Meeting on Operational and Research Capabilities for Better Understanding Solar-Terrestrial Interactions

September 29 – October 3, 2025, Belgrade, Serbia

BOOK OF ABSTRACTS AND CONTRIBUTED PAPERS

Edited by Vladimir A. Srećković, Aleksandra Kolarski, Milica Langović, Mihailo Savić and Nikola Veselinović

Belgrade, 2025

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Scientific Society Isaac Newton Belgrade, Institute of Physics Belgrade, Astronomical Observatory Belgrade

ISBN 978-86-906850-2-8

Published and copyright by: Scientific Society Isaac Newton Belgrade

Printed by: Skripta Internacional, Mike Alasa 54, 11102, Beograd
Number of copies: 50

SCIENTIFIC RATIONALE

Interactions between the Sun and Earth include solar radiation, solar wind, magnetic field variations, and their effects on Earth's magnetosphere, ionosphere, atmosphere, climate, technology, and human health. These interactions are both scientifically significant and practically important, making the "Meeting on operational and research capabilities for better understanding solar-terrestrial interactions" highly relevant.

The conference aims to bridge observational, theoretical, and operational efforts to deepen our understanding of solar-terrestrial phenomena, improve predictive models, and enhance preparedness for solar-driven events. Despite progress, current prediction capabilities remain limited, which hinders effective response. Solar activity influences satellites, communication systems, power grids, and climate patterns. Events like solar flares, coronal mass ejections, and geomagnetic storms can disrupt technology, while long-term solar variability impacts climate.

The interdisciplinary nature of these studies, combined with the explosion of observational data and advancing computational models, calls for integrated approaches. The conference will foster collaboration, promote real-time monitoring tools, explore topics like cosmic ray modulation and space weather effects, and encourage the use of AI and new theoretical frameworks. Ultimately, the event aims to drive innovation and international cooperation, strengthening both scientific understanding and practical readiness.

Participants will have the opportunity to share their work, attend keynote speeches, and engage in discussions about solar physics, space weather, and related topics.

Venue

Institute of Physics Belgrade

[https://doi.org/10.69646/aob250938]
[Abstract]

The role of excited states in Solar-Terrestrial Interactions: MOLESs consortium

Bratislav P. Marinković[1], Jelena B. Maljković[1], Matija Zlatar[2], Felipe Fantuzzi[3] and Nigel J. Mason[3]

[1]Institute of Physics Belgrade, University of Belgrade, 11080 Belgrade, Pregrevica 118, Serbia
ORCID number: 0000-0002-6904-6360
ORCID number: 0000-0001-9176-2673
[2]Institute of Chemistry, Technology and Metallurgy, University of Belgrade, 110800 Belgrade, Njegoševa 12, Serbia
[3]School of Physics and Astronomy, University of Kent, Canterbury CT2 7NH, United Kingdom

[*]Correspondence: bratislav.marinkovic@ipb.ac.rs

Abstract: Particles from the solar wind interact with molecules from the Earth's atmosphere creating ionized species (Marinković et al. 2025) and species with excited states. These states are responsible for Auroral formation, atmospheric chemistry and chemical species production or ozone depletion. The interactions involving excited states affect the overall energy balance and heating/cooling of the atmosphere (Campbell & Brunger 2018, Kirillov 2012). Long ago, the excited states of molecules have been reviewed in the three-volume series by Melvin Robin (1974, 1975, 1985). We are establishing the consortium of researchers aiming to rewrite the classic series and update data. New collection should include new laser methods, spectra in the solid (ice) phase and new theoretical calculations. These data have become so important in recent years for astronomical and space studies, whilst data for biomolecules are largely missing. We have established a webpage of MOLESs consortium (MOlecular Excited

State spectroscopy) https://www.moless-spectroscopy.org/project/ The MOLESs consortium will meet annually in Belgrade. Our intention is to publish data in both e-book format and on-line with recommended data sets. Data-sets will be uploaded and curated in specified databases within VAMDC (Virtual Atomic and Molecular Data Centre) portal https://vamdc.org/structure/databases/ (Dubernet et al. 2916, Albert et al. 2020, Vujčić et al. 2023, Srećković et al. 2025).

Keywords: molecules, excited states, MOLESs consortium

Acknowledgement
BPM. & JBM. acknowledge support of the Science Fund of the Republic of Serbia, Grant No. 6821, 'Atoms and (bio)molecules-dynamics and collisional processes on short time scale ATMOLCOL'.

