Sergio Martin-Alvarez | KIPAC Fellow at Stanford University

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Version from March 24, 2024. 0000-0002-4059-9850

Research interests and research profile:
I generate and study my own numerical simulations to **investigate the formation of galaxies**, from ISM scales (star formation, MHD turbulence, etc.) up to the large scales of our Universe (baryonic feedback and reionization). I am especially interested in **the role played by non-thermal physics such as radiation, cosmic rays, and magnetic fields**, as well as their complex interplay. **Whenever useful for my research, I have developed my own modifications to the RAMSES code, which I mainly use for my simulations.** These span modifications for: quality of life, analysis-related, new physics modules and modifications to the MHD solver. To be able to do my research, **I have led multiple computational time proposals** which granted me extensive computational resources. **I am deeply interested in connecting simulations with observations,** and have the ability to generate **mock multi-wavelength observations of galaxies:** gamma-ray, UV, NIR, as well as **polarimetric observations of FIR, and radio synchrotron emission.** I can also obtain resonant lines using the RASCAS code and IFU-like observations of stellar emission with my newly developed code.

Education

PhD in Astrophysics, University of Oxford — ***10/2015 – 06/2019***
Thesis title: Magnetic fields in and around galaxies. — With J. Devriendt & A. Slyz

MSc in Advanced Physics, Universitat de València — ***09/2014 – 07/2015***
Theoretical physics & astrophysics, 1st class. Thesis title: Cosmological shock waves. — With V. Quilis

MPhys in Physics & Astrophysics, Universitat of Leeds — ***09/2013 – 06/2014***
Erasmus year, 1st class. Thesis title: Blowouts Evolution in Interstellar Bubbles. — With J. Pittard

BSc in Physics, Universitat de València — ***10/2010 – 06/2014***

Research Experience - Astrophysics

KIPAC Fellow, KIPAC, Stanford University — ***09/2022 – Present***
Churchill College By-Fellow, Churchill college, University of Cambridge — ***10/2019 – 08/2022***
Research Associate, IoA & KICC, University of Cambridge — ***08/2019 – 08/2022***
Balzan Fellow, Balzan Centre for Cosmological Studies & IAP (Paris) — ***04/2019 – 06/2019***
UV Research Scholarship, Department of A&A, Universitat de València — ***06/2015 – 09/2015***
IAC Research Scholarship, Instituto de Astrofísica de Canarias (IAC) — ***06/2014 – 09/2014***

Supervised Students

If not the main supervisor for each project, the corresponding main supervisor is underlined. Supervision role is indicated based on scientific advising for the research project.

Graduate Students

Shenghua Liu, Stanford, PhD rotation project, main supervisor — ***09/2023 – Present***
The impact of primordial magnetic fields on the matter power spectrum — With S.E. Clark

Tara DaCunha, Stanford, PhD rotation project, main supervisor — ***04/2023 – Present***
Closing the loop: matching synthetic and real radio observations of galaxies — With E. Lopez-Rodriguez & S.E. Clark

Yuxuan Yuan, Cambridge, PhD project, co-supervisor — ***09/2021 – Present***
Lya emission as a sensitive probe of feedback-regulated LyC escape — With M.G. Haehnelt & D. Sijacki

Francisco Rodriguez-Montero, Oxford, PhD project, main advisor for CR science — ***09/2020 – Present***
Cosmic ray feedback in simulations of spiral galaxies — With J. Devriendt & A. Slyz

Mahsa Sanati, EPFL, PhD projects, main advisor for MHD simulation science — ***09/2019 – 04/2023***
The impact of primordial magnetic fields on dwarf galaxies — With J. Schober & Y. Revaz

Jack Dinsmore, Stanford, PhD rotation project, main supervisor — ***Autumn 2022***
Resolved properties of magnetic field in simulated galaxies — With E. Lopez-Rodriguez & S.E. Clark

Charlie Brooker, Cambridge, MSc project, main supervisor — ***09/2021 – 06/2022***
Galaxy formation and black hole evolution in MHD simulations with AGN — With D. Sijacki

Rahma Alfarsy, Cambridge, MSc project, main supervisor — ***09/2020 – 06/2021***
MHD simulations on the emergence of supermassive black holes during cosmic dawn — With D. Sijacki

Francisco Rodriguez-Montero, Cambridge, MSc project, main supervisor ***09/2019 – 09/2020***
MHD simulations of SNe with cosmic rays With D. Sijacki

Undergraduate and Summer Research Students

Students working towards writing a publication from their undergraduate research are highlighted with *

