

## Dr. Kuldeep Verma PhD, MSc, BSc

Institute of Space Sciences (ICE-CSIC)  
Carrer de Can Magrans, Campus UAB  
08193 Cerdanyola del Valles, Spain  
E-mail: [verma@ice.csic.es](mailto:verma@ice.csic.es); [kuldeep@phys.au.dk](mailto:kuldeep@phys.au.dk)  
Mobile: +917307108094  
Website: <https://www.kuldeepverma-astronomy.com>

Date of Birth: February 1, 1989  
Place of Birth: India  
Nationality: India  
ORCID: 0000-0003-0970-6440  
ResearcherID: AAH-7780-2019  
Skype ID: kuldeep.verma1989

### Overview

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I was officially awarded a PhD degree in physics on March 3, 2017 (thesis defended on October 14, 2016) by the Tata Institute of Fundamental Research (TIFR), Mumbai, India. On October 1, 2016, I joined Stellar Astrophysics Centre (SAC) funded by the Danish National Research Foundation and hosted within the Department of Physics and Astronomy at Aarhus University (AU) in Denmark as a postdoctoral research fellow, and worked there until April 30, 2021. I still hold a formal affiliation with SAC starting from May 1, 2021 to September 30, 2022, and have the privilege to access resources under the centre including a desk, mail account, AU servers and *Grendel-s* computer cluster. From November 1, 2021 to October 31, 2024, I am Juan de la Cierva fellow at the Institute of Space Sciences (ICE-CSIC), Spain. Despite having a couple of offers from the University of New South Wales (UNSW), Australia and ICE-CSIC, I was unemployed between May 1, 2021 and October 31, 2021 due to border restrictions and delayed visa processing caused by the COVID19 pandemic.

My main research interests are stellar astrophysics and Galactic archaeology. As of October 2021, I am coauthor of **24** peer-reviewed publications (of which **8** publications as first author). I am member of a number of national and international organizations including the International Astronomical Union (IAU), European Astronomical Society (EAS) and the United Science Foundation (USF), and scientific consortia including the NASA *Kepler* and TESS and the ESA PLATO asteroseismic science consortia. I have received several national and international fellowships, delivered numerous science talks, and have gained significant teaching and supervision experience for a scientist at my level. I work as referee for scientific articles submitted to various astronomy journals, and act as reviewer for the telescope observing proposals.

### Academic degrees

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27/07/2011 – 03/03/2017	<u>PhD in Physics</u> (Thesis submission: July 26, 2016; Thesis defence: October 14, 2016), TIFR, Mumbai, India Supervisor: Prof. H. M. Antia
15/07/2009 – 25/07/2011	<u>MSc in Physics</u> (FGPA: 7.9/9.0, 1 <sup>st</sup> class), Jawaharlal Nehru University, New Delhi, India
31/07/2006 – 08/06/2009	<u>BSc in Physics/Mathematics/Chemistry(minor)</u> (Marks: 74.2%, 1 <sup>st</sup> class), University of Allahabad, Allahabad, India

### Academic/Research Positions

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01/01/2022 – 31/12/2023	(Prospective) <u>Research Associate</u> , UNSW, Australia Supervisor: Dr. D. Stello
01/11/2021 – 31/10/2024	<u>Juan de la Cierva Fellow</u> , ICE-CSIC, Spain Supervisor: Dr. A. Serenelli
01/05/2021 – 30/09/2022	<u>Formal Long-term Affiliate</u> , AU, Denmark
01/10/2016 – 30/04/2021	<u>Postdoctoral Research Fellow</u> , AU, Denmark Supervisor: Dr. V. Aguirre Børsen-Koch, formerly Dr. V. Silva Aguirre

### Fellowships and Awards

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2021 Received the Spanish Juan de la Cierva Incorporación Postdoctoral Fellowship (93,000 Euro)

- 2020 Invited for interview for the prestigious French CNES Postdoctoral Fellowship (had to withdraw my application at this stage because I already accepted the offer from UNSW)
- 2020 Offered Research Associate position, UNSW, Sydney, Australia
- 2016 Offered Postdoctoral Fellowship, Instituto de Astrofísica e Ciências do Espaço, Universidade do Porto, Porto, Portugal
- 2014 Ratanbai Jerajani Award, for the best seminar in the area of Astronomy and Astrophysics, TIFR, Mumbai, India
- 2010 Junior Research Fellowship (JRF), in the subject of Physical Sciences under the Council of Scientific and Industrial Research (CSIR), India (All India Rank: 79)

