# Matthias **Raphael Stock**

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## Research Interests

Organic and water-based liquid scintillator development and characterization, instrumentation, neutrino physics, solar neutrinos, neutrino astronomy, active galactic nuclei, optical interferometry

## Education

05/2019 – expected 02/2024 **PhD student in Physics**
Technische Universität München (TUM), Germany
Thesis: *"Development and Characterization of Novel Liquid Scintillators for the Detection of Neutrinos in Future Large-Scale Detectors,"*
Research Advisor: Prof. Dr. Lothar Oberauer

10/2015 – 05/2018 **Master of Science in Physics**
Technische Universität München (TUM), Germany
Specialization in Nuclear, Particle and Astrophysics,
Thesis: *"Spectro-Interferometric Signatures of the Broad Line Regions in Active Galactic Nuclei,"* Research Advisor: Prof. Dr. Jason Dexter
Grade: 1.5 (passed with distinction)

09/2016 – 02/2017 **ERASMUS+ exchange student**
Sorbonne Université, France
Nuclei, Particles, Astroparticles and Cosmology (NPAC, Master 2 level)

10/2012 – 09/2015 **Bachelor of Science in Physics**
Technische Universität München (TUM), Germany
Grade: 2.6 (passed)

09/2004 – 06/2012 **Abitur** (General Higher Education Entrance Qualification)
Gymnasium Vilshofen, Germany
Grade: 2.5 (passed with merit)

## Employment

11/2018 – present **Research and teaching assistant**
Technical University of Munich,
TUM School of Natural Sciences, Physics Department,
Chair for Experimental Phyiscs and Astroparticle Physics (E15), Germany

06/2018 – 09/2018 **Research assistant**
Max Planck Institute for Extraterrestrial Physics (MPE),
Infrared/Submillimeter Group, Germany

# Professional Activities

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| 07/2022 – present | Laser protection officer of E15, TUM |
| 09/2020 – present | Chemistry laboratory manager of E15, TUM |
| 05/2019 – present | **PhD Thesis**<br>I develop organic and water-based liquid scintillators using different solvents and fluors. Using light sources, radioactive sources and particle accelerators I characterize liquid scintillators, e.g., for the JUNO and THEIA, concering emission spectra, fluorescence time profiles, relative light yields, and proton quenching factors with dedicated experiments at room and cold temperatures. I analyze the large amounts of data with statistical analysis, model fitting and numerical convolutions. |
| 04/2022 – 02/2023 | JUNO Deputy Young Researcher Representative |
| 07/03/2022 – 07/14/2022 | Active participation in pumping out the far detector of the Double Chooz experiment, Centrale nucléaire de Chooz, France |
| 04/22/2022 – 05/12/2022 | Co-leading beam times at the CN accelerator and at the Tandem-XTU accelerator, INFN LNL, Legnaro, Italy |
| 12/14/2021 – 12/24/2021 | Co-leading a beam time at the CN accelerator, INFN LNL, Legnaro, Italy |
| 06/02/2021 – 06/22/2021 | Co-leading a beam time at the CN accelerator, INFN LNL, Legnaro, Italy |
| 04/12/2021 – 04/23/2021 | Active participation in pumping out the near detector of the Double Chooz experiment, Centrale nucléaire de Chooz, France |
| 01/18/2021 – 01/30/2021 | Active participation in pumping out the near detector of the Double Chooz experiment, Centrale nucléaire de Chooz, France |
| 10/09/2019 – 10/11/2019 | Co-organizer of the *"JUNO DFG Meeting 2019,"* TUM, Germany |
| 09/16/2019 – 09/27/2019 | Co-leading a beam time at the MLL accelerator, Garching, Germany |
| 07/27/2019 – 08/29/2019 | Expert shifter at the *"PMT Characterization and Instrumentation Station for JUNO,"* Pan-Asia, Zhongshan, China |
| 04/28/2019 – 05/06/2019 | Co-leading a beam time at the MLL accelerator, Garching, Germany |
| 08/12/2018 – 08/16/2018 | Assistence in an observing program with ESO VLTI GRAVITY/AT, 24 hours, Paranal Observatory, Chile |
| 05/2017 – 05/2018 | **Master's Thesis**<br>I developed models of the broad line region (BLR) as a collection of optically thin clouds orbiting the supermassive black hole in an active galactic nucleus (AGN). Comparing model predictions for spectral lines and differential phases with interferometric VLTI/GRAVITY data of quasars, e.g., 3C 273, or other AGN, provide constraints on their orientation, structure and dynamics, such as black hole masses, BLR sizes or inclinations. Markov chain Monte Carlo (MCMC) methods were used. |