Azana Queen*, Stanford, Undergraduate research, co-main supervisor ***04/2023 – Present***
Evaluating the accuracy of IFU velocity measurements with UFD galaxy simulations With M.D.L. Reyes & R. Wechsler

Diego B. Maglione*, Stanford, Undergraduate research, main supervisor ***01/2023 – Present***
Magnetic field alignment with density gradients in simulations of galaxies With E. Lopez-Rodriguez & S.E. Clark

Yujina Basnet, Stanford, Undergraduate research, main supervisor ***Summer 2023***
Tracing the pollution of intergalactic magnetic fields from galactic outflows With E. Lopez-Rodriguez & S.E. Clark

Mark T. H. Zhu*, Stanford, Undergraduate research, co-supervisor ***Summer 2023***
Pixelation techniques to reconstruct polarimetric signals in observations With E. Lopez-Rodriguez & S.E. Clark

Jacob Gunn, Cambridge, Summer scholar, main supervisor ***Summer 2020***
The impact of magnetic fields on the LCDM cusp-core problem

Stefano Zazzera, Cambridge, Summer scholar, main supervisor ***Summer 2020***
The impact of magnetic fields on the LCDM cusp-core problem

Petr Jakubcik, Oxford, Undergraduate research, main supervisor ***09/2018 – 09/2019***
Magnetic field amplification during galaxy mergers With J. Devriendt & A. Slyz

Experience

Academic Teaching

Note: supervisors (Cambridge) and tutors (Oxford) are roles with similar responsabilities to those of teaching assistants.

Guest Lecturer for Computational Physics (Physics 113), Stanford University ***2024***
Supervisor for Statistical Physics (3rd year), University of Cambridge ***2020–2021***
Supervisor for Stellar Dynamics & Structure of Galaxies (3rd year), University of Cambridge ***2019–2021***
C1 Astrophysics MPhys Tutor, University of Oxford ***2016–2019***
Astrophysics Laboratory (3rd year) Junior Demonstrator, University of Oxford ***2016–2019***
Scholarship Selection Committee & Leading Examiner, CMSJR, Valencia ***2015***
Spanish BSc Conversation Tutor (1st year), University of Leeds ***2013–2014***
Physics and maths personal tutor, for high school and BSc levels (independent) ***2008–2013***

In addition to the roles indicated above, I have also taught various one-off lectures aimed at undergraduate and graduate students on topics such as python, employing HPC facilities, hydrodynamics, numerical hydrodynamics, and the basics of numerical simulations, amongst others.

Public Outreach Service

Throughout my career, I have frequently engaged actively and taken leading roles in outreach activities and their organisation. Evidence for this is my founding and presidency of DivCien outreach society in Valencia (2014 - 2015), my high outreach engagement and role as outreach coordinator while at Oxford, or my role as part of the KIPAC Community Day Committee. **I have actively participated as well as organised various dozens of talks, workshops, and more.** Many of these events targeted underrepresented or underprivileged communities and those with lower percentages of higher education attendance, aiming to not only foster engagement, but also to provide career advice to younger generations that may be interested in accessing university studies. Finally, in addition to my research being featured in magazines for scientific outreach, I frequently collaborate with my hometown local media to explain and discuss scientific topics of interest. Recent examples are the discovery of phosphine in the clouds of Venus or the reported rotation variations of the Earth's inner core.

Invited Speaker, Starlight Festival ***June 2024***
Noches Astronómicas collaborator (Spanish Outreach), KIPAC, Stanford University ***2022–Present***
KIPAC Community Day committee planning committee (>3000 attendees), Stanford University ***2022***
In charge of organising and coordinating the lectures series, speakers, and presentations.
Oxford Stargazing Committee (∼1500 attendees each edition), University of Oxford ***2016–2018***
In charge of organising and coordinating the demonstrations, stands, and the cafeteria section.
Outreach graduate coordinator, University of Oxford ***2016–2018***
In charge of organising fortnightly events, talks, workshops for children, and telescope nights.
DivCien President & Founder, Students society for Divulgacion Científica (València) ***2014–2015***