## **Publications**

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As of October 2021, I am co-author of **31** publications indexed in the SAO/NASA Astrophysics Data System (H-index of **16** and a total of **800+** citations). These include 23 articles in major astronomy journals (such as Nature Astronomy, The Astrophysical Journal Letter, The Astrophysical Journal, Astronomy & Astrophysics and Monthly Notices of the Royal Astronomical Society), 2 in conference proceedings (1 refereed and 1 non-refereed), 5 online data catalogs and 1 erratum. Altogether, I am first author of 8 publications, while second author of 2.

### **Publications in peer-reviewed scientific journals**

1. M. S. Cunha, I. W. Roxburgh, V. Aguirre Børsen-Koch, ..., K. Verma, et al. 2021, “PLATO Hare-and-Hounds exercise: Asteroseismic model fitting of main-sequence solar-like pulsators”, MNRAS (in press), preprint (arXiv:2110.03332) (citation: 0)
2. V. Aguirre Børsen-Koch, J. L. Rørsted, A. B. Justesen, ..., K. Verma, et al. 2021, “The BAYesian STellar Algorithm (BASTA): a fitting tool for stellar studies, asteroseismology, exoplanets, and Galactic archaeology”, MNRAS (in press), preprint (arXiv:2109.14622) (citation: 0)
3. K. Verma, R. J. J. Grand, V. Silva Aguirre, et al. 2021, “An observational testbed for cosmological zoom-in simulations: constraining stellar migration in the solar cylinder using asteroseismology”, MNRAS, 506, 759 (citations: 1)
4. E. Spitoni, K. Verma, V. Silva Aguirre, et al. 2021, “APOGEE DR16: a multi-zone chemical evolution model for the Galactic disc based on MCMC methods”, A&A, 647, A73 (citations: 14)
5. A. Pietrinferni, S. L. Hidalgo, S. Cassisi, ..., K. Verma, et al. 2021, “The updated BaSTI stellar evolution models and isochrones: II. Alpha-enhanced calculations”, ApJ, 908, 102 (citations: 6)
6. P. E. Nissen, J. Christensen-Dalsgaard, J. R. Mosumgaard, ..., K. Verma, et al. 2020, “High-precision abundances of elements in solar-type stars: Evidence of two distinct sequences in abundance-age relations”, A&A, 640, A81 (citations: 34)
7. E. Spitoni, K. Verma, V. Silva Aguirre, et al. 2020, “Galactic archaeology with asteroseismic ages part II: Confirmation of a delayed gas infall using Bayesian analysis based on MCMC methods”, A&A, 635, A58 (citations: 20)
8. V. Silva Aguirre, D. Stello, A. Stokholm, ..., K. Verma, et al. 2020, “Detection and characterisation of oscillating red giants: first results from the TESS satellite”, ApJL, 889, L34 (citations: 20)
9. W. J. Chaplin, A. M. Serenelli, A. Miglio, ..., K. Verma, et al. 2020, “Age dating of an early Milky Way merger via asteroseismology of the naked-eye star  $\nu$  Indi”, Nat Astron, 4, 382 (citations: 28)
10. K. Verma, V. Silva Aguirre, 2019, “Helium settling in F stars: constraining turbulent mixing using the observed helium glitch signature”, MNRAS, 489, 1850 (citations: 10)
11. D. Huber, W. J. Chaplin, A. Chontos, ..., K. Verma, et al. 2019, “A hot saturn orbiting an oscillating late subgiant discovered by *TESS*”, AJ, 157, 245 (citations: 55)