## Professional Affiliations

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| 01/2021 – present | Double Chooz collaboration |
| 11/2019 – present | THEIA collaboration |
| 01/2019 – present | JUNO collaboration |
| 11/2017 – present | German Physical Society (DPG) |

## Teaching Experience and Training

Technische Universität München

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| Summer 2022 | Tutor, Particle Oscillations (offline and online) |
| Summer 2021 | Tutor, Particle Oscillations (online) |
| Winter 2020/2021 | Tutor, Introduction to Nuclear, Particle and Astrophysics (online) |
| Summer 2020 | Tutor, Particle Oscillations (online) |
| Winter 2019/2020 | Tutor, Introduction to Nuclear, Particle and Astrophysics |
| | Instructor, Physics Lab Course for Food Chemistry |
| | Tutor, Pre-study Physics course |
| Summer 2019 | Tutor, Particle Oscillations |

## Co-supervision of Students

2 Master and 4 Bachelor students, Technische Universität München

## Languages

- German (native)
- English (advanced, TOEFL iBT: 104/120)
- French (elementary, A2)
- Latin (Latinum)

## Computer Skills

- LaTeX, Office programmes
- Python, Mathematica, MATLAB, OriginPro, ROOT
- Photoshop, GIMP, RAW converters, Inkscape

## Summer Schools

- July 17 – 21, 2022 - Summer School of the SFB1258 Munich School on Neutrinos and Dark Matter (MONA), Raitenhaslach, Germany
- June 20 – 24, 2022 - SOUP2022 – The 2nd INFN School on Underground Physics, Gran Sasso National Laboratory and Gran Sasso Science Institute, Italy
- July 12 – 19, 2019 - 19th JINR-ISU Baikal Summer School on Physics of Elementary Particles and Astrophysics, Bolshiye Koty, Russia
- July 9 – 14, 2018 - 9th VLTI Summer School 2018, Lisbon, Portugal (with travel grant)

## Invited Conference Presentations, Colloquia and Seminars

- December 7, 2023 - Plenary talk: *"Status and Prospects of the JUNO Experiment,"* **The 17th International Workshop on Tau Lepton Physics (TAU 2023)**, Louisville, Kentucky, USA
- February 23, 2023 - *"Liquid Scintillator Characterization Experiments for Particle Identification in JUNO and THEIA,"* **DESY**, Zeuthen, Germany (with travel grant)
- January 18, 2020 - *"Fluorescence Decay-Time Spectroscopy of the JUNO Liquid Scintillator using Gamma Radiation and a Pulsed Neutron Beam,"* **INFN Laboratori Nazionali di Legnaro**, Legnaro, Italy

## Contributed Conference Presentations and Posters

- August 30, 2023 - Poster: *Scintillation Time Profiles of Slow Organic and Water-Based Liquid Scintillators using a Pulsed Neutron Beam,"* **XVIII International Conference on Topics in Astroparticle and Underground Physics (TAUP 2023)**, Vienna, Austria
- March 23, 2023 - *"Fluorescence Time Profiles of Slow Organic and Water-Based Liquid Scintillators using a Pulsed Neutron Beam,"* **DPG Spring Meeting 2023**, Dresden, Germany (with travel grant)
- July 20, 2022 - Poster: *"Liquid Scintillator R&D: Overview of Quenching Factor and Scintillation Time Profile Measurements at INFN Legnaro,"* MONA Summer School, Raitenhaslach, Germany
- March 22, 2022 - *"Fluorescence Time Profiles of the JUNO and TAO Liquid Scintillators using a Pulsed Neutron Beam in the Energy Range from 3.5 to 5.5 MeV,"* **DPG Spring Meeting 2022**, Online
- March 16, 2021 - *"Measuring the Fluorescence Time Profile of the JUNO Scintillator with Gamma and Neutron Excitation,"* **DPG Spring Meeting 2021**, Online
- June 24, 2020 - Poster: *"Measuring the Fluorescence Time Profile of the JUNO Liquid Scintillator using Gamma Radiation and a Pulsed Neutron Beam,"* **The XXIX International Conference on Neutrino Physics and Astrophysics (Neutrino 2020)**, Online
- July 17, 2019 - *"Fluorescence Decay Time Measurements of JUNO LS using Gamma Radiation and a Pulsed Neutron Beam,"* **19th JINR-ISU Baikal Summer School on Physics of Elementary Particles and Astrophysics**, Bolshiye Koty, Russia