Community Service, Management, and Communication

KIPAC Post-Baccalaureate Selection Committee Member, KIPAC, Stanford University ***2024***
Magcoffee co-organiser, Cosmic Magnetism informal group meetings, Stanford University ***2022–2024***
Grants panel scientific reviewer, STFC Consolidated Grants ***2019***
Postdoc Committee member, IoA, University of Cambridge ***2020–2022***
Postdoc Welcome Week Organiser (1st edition), IoA, University of Cambridge ***2020–2022***
Galaxies Journal Club - Seminar organiser, IoA, University of Cambridge ***2020–2022***
Galaxy Evolution Seminar & Simulators lunch - Seminars organiser, University of Oxford ***2018–2020***
Graduate Community Committee, Christ Church college, University of Oxford ***2018–2020***
Actively engaged in multiple elected roles, devoted to promote community welfare and inclusion
Welfare Officer (2015/2016), Social Secretary (2015/2016), Ethics & Environment Officer (2016), Dining Officer (2016/2018)
Physics Society of Student Representatives, Universitat de València ***2012–2015***
Physics MSc Students Elected Representative, Universitat de València ***2014–2015***
Physics BSc Students Elected Representative, Universitat de València ***2013–2014***

Conference Organising Committee, 3 events ***2021–Present***
Scientific publications referee, for MNRAS and ApJ journals ***2019–Present***

In addition to my participation in the official programs listed below, I have mentored various students at multiple stages of their careers. Some being my former research & academic students, or high school ones I met during outreach events.
Postgraduate students mentor, Churchill College, University of Cambridge ***2019–2022***
Postdoctoral mentor, IoA, University of Cambridge ***2020–2022***
Official Mentor for International Incoming Students, Universitat de València ***2014–2015***
Official Mentor for Freshmen Students, Universitat de València ***2012–2013***

Miscellaneous experience

Support astronomer, Universitat de València ***02/2015 – 05/2015***
Higgs-$\tau\bar{\tau}$ analysis intern, Universitat de València ***06/2013 – 09/2013***

Selected Awards

Scholarships and prizes

2022 – Present: KIPAC Fellowship - Stanford University, Stanford.
2019 – 2022: Churchill postdoctoral By-Fellowship - Churchill College, Cambridge.
2018: Balzan visitor Fellowship - Balzan Centre for Cosmological Studies, New College, Oxford.
2018: Commendation to 'Contribution to access and outreach' (University of Oxford - Students Union).
2017: Highly commended SEPnet communication awards - Stargazing Team.
2015 – 2019: Hintze Scholarship - University of Oxford.
2015: Introduction to Research Scholarship - Universitat de València.
2014: Summer Research Scholarship - Instituto de Astrofísica de Canarias
2013 – 2014: Erasmus Scholarship - Leeds university.
2010 – 2015: Fully-funded university Scholarship - CMU San Juan de Ribera.

Computing Time (as Principal Investigator)

All indicated awards (in units of 10^6 computing hours: MCPUh) correspond exclusively to projects or subprojects for which I am the principal investigator (or co-PI wherever indicated). For subprojects, full proposals may have received higher amounts than indicated (e.g. SPHINX, 68 Mhours). I have been approximately awarded ~ 50 MCPUh ($+19$ MCPUh requested currently under review - former applications all received $> 80\%$ of the required time) throughout my career to generate my own numerical simulations.
These awards, my modifications of the simulation code RAMSES, and the generation of my own numerical simulations combined illustrate my high independence as a numerical astrophysicist, able to dynamically adapt the software, setup and configuration of my simulations to tackle different scientific open questions and problems.
9 MCPUh - submitted, PI: Understanding radio and FIR Polarimetry with Simulations. DiRAC, UK. ***2023***
10 MCPUh - submitted, co-PI: Primordial Magnetic Fields and Dwarf Galaxies. DiRAC, UK. ***2023***
20 MCPUh, PI: The First Cosmic Ray Radiation-MHD Galaxy Formation Simulations. DiRAC, UK. ***2021***
9 MCPUh, Subproject PI: The Influence of PMFs on the Cosmic Distribution of Baryons. DiRAC, UK ***2021***
2 MCPUh, PI: The Impact of Magnetic Fields on the ISM of Galaxies. ARC, Oxford ***2017–2019***

12 MCPUh, Subproject co-PI: Magnetic Gields in the Epoch of Reionization. PRACE, EU. ***2018***
Full Proposal: The First Luminous Objects and Reionization with SPHINX (PI: J. Rosdahl).
4.5 MCPUh, Subproject PI: Magnetized Galaxy Formation in the SKA Era. DiRAC, UK. ***2018***
Full Proposal: Galaxy Physics from Cosmological to Galactic Scales (PI: A. Slyz)
0.65 MCPUh, PI: Magnetic Fields in Galaxy Formation. ARCHER, UK ***2015–2016***

Other Skills

Coding Skills & Languages

Basic: HTML, QBasic, MATLAB, CUDA **Intermediate**: VisualBasic, R, C/C++

Advanced: PYTHON, Mathematica, LaTeX, FORTRAN, OpenMP, MPI

Languages

Spanish: Native **Catalan**: Native **English**: Bilingual **Mandarin**: Basic

Scientific Presentations

I have presented more than 30 talks, with 15 of them being invited talks and seminars