12. [K. Verma](#), K. Raodeo, S. Basu, et al. 2019, “Helium abundance in a sample of cool stars: measurements from asteroseismology”, [MNRAS](#), 483, 4678 (citations: 27)
13. B. Nsamba, T. L. Campante, M. J. P. F. G. Monteiro, ..., [K. Verma](#), et al. 2018, “Asteroseismic modelling of solar-type stars: internal systematics from input physics and surface correction methods”, [MNRAS](#), 477, 5052 (citations: 25)
14. S. L. Hidalgo, A. Pietrinferni, S. Cassisi, ..., [K. Verma](#), et al. 2018, “The updated *BaSTI* stellar evolution models and isochrones. I. solar-scaled calculations”, [ApJ](#), 856, 125 (citations: 88)
15. [K. Verma](#), K. Raodeo, H. M. Antia, et al. 2017, “Seismic measurement of the locations of the base of convection zone and helium ionization zone for stars in the *Kepler* seismic LEGACY sample”, [ApJ](#), 837, 47 (citations: 29)
16. V. Silva Aguirre, M. N. Lund, H. M. Antia, ..., [K. Verma](#), et al. 2017, “Standing on the shoulders of dwarfs: the *Kepler* asteroseismic LEGACY sample. II. radii, masses, and ages”, [ApJ](#), 835, 173 (citations: 158)
17. M. N. Lund, V. Silva Aguirre, G. R. Davies, ..., [K. Verma](#), et al. 2017, “Standing on the shoulders of dwarfs: the *Kepler* asteroseismic LEGACY sample. I. oscillation mode parameters”, [ApJ](#), 835, 172 (citations: 135)
18. [K. Verma](#), S. Hanasoge, J. Bhattacharya, et al. 2016, “Asteroseismic determination of fundamental parameters of Sun-like stars using multi-layered neural networks”, [MNRAS](#), 461, 4206 (citations: 12)
19. D. R. Reese, W. J. Chaplin, G. R. Davies, ..., [K. Verma](#), et al. 2016, “SpaceInn hare-and-hounds exercise: estimation of stellar properties using space-based asteroseismic data”, [A&A](#), 592, A14 (citations: 26)
20. W. J. Chaplin, M. N. Lund, R. Handberg, ..., [K. Verma](#), et al. 2015, “Asteroseismology of solar-type stars with *K2*: detection of oscillations in C1 data”, [PASP](#), 127, 1038 (citations: 26)
21. T. Appourchaux, H. M. Antia, W. H. Ball, ..., [K. Verma](#), et al. 2015, “A seismic and gravitationally bound double star observed by *Kepler*. Implication for the presence of a convective core”, [A&A](#), 582, A25 (citations: 32)
22. [K. Verma](#), H. M. Antia, S. Basu, et al. 2014, “A theoretical study of acoustic glitches in low-mass main-sequence stars”, [ApJ](#), 794, 114 (citations: 21)
23. [K. Verma](#), J. P. Faria, H. M. Antia, et al. 2014, “Asteroseismic estimate of helium abundance of a solar analog binary system”, [ApJ](#), 790, 138 (citations: 42)

#### Publications in peer-reviewed conference proceedings

1. [K. Verma](#), J. P. Faria, H. M. Antia, et al. 2015, “Asteroseismic estimate of helium abundance of 16 Cyg A, B”, [EPJ Web of conferences](#), 101, 06066 (citations: 0)

#### ***Oral Scientific Communications***

As of October 2021, I have presented **10** science talks, including **4** invited seminars, **1** invited talk and **5** contributed talks at various national and international universities/institutes and conferences/workshops.

1. Invited Talk titled “A comparison of the predictions of Auriga simulations with the APOKASC and *Gaia* data”: *Chemical Evolution of Galaxies: the next 25 years* workshop, Sexten Center for Astrophysics, Sexten, Italy, January 11, 2020
2. Contributed Talk titled “Helium settling in F stars: Constraining turbulent mixing using observed signature of helium ionization”: *TASC5/KASC12* workshop, MIT Cambridge, USA, July 23, 2019
3. Invited Seminar titled “Asteroseismology as a tool to study stellar physics and Galactic chemical evolution”: Instituto de Astrofísica e Ciências do Espaço, Universidade do Porto, Portugal, July 10, 2019
4. Contributed Talk titled “Studying mixing in the outer layers using signatures of the acoustic glitches from *Kepler* data”: *TASC4/KASC11* workshop, AU, Denmark, July 13, 2018