- December 10, 2018 - *"Spectro-Interferometric Signatures of the Broad Line Regions in Active Galactic Nuclei"*, **TORUS 2018**, Puerto Varas, Chile (with travel grant)
- July 10, 2018 - *"Spectro-Interferometric Signatures of the Broad Line Regions in Active Galactic Nuclei,"* **9th VLTI Summer School 2018**, Lisbon, Portugal (with travel grant)

## Peer-Reviewed Publications

990+ citations & h-index 14 (Google Scholar), ORCID: 0000-0002-5963-7431, ResearchGate, INSPIRE, ADS

21. *"JUNO sensitivity to $^7$Be, pep, and CNO solar neutrinos,"* JUNO Collaboration: A. Abusleme et al., including **M.R. Stock**, 2023, JCAP 10 (2023) 022, arXiv:2303.03910
20. *"The JUNO experiment Top Tracker,"* JUNO Collaboration: A. Abusleme et al., including **M.R. Stock**, 2023, Nucl. Instr. and Meth. in Phys. Res. Sec. A 1057, 168680, arXiv:2303.05172
19. *"JUNO sensitivity to the annihilation of MeV dark matter in the galactic halo,"* JUNO Collaboration: A. Abusleme et al., including **M.R. Stock**, 2023, JCAP 09 (2023) 001, arXiv.2306.09567
18. *"Nuclear physics midterm plan at Legnaro National Laboratories (LNL),"* M. Ballan et al., including **M.R. Stock**, 2023, Eur. Phys. J. Plus **138**, 709
17. *"JUNO Sensitivity on Proton Decay $p \rightarrow \bar{\nu}K^+$ Searches,"* JUNO Collaboration: A. Abusleme et al., including **M.R. Stock**, 2023, Chinese Phys. C **47** (10), 1-17
16. *"Mass testing and characterization of 20-inch PMTs for JUNO,"* JUNO Collaboration: A. Abusleme et al., including **M.R. Stock**, 2022, Eur. Phys. J. C **82**, 1168
15. *"Sub-percent Precision Measurement of Neutrino Oscillation Parameters with JUNO,"* JUNO Collaboration: A. Abusleme et al., including **M.R. Stock**, 2022, Chinese Phys. C **46** 123001
14. *"Prospects for Detecting the Diffuse Supernova Neutrino Background with JUNO,"* JUNO Collaboration: A. Abusleme et al., including **M.R. Stock**, 2022, JCAP 10 (2022) 033, arXiv:2205.08830v1
13. *"The Double Chooz antineutrino detectors,"* Double Chooz Collaboration: H. de Kerret et al., including **M.R. Stock**, 2022, Eur. Phys. J. C **82**, 804,
***Contribution:*** *Active participation in measuring the weight of the liquid of the Gamma Catcher of the Near detector to derive the proton number.*
12. *"Potential for a precision measurement of solar pp neutrinos in the Serappis Experiment,"* L. Bieger et al., including **M.R. Stock**, 2022, Eur. Phys. J. C **82**, 779
11. *"Damping signatures at JUNO, a medium-baseline reactor neutrino oscillation experiment,"* JUNO Collaboration: J. Wang et al., including **M.R. Stock**, 2022, J. High Energ. Phys. **2022**, 62
10. *"Combined sensitivity of JUNO and KM3NeT/ORCA to the neutrino mass ordering,"* KM3NeT Collaboration, JUNO Collaboration Members: S. Aiello et al. including **M.R. Stock**, 2022, J. High Energ. Phys. **2022**, 55
9. *"JUNO physics and detector,"* JUNO Collaboration: A. Abusleme et al., including **M.R. Stock**, 2022, Progress in Particle and Nuclear Physics, 123, 103927, arXiv:2104.02565v2