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CIP - Каталогизација у публикацији
Народна библиотека Србије, Београд

520/524(048)
55(048)

INTERNATIONAL SCIENTIFIC CONFERENCE Meeting on Operational and Research Capabilities for Better Understanding Solar-Terrestrial Interactions (2025 ; Beograd)

Book of Abstracts and Contributed Papers / [International scientific conference] Meeting on Operational and Research Capabilities for Better Understanding Solar-Terrestrial Interactions, September 29 – October 03 2025, Belgrade, Serbia ; [organizer Scientific Society Isaac Newton Belgrade [and] Institute of Physics Belgrade [and] Astronomical Observatory Belgrade] ; edited by Vladimir A. Srećković ... [et al.]. - Belgrade : Scientific Society Isaac Newton, 2025 (Beograd : Skripta internacional). - 120 str. : ilustr. ; 24 cm

Tiraž 50. - Bibliografija uz većinu apstrakata. - Registar.

ISBN 978-86-906850-2-8 (SSIN)

1. Srećković, Vladimir A., 1972- [уредник]
а) Космичко време -- Апстракти б) Астрофизика -- Апстракти в) Геофизика -- Апстракти

COBISS.SR-ID 157863177

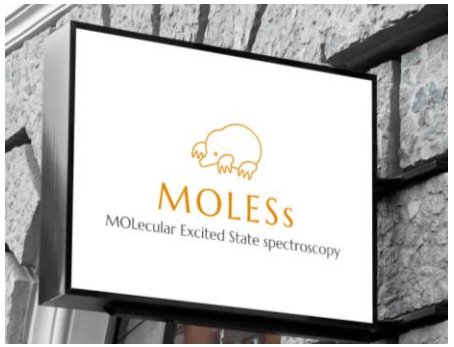
The role of excited states in Solar-Terrestrial Interactions: MOLESs consortium

https://www.moless-spectroscopy.org/project/

Bratislav P. Marinković, Jelena B. Maljković, Matija Zlatar, Felipe Fantuzzi and Nigel J. Mason

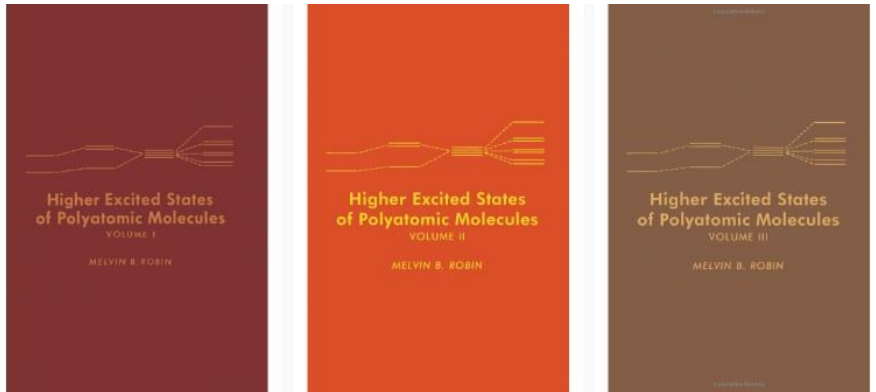
MOLESs -

MOLecular Excited State spectroscopy



The consortium of researchers aiming to rewrite the classic Melvin Robin's three-volume series and update data on higher excited molecular states. New collection should include new laser methods, spectra in the solid (ice) phase and new theoretical calculations.

"Higher Excited States of Polyatomic Molecules"



Why the excited states are relevant in Solar-Terrestrial Interactions?

Particles from the solar wind interact with molecules from the Earth's atmosphere creating ionized species (Marinković et al. 2025) and species with excited states. These states are responsible for Auroral formation, atmospheric chemistry and chemical species production or ozone depletion. The interactions involving excited states affect the overall energy balance and heating/cooling of the atmosphere (Campbell & Brunger 2018, Kirillov 2012).