1, AAS Winter meeting, New Orleans, USA ***2024***
2, IAP colloquium: New simulations for new problems in galaxy formation, Paris, France ***2023***
3 Invited Contribution, The MW and its high-z progenitors in theory and observations, Cambridge, UK ***2023***
4 Invited Talk, The Physics of Cosmic Rays Workshop, Lyon, France ***2023***
5 Invited Colloquium (home institution), KIPAC, Stanford, USA ***2023***
6, RAMSES User Meeting 2023 (virtual) ***2023***
7 Invited Participant, Recent Advances in Galaxy Formation and Reionization, Seoul, Korea ***2022***
8 Invited Talk, CGI Seminar (UCSC), Santa Cruz, USA ***2023***
9 Invited Talk, Galaxies Seminar, University of Cambridge, UK ***2022***
10 Invited Talk, Astrophysics Seminar, University of Surrey, UK ***2022***
11 Invited Talk, KIPAC Tea Seminar, Stanford University, USA ***2022***
12 Invited Talk, IAU H1 Commission - The Local Universe (virtual) ***2021***
13, RAMSES User Meeting 2021 (virtual) ***2021***
14, RAS meeting: Galactic magnetic fields (virtual) ***2021***
15 Invited Talk (home institution), Cosmology Seminar, University of Cambridge, UK (virtual) ***2021***
16 Invited Talk (home institution), Institute Seminar, University of Cambridge, UK (virtual) ***2021***
17 Invited Talk, SPHINX, RASCAS and TRIPLE meeting, Lyon, France (virtual) ***2021***
18, SPHINX, RASCAS and TRIPLE meeting, Lyon, France (virtual) ***2020***
19, Cosmic Turbulence and Magnetic Fields, Cargèse, France ***2019***
20, DiRAC Day 2019, Leicester, UK ***2019***
21, Modeling Meerkats: Comparing galaxy formation simulations to MeerKAT, Kruger, South Africa ***2019***
22 Invited Talk, Galaxies Seminar, Institut d'Astrophysique de Paris, France ***2019***
23, RAMSES User Meeting 2018, Lyon, France ***2018***
24 Invited Talk, Astrophysics Seminar, University of Bologna, Italy ***2018***
25 Invited Talk (home institution), Galaxy Evolution Seminar, University of Oxford, UK ***2018***
26, Magnetic Fields or Turbulence, Hsinchu, Taiwan ***2018***
27 Invited Talk, Astrophysics Seminar, University of Surrey, UK ***2017***
28, Magnetic Fields in the Universe VI, Natal, Brazil ***2017***
29, RAMSES User Meeting 2017, Nice, France ***2017***
30, DiRAC Day 2017, Exeter, UK ***2017***
31, RAMSES User Meeting 2016, Paris, France ***2016***

Publication List

Find a more up to date list and information about my publications on my webpage and on ADS.
Underlined paper titles for each publication serve as hyperlinks to each publication in the electronic version of this CV.

Refereed publications as lead author

1, S. Martin-Alvarez, E. Lopez-Rodriguez, T. Dacunha, A.S. Borlaff, S.E. Clark, et al. ***ApJ, 2024***
A Tomographic View of FIR and Radio Polarimetric Observations through MHD Sims. of Galaxies 35pp, 17 figures

2, S. Martin-Alvarez, D. Sijacki, M.G. Haehnelt, M. Farcy, Y. Dubois, et al. ***MNRAS, 2023***
Pandora project - I. Impact of RT, MHD, and CRs on baryonic and DM dwarf properties 26pp, 15 figures

3, S. Martin-Alvarez, J. Devriendt, A. Slyz, D. Sijacki, et al. ***MNRAS, 2022***
Towards convergence of turbulent dynamo amplification in cosmological simulations 20pp, 17 figures

4, S. Martin-Alvarez, H. Katz, D. Sijacki, J. Devriendt, and A. Slyz ***MNRAS, 2021***
Unraveling the origin of magnetic fields in galaxies 19pp, 13 figures
Featured in scientific magazines such as Academic Times and New Scientist

5, S. Martin-Alvarez, J. Devriendt, A. Slyz, and C. Gomez-Guijarro ***MNRAS, 2020***
How primordial magnetic fields shrink galaxies 23pp, 15 figures
Featured in magazines such as New Scientist.

