Clara **Sousa-Silva**

Quantum Astrochemist · Science Communicator

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Education

PhD in Astrophysics - Quantum Chemistry

London, UK

University College London - ExoMol group

2011-2015

- Thesis: "Modelling Phosphine Spectra for the Atmospheric Characterization of Cool Stars and Exoplanets". Advisor: J Tennyson.
  - For my PhD thesis I focused on the simulation of the phosphine spectra and associated thermodynamic properties from theoretical quantum chemistry. Work ranged from the exotic (phosphine tunnelling) to the practical (calculation of the temperature dependence of the phosphine spectrum). I have published five first-author articles associated with the work performed throughout my PhD.

Integrated MPhys - Masters of Physics and Astronomy with Honours

Edinburgh, Scotland

University of Edinburgh

2005-2010

- Thesis: "Influence of a Star's Evolution on its Planetary System". Grade: **A**.
  - For my masters thesis I worked towards explaining the White Dwarf Cemetery which refers to the then mysterious absence of planetary companions to white dwarf stars. I developed a dynamical n-body simulation of planetary systems with varying numbers of giant planets and studied their orbital evolution throughout the host star's lifetime.

Employment

Research Scientist - 51 Pegasi b Fellow

Cambridge, USA

Massachusetts Institute of Technology

Aug 2018 - Present

- Using computational chemistry to understand potential alien biospheres. Project includes expanding the RASCALL database to in-clude spectra for thousands of molecules associated with astrobiology.
- Working with the TESS and the Ariel space missions on the unequivocal detection and characterization of exoplanets.
- Updating the PH_3 linelist for integration into HITEMP, GEISA and ExoMOl databases , and application to high-resolution spectroscopy.

Postdoctoral Associate

Cambridge, USA

Massachusetts Institute of Technology

Sept 2016 - July 2018

- Joint post-doc at the Kavli Institute and the department of Earth, Atmospheric and Planetary Sciences.
- Primary research focus: Large scale simulation of molecular opacities. Leading the RASCALL (Rapid Approximate Spectral Calculations for ALL) project, which combines organic chemistry and quantum physics to simulate spectra of potentially important volatiles.
- Primary research group is the biosignature detection research being led by Professor Sara Seager.

Head of Education for the Twinkle Space Mission

London, UK

University College London

Jan 2015 - Sep 2016

- Creator of the educational and outreach program EduTwinkle, which aims to: create productive relationships between schools and space missions; widen participation in higher education by under-represented groups; and increase girls' uptake of STEM subjects.
- Founder of ORBYTS (Original Research by Young Twinkle Students), where high school students collaborate with scientists to produce publishable research (e.g., Chubb+ 2018 and McKemmish+ 2017, where I'm the senior author and 14 students are official co-authors).

Research Associate - Quantum Chemistry

London, UK

University College London (Goldman Sachs and Researchers in Schools sponsorship)

Sep 2015 - Aug 2016

- Part-time post-doctorate alongside my secondary school teaching with RIS (see below).
- Led research projects into the tunnelling motion of phosphine (see Sousa-Silva+ 2016) and spectral symmetry.

Secondary School Teacher - Researcher in Schools (RIS)

London, UK

Brilliant Club/Goldman Sachs/King's College London/Highams Park School

Sep 2014 - Jul 2016

- Member of the first RIS cohort, which trains scientists to teach alongside their research (Qualified Teacher Status awarded June 2016).
- Taught 19 classes of middle- and high-school students in Geology, Chemistry, Physics and Astronomy.
- Led outreach programs for 6-18 yr olds, with focus on widening participation and addressing the gender imbalance in physics.
- Led an action research project on the impact of classroom incorporation of career prospects at all key stages (Ages 11- 18).

Research Intern

Ljubljana, Slovenia

Chemistry Department of the Institut Josef Stefan

Sep 2010 - Dec 2010

- Built and monitored the experimental set-up for the study of the crystal structure of hydrazinium fluorocadmate, and developed a computational program for the calibration of the institute's spectrometer (see Sousa-Silva et al 2013).
- Duties also included purchasing equipment and liaising with companies, organizing meetings and presentations, researching companies and their equipment, performing data analysis, software development, reactor set-up and assisting in the laboratory.

