



Annual report 2025



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Annual report

2025

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Rosseland Centre for Solar Physics (RoCS)

Our vision is
understanding
the workings of the
energetic Sun.

1

To understand the origin and evolution of the solar magnetic field on spatial scales ranging from the smallest observable (<100 km) to the size of active regions (100,000 km).

2

To understand the dynamic structuring and mass and energy transfer in the solar atmosphere from the relatively cool (6,000 K) surface to the multimillion degree corona.

3

To understand which configurations of the magnetic field, ambient and emerging, lead to the development of dynamic phenomena such as surges, jets and flares of all sizes that permeate the active solar atmosphere.

4

To go beyond the single-fluid magnetohydrodynamic (MHD) paradigm, which breaks down in the nearly neutral chromosphere and the almost collisionless coronal plasma. We will do this by applying multi-fluid and particle-in-cell techniques, providing new understanding of heating and particle acceleration in both quiet and active solar environments.



↑ Group photo from the external retreat at Hoel gård, May 22 2025. Credit: private

From the Director

This is the eighth annual report of the Rosseland Centre for Solar Physics (RoCS), one of the 10 centers of excellence selected by the Research Council of Norway in the fourth round of the centers of excellence scheme.

We have continued the high activity throughout 2025. The doctoral and postdoctoral research fellows have been very active in organising retreats, seminars, workshops, short presentations at the monthly solar-stellar lunches, and many other social activities. These activities are at the heart of a well-functioning research environment, and this annual report elucidates some of them.

The external retreat was in 2025 at Hoel gård, at the shore of the biggest lake in Norway, Lake Mjøsa, about a two-hour drive from Oslo. The lake surroundings gave a perfect setting for a relaxed and efficient retreat. In addition to the usual social events, we held poster sessions with discussions in smaller groups. An external speaker had a (much-needed) session on time management. Thanks to the organizing committee

(Aline, Andrius, Benedikte, Michael, Quentin, and Valeriia) for a well-organized and executed program. The average score in the evaluation scheme was 9.2 (out of 10)!

The internal retreat returned to the original format this time, with the main focus on presentations by all members, with the PIs giving more review-type talks. A lot of time was set aside for the discussions, and we all felt this was very rewarding. The conference dinner was at one of Benedikte's favourite restaurants, "Statholderens Mat & Vinkjeller", with a ten-course dinner (record number of courses for a retreat – only fitting for the many records of 2025). The retreat was very successful, thanks to a hard-working committee (Benedikte, Carlos, Fan, Mats K., and Yixiao).



Research results are important, but it is also essential to communicate them to both the scientific community and society at large.

RoCS is like a big family, but constantly changing: new people come and some leave. Three postdocs started in 2025: Pooja Devi as an institute-funded postdoc, Harsh Mathur on the DSTrain Cofund program, and Yixiao Zhou as a Marie-Curie Postdoctoral Fellow. In addition to many new people coming in, we also have people moving out. Reetika Joshi finished her postdoc period in March and moved to the NASA Goddard Space Flight Center in the US (but will return to RoCS in March 2026). Nicolas Poirier finished in August and moved to the LPC2E lab in Orléans. Quentin Noraz finished in November and moved to KU-Leuven. We had five PhD thesis defences in 2025: Aditi Bhatnagar, George Cherry, Elisabeth Enerhaug, Michael Haahr, and Kilian Krikova. A hearty welcome to newcomers and best wishes for their new careers to those leaving.

The activity was high in 2025, and reports organised by theme are given in Section 2. Continuing the feature from last year, Appendix 1 provides summaries of all Master's theses (none in 2025) and PhD theses (a record number of five). Appendix 2 provides a full list of the 94 papers published in refereed journals in 2025. This is a record number by a large margin (the years 2022-2024 had 60-62 papers per year from RoCS members).

Research results are important, but it is also essential to communicate them to both the scientific community and society at large. Our full-time communication advisor, Eyrun Thune, has actively promoted solar physics together with the RoCS crowd. Many venues were used: the Astronomy Olympiad, newspapers, podcasts, TV, radio, and social media – we were active everywhere. You can read more about the important outreach activities on page 30.

Since doctoral and postdoctoral research fellows are at RoCS for a limited period, it is important to provide career development activities. One very popular such activity is career talks by former alumni, which continued in 2025 – the presentations show that the skills you develop at RoCS can also be very valuable for a career outside academia.

The International Rosseland Visitor Programme is covered in Section 3, and we continue the tradition with some glimpses from life at RoCS in Section 4. Among other topics, you can read about what happens behind the scenes, RoCS researcher

Valeriia Liakh honored with the 2025 ESPD Giancarlo Noci Early Career Researcher Prize, northern lights, research visits, summer students, new projects funded by the Research Council of Norway (RCN), a workshop on reconnection, and the Joint IRIS/MUSE science team meeting. Life at RoCS is certainly varied, productive, and rewarding.

In addition to the workshop on reconnection, we hosted a mini-workshop on the continued development of the radiation-hydrodynamics code RADYN. The goal is to gather the various versions into a public-domain, well-maintained code framework.

In 2025, we also submitted several proposals in response to various funding calls. A proposal to fund the Norwegian participation in the European Solar Telescope (EST) project received top priority from the University of Oslo in the RCN Infrastructure call. We expect the results to be announced in the fall of 2026, and keep our fingers crossed for the funding of this flagship project for European solar physics. An extraordinary call from the RCN on funding highly talented researchers from abroad for three years at a center of excellence or in connection with an established researcher RCN project was published in the summer. RoCS submitted two applications, and both were funded: Souvik Bose started in January 2026, and Reetika Joshi will join in March 2026.