6, S. Martin-Alvarez, J. Devriendt, A. Slyz, and R. Teyssier ***MNRAS, 2018***
A three-phase amplification of the cosmic magnetic field in spiral galaxies 24pp, 20 figures

7, S. Martin-Alvarez, S. Planelles, and V. Quilis ***ApSS, 2017***
On the interplay between cosmological shock waves and their environment 16pp, 10 figures
Journal issue cover picture

Refereed publications as co-first author or with primary involvement

8, C. Witten, N. Laporte, S. Martin-Alvarez, D. Sijacki, et al. ***Nature Astronomy, 2024***
Deciphering Lyman-alpha Emission Deep into the Epoch of Reionisation
Makes use of my new RTCRMHD cosmological high-res simulations. Performed all the simulation analysis.

9, H. Katz & S. Martin-Alvarez, J. Rosdahl, T. Kimm, et al. ***MNRAS, 2021***
Introducing SPHINX-MHD: The Impact of Primordial Magnetic Fields [...]
Co-first authored

10, H. Katz & S. Martin-Alvarez, J. Devriendt, A. Slyz, and T. Kimm ***MNRAS, 2019***
Magnetogenesis at cosmic dawn: tracing the origins of cosmic magnetic fields
Co-first authored

Refereed publications from supervised & advised students

11, T. Dacunha, S. Martin-Alvarez, E. Lopez-Rodriguez, and S.E. Clark ***ApJ, in prep***
Closing the Loop: Recovering simulated galactic magnetic fields in synthetic observations

12, M. Sanati, S. Martin-Alvarez, J. Schober, and Y. Revaz ***A&A, submitted***
Dwarf galaxies as a probe of a primordially magnetized Universe

13, Y. Yuan, S. Martin-Alvarez, M.G. Haehnelt, T. Garel, and D. Sijacki ***MNRAS, submitted***
Lyα emission as a sensitive probe of feedback-regulated LyC escape at high and low redshift

14, F. Rodriguez-Montero, S. Martin-Alvarez, A. Slyz, J. Devriendt, et al. ***MNRAS, submitted***
The impact of cosmic rays on the ISM and galactic outflows of Milky Way analogues

15, F. Rodriguez-Montero, S. Martin-Alvarez, D. Sijacki, A. Slyz, J. Devriendt, et al. ***MNRAS, 2021***
Momentum deposition of Supernovae with Cosmic Rays

Refereed publications I am part of

16, A.S. Borlaff, E. Lopez-Rodriguez, R. Beck, S.E. Clark, et al. including S. Martin-Alvarez ***ApJ, 2023***
SALSA Legacy Program. V. First Results on the Magnetic Field Orientation of Galaxies

17, E. Lopez-Rodriguez, A.S. Borlaff, R. Beck, W.T. Reach, et al. including S. Martin-Alvarez ***ApJ, 2023***
SALSA Legacy Program: The Magnetic Fields in the Multiphase ISM of the Antennae Galaxies

18, J. Rosdahl, J. Blaizot, H. Katz, T. Kimm, et al. including S. Martin-Alvarez ***MNRAS, 2022***
LyC escape from SPHINX galaxies in the Epoch of Reionization

19, E. Lopez-Rodriguez, S.A. Mao, R. Beck, A.S. Borlaff, et al. including S. Martin-Alvarez ***ApJ, 2022***
SALSA Legacy Program. IV. Program Overview and First Results on the Polarization Fraction

20, E. Lopez-Rodriguez, M. Clarke, S. Shenoy, W. Vacca, et al. including S. Martin-Alvarez ***ApJ, 2022***
SALSA Legacy Program. III. First Data Release and On-the-fly Polarization Mapping Characterization

21, M. Farcy, J. Rosdahl, Y. Dubois, J. Blaizot, and S. Martin-Alvarez ***MNRAS, 2022***
RMHD simulations of cosmic ray feedback in disc galaxies

22, H. Katz, J. Rosdahl, T. Kimm, T. Garel, et al. including S. Martin-Alvarez ***MNRAS, 2022***
The Nature of High [OIII]$_{88\mu m}$/[CII]$_{158\mu m}$ Galaxies in the Epoch of Reionization [...]

23, O. Attia, R. Teyssier, H. Katz, T. Kimm, S. Martin-Alvarez, et al. ***MNRAS, 2021***
Cosmological magnetogenesis: the Biermann battery during the Epoch of reionization

24, C. Gómez-Guijarro, G. E. Magdis, F. Valentino, S. Toft, et al. including S. Martin-Alvarez ***ApJ, 2019***
Compact Star-Forming Galaxies as Old Starbursts Becoming Quiescent