Recent Talks and Panels

Astronomy Seminar (INVITED) — *NYU, USA*

Speaker — *Feb. 2019*
MIT Haystack Colloquium (INVITED) — *Haystack Observatory, USA*

Colloquium Speaker — *Jan. 2019*
Life Beyond Earth (INVITED) — *Museum of Science, Boston*

Panelist — *Nov. 2018*
Roadmap for Universal Life (INVITED) — *Lorentz Centre, Netherlands*

Workshop Speaker — *Nov. 2018*
Big History (INVITED) — *UVA, Netherlands*

Special Guest Lecturer — *Oct. 2018*
Anton Pannekoek Institute Seminar (INVITED) — *UVA, Netherlands*

Speaker — *Oct. 2018*
Science Faculty Colloquium (INVITED) — *FCUL, Portugal*

Speaker — *Oct. 2018*
High Resolution Spectroscopy For Exoplanet Atmospheres (INVITED) — *Nice, France*

HoRSE Conference Speaker — *Oct. 2018*
Spectroscopy of Exoplanets (INVITED) — *Cumberland Lodge, Windsor, UK*

Conference — *Jul. 2018*
FutureFest (PUBLIC) — *Tobacco Dock, London, UK*

Invited Panelist — *Jul. 2018*
HITRAN Conference (CONTRIBUTED) — *CfA, Cambridge, USA*

Speaker — *Jul. 2018*
Breakthrough Discuss (INVITED) — *Stanford University, USA*

Panelist — *April 2018*
Stars & Planets Seminar (INVITED) — *CfA, Cambridge, USA*

Speaker — *Jan 2018*
231th AAS Meeting (CONTRIBUTED) — *Washington, DC, USA*

Speaker at both the Education and Astrobiology sessions (two talks) — *Jan 2018*
BostonTalks (PUBLIC) — *WGBH, Boston, USA*

HappyHour presents Space (Speaker) — *Nov. 2017*
Harvard Retirement (INVITED) — *Cambridge, USA*

Guest Lecturer — *Nov 2017*

Proposals, White Papers, Working Groups and Committees

2019-Now	**TESS Team**, Target of Interest vetter for planetary candidates from the TESS mission, using both the SPOC and the QLP pipelines.	*TOI Vetter*
2018-Now	**ARIEL Working Group for Molecular Spectroscopy**, Working group focused on spectroscopic parameters to support the science of the ARIEL space mission.	*Leader*
2016-Now	**WiXII (Women in Course 12) Board**, Organization dedicated to fostering a welcoming, supportive community for everyone in EAPS (MIT).	*Cabinet Member*
2017-Now	**Diversity Council**, Advisory group for the implementation and improvement of diversity strategies.	*Postdoctoral Representative*
2018-2019	**Countless 2020 AMO and Astronomy Decadal Survey White Papers**, e.g., arXiv:1811.06157, arXiv:1903.04686, and arXiv:1903.04664	*Theoretical Spectra Expert*
2018	**Hubble Space Telescope Cycle 27 GO Proposal - PI: L Kreidberg**, The ANTHEM Program: Atmospheres of sub-Neptunes from TESS with HST Exploratory Measurements (submitted)	*Molecular Opacities Expert*
2018	**NASA NUP Proposal - PI: N Lewis/N Batalha**, A Community Tool for Computing, Visualizing, and Manipulating Molecular & Atomic Opacities	*Molecular Opacities Expert*
2018	**NASA Exobiology Proposal - PI: S Seager**, A Database Approach to Life's use of Chemical Space for Insight into the Nature and Signatures of Life on Other Worlds	*Molecular Opacities Expert*
2017	**JWST Cycle 1 Proposal - PI: J de Wit**, Observation of the innermost planet of TRAPPIST-1 for atmospheric characterization (in prep).	*Molecular Opacities Expert*
2017	**SEEC/NExSS White Paper for NAS call on Exoplanet Science Strategy**, Exploring Extreme Space Weather Factors of Exoplanetary Habitability	*Co-author*

Relevant Awards

51 Pegasi b Felllowship Grant Award — *EAPS, MIT*

Heising-Simons Foundation — *2019*

- The 51 Pegasi b Fellowship provides exceptional postdoctoral scientists with the opportunity to conduct theoretical, observational, and experimental research in planetary astronomy. Grant Award: $375,000.