8. *"Radioactivity control strategy for the JUNO detector,"* JUNO Collaboration: A. Abusleme et al., including **M.R. Stock**, 2021, J. High Energ. Phys. **2021**, 102

7. *"The design and sensitivity of JUNO's scintillator radiopurity pre-detector OSIRIS,"* JUNO Collaboration: A. Abusleme et al., including **M.R. Stock**, 2021, Eur. Phys. J. C **81**, 973

6. *"JUNO sensitivity to low energy atmospheric neutrino spectra,"* JUNO Collaboration: A. Abusleme et al., including **M.R. Stock**, 2021, Eur. Phys. J. C **81**, 887

5. *"Calibration strategy of the JUNO experiment,"* JUNO Collaboration: A. Abusleme et al., including **M.R. Stock**, 2021, J. High Energ. Phys. **2021**, 4

4. *"Feasibility and physics potential of detecting $^8B$ solar neutrinos at JUNO,"* JUNO Collaboration: A. Abusleme et al., including **M.R. Stock**, 2021, Chinese Phys. C **45** 023004

3. *"THEIA: an advanced optical neutrino detector,"* M. Askins et al., including **M.R. Stock**, 2020, Eur. Phys. J. C **80**, 416

2. *"Combined sensitivity to the neutrino mass ordering with JUNO, the IceCube Upgrade, and PINGU,"* IceCube-Gen2 Collaboration, and JUNO Collaboration Members: M. G. Aartsen et al., including **M.R. Stock**, 2020, Phys. Rev. D **101**, 032006

1. *"Spatially resolved rotation of the broad-line region of a quasar at sub-parsec scale,"* GRAVITY collaboration: E. Sturm, J. Dexter, O. Pfuhl, **M.R. Stock** et al., 2018, Nature **563**, 657–660, arXiv:1811.11195v1,
***Contribution:*** *I developed models and fit them to VLTI/GRAVTIY data of the quasar 3C 273 to derive, e.g., BLR size and BH mass. I created all figures.*

## Selected Unrefereed Publications

- *"Scintillation Time Profiles of Slow Organic and Water-Based Liquid Scintillators using a Pulsed Neutron Beam,"* **M.R. Stock** et al., submitted to Proc. of Sci. (TAUP2023) 287

- *"The Design and Technology Development of the JUNO Central Detector,"* JUNO Collaboration: A. Abusleme et al., including **M.R. Stock**, 2023, submitted to Eur. Phys. J. C, arXiv:2311.17314

- *"Fast neutron production at the LNL Tandem from the $^7Li(^{14}N, xn)X$ reaction,"* P. Torres-Sánchez, H. Th. J. Steiger et al., including **M.R. Stock**, 2023, arXiv:2311.06143v1,
***Contribution:*** *Active participation in the beamtime*

- *"Real-time Monitor for the Next Core-Collapse Supernova in JUNO,"* JUNO Collaboration: A. Abusleme et al., including **M.R. Stock**, 2023, submitted to JCAP, arXiv.2309.07109

- *"The Core of the Matter — Spatially Resolving Active Galactic Nuclei with GRAVITY,"* GRAVITY collaboration: E. Sturm et al., including **M.R. Stock**, 2022, ESO The Messenger, 188:20-25

- *"Model Independent Approach of the JUNO $^8B$ Solar Neutrino Program,"* JUNO Collaboration: J. Zhao et al., including **M.R. Stock**, 2022, arXiv:2210.08437v1

- *"THEIA: Summary of physics program. Snowmass White Paper Submission,"* M. Askins et al., including **M.R. Stock**, 2022, arXiv:2202.12839v1

- *"TAO Conceptual Design Report: A Precision Measurement of the Reactor Antineutrino Spectrum with Sub-percent Energy Resolution,"* JUNO Collaboration: A. Abusleme et al., including **M.R. Stock**, 2020, arXiv:2005.08745v1
- *"Spatially Resolving the Quasar Broad Emission Line Region,"* GRAVITY collaboration: R. Abuter et al., including **M.R. Stock**, 2019, ESO The Messenger, 178:20–24