5. Contributed Talk titled “Constraining additional mixing processes using the observed helium signature in oscillation frequencies from *Kepler*”: *EWASS* special session, Liverpool, UK, April 3, 2018
6. Contributed Talk titled “Seismic estimate of the envelope helium abundance for stars in *Kepler* seismic LEGACY sample”: *TASC3/KASC10* workshop, University of Birmingham, UK, July 19, 2017
7. Invited Seminar titled “Seismic study of Sun-like stars using glitch analysis and machine learning approaches”: Indian Institute of Astrophysics, Bangalore, India, September 14, 2016
8. Invited Seminar titled “Asteroseismology of Sun-like main-sequence stars: inferences using acoustic glitch signatures and machine learning approaches”: AU, Denmark, May 26, 2016
9. Contributed Talk titled “Asteroseismic inference of convection-zone depth and envelope helium abundance”: *Advances in Seismology: A Dialogue Across Disciplines* conference, TIFR, India, December 9, 2015
10. Invited Seminar titled “Seismology of solar-like stars”: Japan-Asia Youth Exchange Program in Science, Osaka University, Japan, November 30, 2015

### ***Teaching and Supervision***

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- Advanced Stellar Structure and Evolution: Category: Invited Lecturer (3 hours); Level: Postgraduate; Semester: Autumn 2018; AU, Denmark
- Jonas Dornonville de la Cour: Category: Supervisor; Level: Undergraduate; Semester: Spring 2018; Thesis title: “Classifying Stellar Pulsations based on their Light Curves using Machine Learning”; AU, Denmark
- Astronomy & Astrophysics I: Category: Teaching Assistant; Level: Doctorate; Semester: Autumn 2014; TIFR, Mumbai, India
- Computational Methods II: Category: Teaching Assistant; Level: Doctorate; Semester: Spring 2014; TIFR, Mumbai, India
- Classical Electrodynamics I: Category: Teaching Assistant; Level: Doctorate; Semester: Autumn 2013; TIFR, Mumbai, India

### ***Referee***

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- Referee scientific articles for *The Astrophysical Journal* (ApJ) and *Astronomy & Astrophysics* (A&A)
- Review observing proposals for the Canada-France-Hawaii Telescope (CFHT)

### ***Membership of Societies, Consortia and Organizations***

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- Member of the International Astronomical Union (IAU), European Astronomical Society (EAS) and the United Science Foundation (USF)
- Member of a number of work packages within WP 121 (on Stellar Models), 124 (on Seismic Diagnostics) and 125 (on Determination of Stellar Parameters) in the framework of the PLATO Science Management (PSM).
- Member of the TESS Asteroseismic Science Operations Center (TASOC), as well as of the TESS Asteroseismic Science Consortium (TASC) Working Group 2 (on Oscillations in Solar-Type Stars) and 7 (on Red Giant Oscillations), and also part of the coordinated activity TESS Data for Asteroseismology
- Member of the *Kepler* Asteroseismic Science Operations Center (KASOC), as well as of the *Kepler* Asteroseismic Science Consortium (KASC) Working Group 1 (on Solar-Like Oscillations) and 8 (on RGB Oscillations)
- Member of the SONG Data Archive (SODA)

### ***Attended Schools, Conferences and Workshops***

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1. PLATO WP12 HOW#2 virtual workshop (invited) on *Uncertainties in stellar properties determination*, April 12–15, 2021

2. PLATO WP12 HOW#1 virtual workshop (invited) on *the PLATO Stellar Analysis Pipeline: architecture, workflow, dataflow*, November 4–6, 2020
3. Workshop (invited) on *Chemical Evolution of Galaxies: the next 25 years*, Sexten Center for Astrophysics, Sexten, Italy, January 7–11, 2020
4. PLATO STESCI workshop III (invited), Residencia de Investigadores, Barcelona, Spain, November 19–22, 2019
5. TASC5/KASC12 workshop, Massachusetts Institute of Technology, Cambridge, USA, July 22–26, 2019
6. TASC4/KASC11 workshop on *First Light in a new Era of Astrophysics*, AU, Denmark, July 8–13, 2018
7. EWASS special session on *Open problems in modelling chemical element transport in stars*, Arena and Convention Centre, Liverpool, UK, April 3–6, 2018
8. Summer School on *Modules for Experiments in Stellar Astrophysics (MESA)*, University of California, Santa Barbara, USA, August 14–18, 2017
9. TASC3/KASC10 workshop on *TESSting Stellar Astrophysics*, University of Birmingham, UK, July 16–21, 2017
10. Conference on *Advances in Seismology: A Dialogue Across Disciplines*, TIFR, Mumbai, India, December 7–11, 2015
11. Sakura Science, Japan-Asia Youth Exchange Program in Science, Osaka University, Japan, November 30–December 4, 2015
12. DWIH Indo-German Winter School on *Solar and stellar astrophysics*, TIFR, Mumbai, India, November 3–7, 2014
13. 24<sup>th</sup> Evry Schatzman School on *Asteroseismology and next generation stellar models*, Station Biologique de Roscoff, France, September 28–October 3, 2014
14. 9<sup>th</sup> Heidelberg Astronomy Summer School on *Frontiers of stellar structure and evolution*, Max-Planck-Institut für Astronomie, Heidelberg, Germany, September 22–27, 2014
15. 4<sup>th</sup> IIA-PennState School on *Astrostatistics*, Vainu Bappu Observatory, Indian Institute of Astrophysics, Bangalore, India, July 22–29, 2013
16. Winter School on *Astronomical and cosmological surveys*, TIFR, Mumbai, India, December 10–17, 2012

