Mario Damiano

Ph.D. in Astrophysics

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Professional Objectives

○ Analysis of the composition and dynamics within exoplanetary atmospheres.
○ Spectroscopic data interpretation from observations gathered via space-based and terrestrial facilities.
○ Implementation of inverse information extraction techniques via Bayesian statistics.
○ Automation of data evaluation processes leveraging Machine Learning (ML) and Deep Learning (DL) 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.

○ Developed a novel pipeline, ExoTR, for interpreting exoplanetary transmission spectroscopic data. Implemented Bayesian statistics utilizing the Multi Nested Sampling algorithm.
○ Developing a pipeline for analyzing James Webb Space Telescope (JWST) data.
○ Augmenting the capabilities of EXOSIMS, a sophisticated yield model analysis tool employed to simulate telescope performances. This endeavor is specifically aimed at enhancing the forthcoming NASA flagship mission, the Habitable World Observatory (HWO).
○ Composed proposals for planning observations with HST and 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, $\mathrm{ExoReL}^{\Re}$, for interpreting exoplanetary reflection spectroscopic data. Implemented Bayesian statistics utilizing the Multi Nested Sampling algorithm.
○ Engineered a Neural Network model to expedite the retrieval process within $\mathrm{ExoReL}^{\Re}$. 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 Hubble Space Telescope (HST) data.
○ Composed proposals for planning observations with HST and 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.*

BSc Physics Science, *University of Palermo (UNIPA), Palermo, Italy.*,
Advisors: Prof. Giovanni Peres and Dr. Giuseppina Micela.
Thesis title: *Exoplanets and stellar activity in the IR-band.*

Awards, honors, grants, and fellowships

○ 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;
○ Ph.D. studentship, European Research Council (ERC) and National Institute for Astrophysics (INAF), 2015.

IT Skills

○ Extensive knowledge of the Python language (7 years of experience), 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 and DL 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. LATEX, Microsoft Office, Apple Keynote, Overleaf);
○ Daily usage of server resources (knowledge of bash scripting and PBS 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.

Conference Presentations

2023 'Atmospheric characterization of temperate rocky planets through reflection spectroscopy', 241st 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 RE-FLECTION SPECTROSCOPY', Astrobiology Science Conference (AbSciCon), Atlanta, GA, United States.

2020 'EXOPLANETARY CHARACTERIZATION THROUGH REFLECTION SPECTROSCOPY', 2nd Starshade Science Industry Partnership (SIP) forum, Boulder, CO, United States.

2020 'EXOPLANETARY CHARACTERIZATION THROUGH REFLECTION SPECTROSCOPY', 235th 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', 10th 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.

Competitively awarded proposals and observing time

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"*

Academic service

2021-present Referee activities for Nature Astronomy (NatAstron), Astronomy and Astrophysics (A&A), and IOP Publishing.

Student advising

2023 Served as a co-mentor for two graduate 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	Co-tutored two graduate students within the SURF@JPL program.
	Pasadena, CA,US.
	$1-$ Use of Bayesian statistics to perform spectral interpretation in preparation of JWST observations;
	$2-$ development of ML/DL algorithms to analyze the NASA exoplanet archive in order to classify the planets and identify population distributions.
2017	Co-advised UNIPA master student for an internship on data analysis of high-resolution spectroscopic observations.
	Palermo, Italy.

▬▬ Publications

First author peer-reviewed manuscripts

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 μm*
   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$^{\Re}$: 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., Tsiaras, A., Zingales, T., Tinetti, G.,
   AJ, 154, 39, Jul 2017 - DOI: 10.3847/1538-3881/aa738b

Co-Author

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., Kopparapu, 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 NIRCam*,
   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