOPY’, JPL Postdoc Seminar Series, Jet Propulsion Laboratory, CA, US.
- 2019** ‘TWO LENSES FOR GLASSES: LOW- AND HIGH-RESOLUTION SPECTROSCOPIC OBSERVATIONS OF EXOPLANETARY ATMOSPHERES’, Yuk luncheon seminar, California Institute of Technology, CA, US.
- 2019** ‘TWO LENSES FOR GLASSES: LOW- AND HIGH-RESOLUTION SPECTROSCOPIC OBSERVATIONS OF EXOPLANETARY ATMOSPHERES’, JPL luncheon seminar, Jet Propulsion Laboratory, CA, US.
- 2017** ‘SPECTROSCOPIC OBSERVATIONS OF HOT-JUPITERS WITH THE HUBBLE WFC3 CAMERA’, INAF-OAPa seminar series, INAF-Astronomical Observatory of Palermo (INAF-OAPa), Palermo, Italy.

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## Conference Presentations

- 2023** 'ATMOSPHERIC CHARACTERIZATION OF TEMPERATE ROCKY PLANETS THROUGH REFLECTION SPECTROSCOPY', 241<sup>st</sup> American Astronomical Society (AAS) meeting, Seattle, WA, United States.
- 2022** 'ATMOSPHERIC CHARACTERIZATION OF TEMPERATE ROCKY PLANETS THROUGH REFLECTION SPECTROSCOPY', Astrobiology Science Conference (ExoSS workshop), Pasadena, CA, United States.
- 2022** 'ATMOSPHERIC CHARACTERIZATION OF TEMPERATE ROCKY PLANETS THROUGH REFLECTION SPECTROSCOPY', Astrobiology Science Conference (AbSciCon), Atlanta, GA, United States.
- 2020** 'EXOPLANETARY CHARACTERIZATION THROUGH REFLECTION SPECTROSCOPY', 2<sup>nd</sup> Starshade Science Industry Partnership (SIP) forum, Boulder, CO, United States.
- 2020** 'EXOPLANETARY CHARACTERIZATION THROUGH REFLECTION SPECTROSCOPY', 235<sup>th</sup> American Astronomical Society (AAS) meeting, Honolulu, HI, United States.
- 2019** 'EXOPLANET REFLECTED LIGHT RETRIEVAL: WHAT CAN WE LEARN?', Division Planetary Science (DPS) 51 / European Planetary Science Congress (EPSC) 14, Geneva, Switzerland.
- 2018** 'PLANETARY SIGNAL EXTRACTION VIA HIGH-RESOLUTION SPECTROSCOPY', Centre for Planetary Science (CPS) meeting, Mullard Space Science Laboratory (MSSL), England, UK.
- 2018** 'PLANETARY SIGNAL EXTRACTION VIA HIGH-RESOLUTION SPECTROSCOPY', Workshop for collaboration with Indian science community, University College London, London, England, UK.
- 2017** 'NEAR-IR TRANSMISSION SPECTRUM OF HAT-P-32B USING WFC3 CAMERA ON BOARD HST', European Planetary Science Congress (EPSC) 12, Riga, Latvia.
- 2017** 'PLANETARY SIGNAL EXTRACTION VIA HIGH-RESOLUTION SPECTROSCOPY: WORK IN PROGRESS', 10<sup>th</sup> GAPS2.0 meeting, Palermo, Italy.
- 2016** 'SPECTROSCOPIC OBSERVATIONS OF HOT-JUPITERS WITH THE HUBBLE WFC3 CAMERA', Division for Planetary Sciences (DPS) 48 / European Planetary Science Congress (EPSC) 11, Pasadena, CA, US.

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## Competitively awarded proposals and observing time

- 2024** 25.0 primary JWST hours awarded in Cycle 3. Co-I of GO-05177: *"Detailed Atmospheric Characterization of a Unique Low-Temperature Exo-Saturn"*
- 2024** 17.0 primary JWST hours awarded in Cycle 3. Co-I of GO-04711: *"Efficient and Detailed Characterization of a Temperate Water World Candidate"*
- 2023** 13.1 primary JWST hours awarded in Cycle 2. PI of GO-03942: *"Probing the volcanic outgassing activity of a warm sub-Earth planet"*
- 2021** 14.4 primary JWST hours awarded in Cycle 1. PI of GO-02334: *"Exploring the nature of a temperate exoplanet in the Fulton gap"*
- 2021** 67.9 primary JWST hours awarded in Cycle 1. Co-I of GO-02372: *"Deep Characterization of the Atmosphere of a Temperate Sub-Neptune"*
- 2021** 15.4 primary JWST hours awarded in Cycle 1. Co-I of GO-01952: *"Determining the Atmospheric Composition of the Super-Earth 55 Cancri e"*
- 2020** 8 primary HST orbits awarded in Cycle 28. Co-I of GO-16448: *"Confirming a tentative detection of an atmosphere around a potentially rocky planet"*

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## Academic service

**2021-present** Peer reviewer for Nature Astronomy (NatAstron), Astronomy and Astrophysics (A&A), and IOP Publishing (AJ, ApJ, and PSJ).