### ***Technical Expertise/Skills***

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- Stellar evolution codes: Extensive experience in using the code *Modules for Experiments in Stellar Astrophysics (MESA)*, while working knowledge of the *GARching STEllar Evolution Code (GARSTEC)*
- Stellar pulsation codes: Extensive experience in using the *Aarhus adiabatic oscillation package (ADIPLS)*, while working knowledge of the GYRE code
- Stellar model fitting code: Extensive experience in using and further developing the *BAYesian STEllar Algorithm (BASTA)* code
- Chemical evolution models: Moderate experience in using two-infall chemical evolution model code
- Cosmological zoom-in simulations: Working knowledge of the *Auriga* simulations
- Machine learning: Deep learning, a 5-course specialization by *deeplearning.ai* on Coursera. Specialization Certificate earned on February 18, 2018. Extensive experience using the machine learning platforms *Theano*, *TensorFlow* and *Keras*
- Bayesian statistics: Extensive experience in using the Markov Chain Monte Carlo (MCMC) ensemble sampler, *emcee*: The MCMC Hammer
- Programming languages: Extensive experience using *Fortran*, *Python* and *Bash Shell*, while working knowledge of *Mathematica*

- Operating systems: Extensive experience in using *Linux* and *Macintosh*, while working knowledge of *Windows*. Extensive experience in using high-performance computing facilities, and managing big data (~terabyte)

## ***Languages***

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- Hindi: Native proficiency
- English: Full professional proficiency

## ***Contact Persons for Recommendation Letters***

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1. Dr. V. Aguirre Børsen-Koch (Postdoctoral supervisor)  
SAC, Department of Physics and Astronomy, AU  
Ny Munkegade 120, Building 1520, DK-8000 Aarhus C, Denmark  
Email: [victor@phys.au.dk](mailto:victor@phys.au.dk); Phone: +4587156352
2. Prof. H. M. Antia (PhD supervisor)  
Center for Excellence in Basic Sciences  
Nalanda, near National Center for Nano Science and Nano Technology  
University of Mumbai, Kalina, Santacruz East, Mumbai, Maharashtra 400098  
Email: [antia@tifr.res.in](mailto:antia@tifr.res.in); Phone: +919969506543
3. Prof. J. Christensen-Dalsgaard  
SAC, Department of Physics and Astronomy, AU  
Ny Munkegade 120, Building 1520, DK-8000 Aarhus C, Denmark  
Email: [jcd@phys.au.dk](mailto:jcd@phys.au.dk); Phone: +4587155604
4. Dr. A. Serenelli  
Institute of Space Sciences (ICE-CSIC)  
Carrer de Can Magrans, Campus UAB, 08193 Cerdanyola del Valles, Spain  
Email: [aldos@ice.csic.es](mailto:aldos@ice.csic.es); Phone: +34937379788
5. Dr. E. Spitoni  
Universite Cote d'Azur, Observatoire de la Cote d'Azur, CNRS, Laboratoire Lagrange  
96 Boulevard de l'Observatoire, CS 34229, 06304 Nice Cedex 4, France  
Email: [emanuele.spitoni@oca.eu](mailto:emanuele.spitoni@oca.eu); Phone: +33492003191