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Campbell & Brunger, 2018, Planet. Space Sci, 151, 11-18.
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The Kinetics of N2 Triplet Electronic States in the Upper and Middle Atmosphere During Relativistic Electron Precipitation

$$e + N_2(X^1\Sigma_g^+, v = 0) \rightarrow N_2(A^3\Sigma_u^+, v' = 0\text{–}29) + e \qquad N_2(A^3\Sigma_u^+, v') \rightarrow N_2(X^1\Sigma_g^+, v'') + h\nu_{VK},$$

$$\rightarrow N_2(B^3\Pi_g, v' = 0\text{–}18) + e \qquad N_2(B^3\Pi_g, v') \leftrightarrow N_2(A^3\Sigma_u^+, v'') + h\nu_{1PG},$$

$$\rightarrow N_2(W^3\Delta_u, v' = 0\text{–}21) + e \qquad N_2(W^3\Delta_u, v') \leftrightarrow N_2(B^3\Pi_g, v'') + h\nu_{WB},$$

$$\rightarrow N_2(B'^3\Sigma_u^-, v' = 0\text{–}15) + e \qquad N_2(B'^3\Sigma_u^-, v') \leftrightarrow N_2(B^3\Pi_g, v'') + h\nu_{AG},$$

$$\rightarrow N_2(C^3\Pi_u, v' = 0\text{–}4) + e \qquad N_2(C^3\Pi_u, v') \rightarrow N_2(B^3\Pi_g, v'') + h\nu_{2PG}.$$

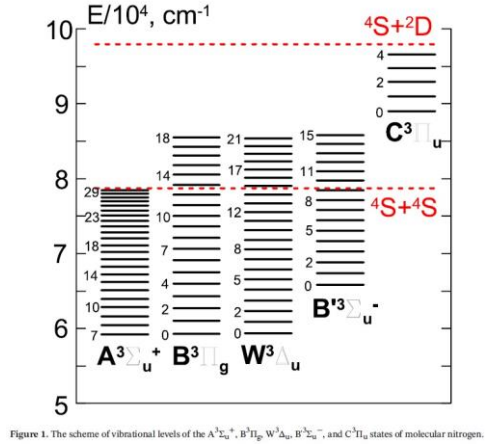
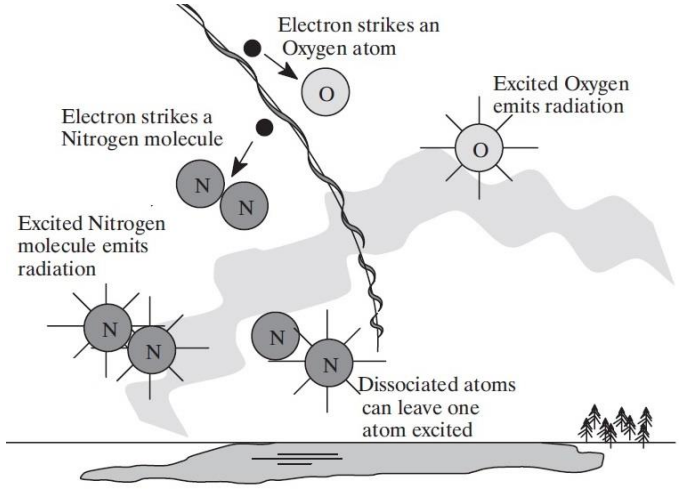


Figure 1. The scheme of vibrational levels of the $A^3\Sigma_u^+$, $B^3\Pi_g$, $W^3\Delta_u$, $B'^3\Sigma_u^-$, and $C^3\Pi_u$ states of molecular nitrogen.

The scheme of vibrational levels of the $A^3\Sigma u^+$, $B^3\Pi g$, $W^3\Delta u$, $B'^3\Sigma u^-$, and $C^3\Pi u$ states of molecular nitrogen.



Space-Weather-Prediction-Center_NOAA Chapter_4 Solar-Terrestrial Interactions

CEQPAS

Centennial of Quantum Theory: Progress in Atomic and Molecular Structure

https://www.moless-spectroscopy.org/ceqpas/

- The program will be structured into five interlinked sessions:
- 1. Atomic and molecular spectroscopy and its applications to atmospheric sciences and astronomy.
- 2. Collisions and their applications in plasma physics.
- 3. Studies in chemical physics and physical chemistry.
- 4. The use of artificial intelligence and machine learning for atomic and molecular data analysis and generation.
- 5. The application of quantum science to our wider understanding of phenomena, including radiation sciences.
- **Date**: 3rd-5th November 2025
- **Place**: Institute of Physics, Pregrevica 118, Belgrade.

Meeting on Operational and Research Capabilities for Better Understanding Solar- Terrestrial Interactions

29 September – 3 October 2025

October 2025