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## Student advising

- 2023** Served as a co-mentor for two undergraduate students participating in the SURF@JPL program. One project focused on leveraging Bayesian statistics for spectral interpretation, laying the groundwork for future direct imaging observations and telescope operations. The other was focused on performing data analysis of novel HST/JWST data.  
Pasadena, CA,US.
- 2022** Served as a co-mentor of two undergraduate students within the SURF@JPL program. One project focused on leveraging Bayesian statistics to perform spectral interpretation in preparation of JWST observations. The other one focused on the development of ML algorithms to analyze the NASA exoplanet archive in order to classify the planets and identify population distributions.  
Pasadena, CA,US.
- 2017** Co-advised UNIPA master student for an internship on data analysis of high-resolution spectroscopic observations.  
Palermo, Italy.

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## Publications

### First author peer-reviewed manuscripts

10. *LHS 1140 b is a potentially habitable water world*  
**Damiano, M.**, Bello-Arufe, A., Yang, J., Hu, R.,  
Submitted for review to ApJL
9. *Starshade Exoplanet Data Challenge: What We Learned*  
**Damiano, M.**, Shaklan, S., Hu, R., Dunne, B., Tanner, A., Nida, A., Carson J. C., Hildebrandt, S. R., Lisman, D.,  
Submitted for review to JATIS
8. *Reflected spectroscopy of small exoplanets III: probing the UV band to measure biosignature gasses*  
**Damiano, M.**, Hu, R., Mennesson, B.,  
AJ, 166, 157, Sep 2023 - DOI: 10.3847/1538-3881/acefd3
7. *A transmission spectrum of the sub-Earth planet L98-59 b in 1.1-1.7  $\mu\text{m}$*   
**Damiano, M.**, Hu, R., Barclay, T., Zieba, S., Kreidberg, L., Brande, J., Colon, K. D., Covone, G., Crossfield, I., Domagal-Goldman, S. D., Fauchez, T. J., Fiscale, S., Gallo, F., Gilbert, E., Hedges, C. L., Kite, E. S., Kopparapu, R. K., Kostov, V. B., Morley, C., Mullally, S. E., Pidhorodetska, D., Schlieder, J. E., Quintana, E. V.,  
AJ, 164, 225, Oct 2022 - DOI: 10.3847/1538-3881/ac9472
6. *Reflected spectroscopy of small exoplanets II: characterization of terrestrial exoplanets*  
**Damiano, M.** & Hu, R.,  
AJ, 163, 299, May 2022 - DOI: 10.3847/1538-3881/ac6b97
5. *Reflected spectroscopy of small exoplanets I: determining the atmospheric composition of sub-Neptune planets*  
**Damiano, M.** & Hu, R.,  
AJ, 162, 200, Oct 2021 - DOI: 10.3847/1538-3881/ac224d

4. *Multi-orbital-phase and multi-band characterization of exoplanetary atmospheres with reflected light spectra*  
**Damiano, M.**, Hu, R., Hildebrandt, S. R.,  
AJ, 160, 206, Nov 2020 - DOI: 10.3847/1538-3881/abb76a
3. *ExoReL<sup>℞</sup>: A Bayesian Inverse Retrieval Framework For Exoplanetary Reflected Light Spectra*  
**Damiano, M.** & Hu, R.,  
AJ, 159, 175, Mar 2020 - DOI: 10.3847/1538-3881/ab79a5
2. *A Principal Component Analysis-based Method to Analyze High-resolution Spectroscopic Data on Exoplanets*  
**Damiano, M.**, Micela, G., Tinetti, G.,  
ApJ, 878, 153, June 2019 - DOI: 10.3847/1538-4357/ab22b2
1. *Near-IR transmission spectrum of HAT-P-32 b using HST/WFC3.*  
**Damiano, M.**, Morello, G., Tsirias, A., Zingales, T., Tinetti, G.,  
AJ, 154, 39, Jul 2017 - DOI: 10.3847/1538-3881/aa738b