Sagan Fellowship (Declined) — *CfA, Harvard*

NASA Hubble Fellowship Program (NHFP) — *2019*

- The NHFP program supports outstanding postdoctoral scientists to pursue independent research which contributes to NASA Astrophysics. Sagan fellows are selected to answer the question: "Are We Alone?". Award granted for the project proposal entitled: "The Smallest Tools Can Answer the Biggest Questions: Decoding Exoplanet Biospheres with Quantum Chemistry".

MIT Physics Research Fellows Grant — *MIT*

Physics Department, MIT — *2018*

- Award granted for the project proposal entitled "Creating a Rosetta Stone for the Interpretation of Exoplanet Biospheres". Sponsors: Heising-Simons Foundation.

Publications

in review	**C Sousa-Silva, JJ Petkowski and S Seager**, *Molecular Simulations for the Spectroscopic Detection of Atmospheric Gases*	*PCCP*
in review	**C Sousa-Silva, S Seager, JJ Petkowski, S Ranjan, Z Zhan, R Hu and W. Bains**, *On Phosphine as a Biosignature Gas in Exoplanet Atmospheres*	*Astrobiology*
2019	**W Bains, JJ Petkowski, C Sousa-Silva and S Seager**, *Trivalent Phosphorus and Phosphines as Components of Biochemistry in Anoxic Environments*	*Astrobiology*
2019	**W Bains, JJ Petkowski, C Sousa-Silva and S Seager**, *New environmental model for thermodynamic ecology of biological phosphine production*	*Science of the Total Environment*
2018	**K L Chubb, M Joseph, J Franklin, N Choudhury, T Furtenbacher, A G Császár, G Gaspard, P Oguoko, A Kelly, S N Yurchenko, J Tennyson and C Sousa-Silva***, *MARVEL analysis of the measured high-resolution rovibrational spectra of C_2H_2*, 204: 42-55; doi:10.1016/j.jqsrt.2017.08.018	*JQSRT*
2017	**C Sousa-Silva, E J Barton, K L Chubb, M Gorman, L K McKemmish and J Tennyson**, *Original Research By Young Twinkle Students (ORBYTS)*, 53.1: 015020	*Physics Education*
2017	**L K McKemmish, T Masseron, S Sheppard, E Sandeman, Z Schofield, T Furtenbacher, A G Csaszar, J Tennyson and C Sousa-Silva***, *MARVEL Analysis of the Measured High-resolution Rovibronic Spectra of 48Ti16O*, 228.2: 15	*ApJ Sup*
2016	**C Sousa-Silva, J Tennyson and S N Yurchenko**, *Communication: Tunnelling Splitting in the Phosphine Molecule*, 145, 091102; doi: 10.1063/1.4962259	*J Chem Phys*
2016	**J Tennyson, S Yurchenko,** *et al., including* **C Sousa-Silva**, *The ExoMol database: molecular line lists for exoplanet and other hot atmospheres*, 327, 73-94	*JMS*
2014	**C Sousa-Silva, A F Al-Refaie, J Tennyson, S N Yurchenko**, *ExoMol line lists - VII: The Rotation-vibration Spectrum of Phosphine up to 1500K*, 446.3: 2337-2347; doi:10.1093/mnras/stu2246	*MNRAS*
2014	**C Sousa-Silva, N Hesketh, S N Yurchenko and J Tennyson** , *High Temperature Partition Functions and Thermodynamic Data for Phosphine and Ammonia*, 142: 66-74; doi:10.1016/j.jqsrt.2014.03.012	*JQSRT*
2013	**C Sousa-Silva, S N Yurchenko and J Tennyson**, *A Computed Room Temperature Line List for Phosphine*, 288: 28-37; doi: 10.1016/j.jms.2013.04.002	*JMS*
2013	**C Sousa-Silva, G Veryasov, E Goreshnik, M Ponikvar and A Jesih**, *Crystal Structure and Vibrational Spectra of Hydrazinium (+1) Fluorocadmate*, 144.10: 1455-1459	*MfCCM*

* Indicates a supervisory role

h-index: 7, total citations: 299. Total articles published in peer-reviewed journals since 2013: 11 (+ 2 articles in review). First-author articles: 6 (+ 2 articles in review).