### Co-Author

15. *A secondary atmosphere on the rocky exoplanet 55 Cancri e,*  
Hu, R., Bello-Arufe, A., Zhang, M., Paragas, K., Zilinskas, M., van Buchem, C., Bess, M., Patel, J., Ito, Y., **Damiano, M.**, Scheucher, M., Oza, A.V., Knutson, H.A., Miguel, Y., Dragomir, D., Brandeker, A., Demory, B.O.,  
Nature, May 2024 - DOI: 10.1038/s41586-024-07432-x
14. *Quantifying the impacts of schedulability on science yield of exoplanet imaging missions,*  
Savransky, D., Knight, R., Turmon, M., Spohn, C., Morgan, R., **Damiano, M.**, Genszler, G., Kulik, J.,  
SPIE, 126801K, Oct 2023 - DOI: 10.1117/12.2677102
13. *Exo-Earth yield of a 6m space telescope in the near-infrared,*  
Morgan, R., Savransky, D., **Damiano, M.**, Lisman, D., Mennesson, B., Mamajek, E. E., Robinson, T. D., Turmon, M.,  
SPIE, 126801L, Oct 2023 - DOI: 10.1117/12.2677785
12. *Exoplanet Detection from Starshade Images using Convolutional Neural Networks,*  
Ahmed, Z., D'Amico, S., Hu, R., **Damiano, M.**,  
SPIE, 1268028, Oct 2023 - DOI: 10.1117/12.2676600
11. *The transmission spectrum of the potentially rocky planet L 98-59 c,*  
Barclay, T., Sheppard, K. B., Latouf, N., Mandell, A. M., Quintana, E. V., Gilbert, E. A., Liuzzi, G., Villanueva, G. L., Arney, G., Brande, J., Colón, K. D., Covone, G., Crossfield, I. J. M., **Damiano, M.**, Domagal-Goldman, S. D., Fauchez, T. J., Fiscale, S., Gallo, F., Hedges, C. L., Hu, R., Kite, E. S., Koll, D., Koppa-rapu, R. K., Kostov, V. B., Kreidberg, L., Lopez, E. D., Mang, J., Morley, C. V., Mullally, F., Mullally, S. E., Pidhorodetska, D., Schlieder, J. E., Vega, L. D., Youngblood, A., Zieba, S.,  
arXiv, 2301.10866, Jan 2023
10. *Early Release Science of the Exoplanet WASP-39b with JWST NIRSpec G395H,*  
The Early Release Science Team, 92 co-authors,  
Nature, Jan 2023 - DOI: 10.1038/s41586-022-05591-3
9. *Early Release Science of the exoplanet WASP-39b with JWST NIRCам,*  
The Early Release Science Team, 99 co-authors,  
Nature, Jan 2023 - DOI: 10.1038/s41586-022-05590-4
8. *Identification of carbon dioxide in an exoplanet atmosphere,*  
The Early Release Science Team, 131 co-authors,  
Nature, Sept 2022 - DOI: 10.1038/s41586-022-05269-w

7. *Unveiling shrouded oceans on temperate sub-Neptunes via transit signatures of solubility equilibria vs. gas thermochemistry*,  
Hu, R., **Damiano, M.**, Scheucher, M., Kite, E., Seager, S., Rauer, H.,  
ApJL, 921, L8, Oct 2021 - DOI: 10.3847/2041-8213/ac1f92
6. *Starshade Exoplanet Data Challenge*,  
Hu, R., Hildebrandt, S. R., **Damiano, M.**, Shaklan, S., Martin, S., Lisman, D.,  
JATIS, 7(2), 021216, Mar 2021 - DOI: 10.1117/1.JATIS.7.2.021216
5. *The Transiting Exoplanet Community Early Release Science Program for JWST*,  
Bean, J.L., plus 96 co-authors,  
PASP 130k4402, Nov 2018 - DOI: 10.1088/1538-3873/aadbf3
4. *A chemical survey of exoplanets with ARIEL*,  
Tinetti, G., plus 242 co-authors,  
Exp Astron 46, 135, Sep 2018 - DOI: 10.1007/s10686-018-9598-x
3. *A Population Study of Gaseous Exoplanets*,  
Tsiaras, A., Waldmann, I.P., Zingales, T., Rocchetto, M., Morello, G., **Damiano, M.**, Karpouzas, K.,  
Tinetti, G., McKemmish, L.K., Tennyson, J., and Yurchenko, S.N.,  
AJ, 155, 156, Mar 2018 - DOI: 10.3847/1538-3881/aaaf75
2. *A New Approach to Analyzing HST Spatial Scans: The Transmission Spectrum of HD 209458 b*,  
Tsiaras, A., Waldmann, I.P., Rocchetto, M., Varley, R., Morello, G., **Damiano, M.**, Tinetti, G.,  
ApJ, 832, 202, Dec 2016 - DOI: 10.3847/0004-637X/832/2/202
1. *Detection of an Atmosphere Around the Super-Earth 55 Cancri e*,  
Tsiaras, A., Rocchetto, M., Waldmann, I.P., Venot, O., Varley, R., Morello, G., **Damiano, M.**, Tinetti, G.,  
Barton, E.J., Yurchenko, S.N., Tennyson, J.,  
ApJ, 820, 99, Apr 2016 - DOI: 10.3847/0004-637X/820/2/99