As people are the most important part of a centre, we have short presentations of all the members in section 5. In 2025, there were 60 people from 20 nationalities across three continents at RoCS. I would also like to take this opportunity to congratulate adjunct professor Lyndsay Fletcher on being awarded "Member of the Order of the British Empire (MBE)" in 2025.

We have seen major progress towards the goals of RoCS, and after several records were set in 2025, we look forward to 2026 with even more PhD defences and a high level of activity.

January 2026

Mats Carlsson
Director of RoCS

The background of the slide is a photograph of a sunset or sunrise. The sky is a deep orange, and the sun is partially obscured by dark, silhouetted clouds. A large, bright white circle is positioned on the left side of the image, containing the text "2025 Activities by theme" in a red, sans-serif font.

2025 Activities by theme

Simulations 2025

There are some recurring questions that have been with us since the study of the outer solar atmosphere began, sometime in the 1940s. Central amongst these questions are those pertaining to understanding energy transfer through the chromosphere, which also is paramount to solving the coronal heating problem.

RoCS members and students have spent the year analysing a number of simulations to investigate the propagation and dissipation of various waves. The focus has been on acoustic waves: These dominate the lower chromosphere, which is situated above the photosphere, but which ends at the so-called $\beta=1$ layer where the energy density of the plasma equals the energy density of the magnetic field. The layer marks the boundary where the magnetic field and processes dependent on the field, such as Joule dissipation, begin to dominate. However, the topology of the magnetic field can be very

complex, also at lower heights, including structures such as current sheets, where heating can be intense and energetic episodic events will originate.

Disentangling energy dissipation mechanisms

Thus, disentangling and quantifying the respective roles of acoustic shocks and current sheets in chromospheric modeling is vital. This year's studies have indeed found that shocks dominate the energy deposition in the lower chromosphere, accounting for up to 59% of the mechanical heating rate near the $\beta=1$

layer. In contrast, current sheets become the primary contributor above this layer in the upper chromosphere where plasma $\beta \ll 1$. Overall, 66% of the mechanical chromospheric heating is powered by the combined action of shocks and current sheets, with 13% emerging from regions where shocks and current sheets overlap, underscoring the pivotal role of dynamic coupling in the chromosphere. These results support a multi-process view of the chromospheric heating in the Quiet Sun, dominated by shocks, current sheets, and non-steep gradient dynamics (see Figure 1).

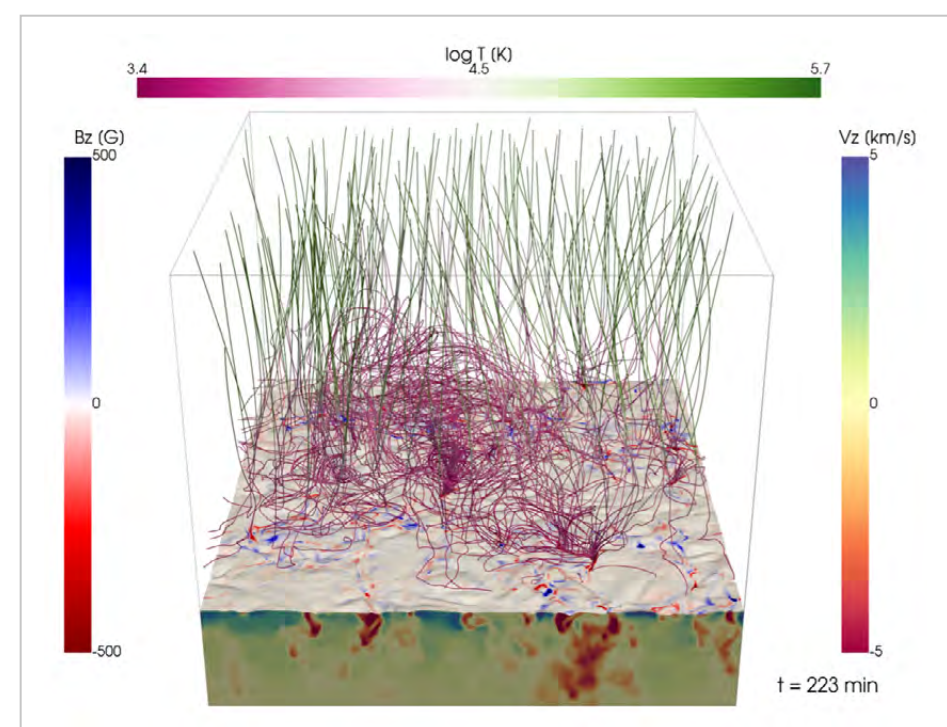


Figure 1 3D visualization of simulation employed in disentangling the various energy dissipation mechanisms at play in the Quiet Sun chromosphere. The horizontal and corrugated slice represents the $\tau_{500} = 1$ surface, coloured with the photospheric vertical magnetic field B_z . Vertical convective velocities V_z are illustrated on the side of the upper-convection zone. 15×15 seeds have been uniformly distributed horizontally at 3 Mm to trace magnetic field lines. These lines connect to different structures, and preferentially to magnetic concentration located in intergranular lanes at the photosphere. Magnetic field lines are coloured by temperature, ranging from pink in the temperature minimum region of the chromosphere (~ 4000 K), to white in the transition region ($\sim 40\,000$ K), and finally green when reaching the low corona at the top of our box ($\sim 500\,000$ K). Note the vortex-like pink feature at the middle of the box, known as a magnetic tornado (or swirl). From Noraz et al., A&A 2025.

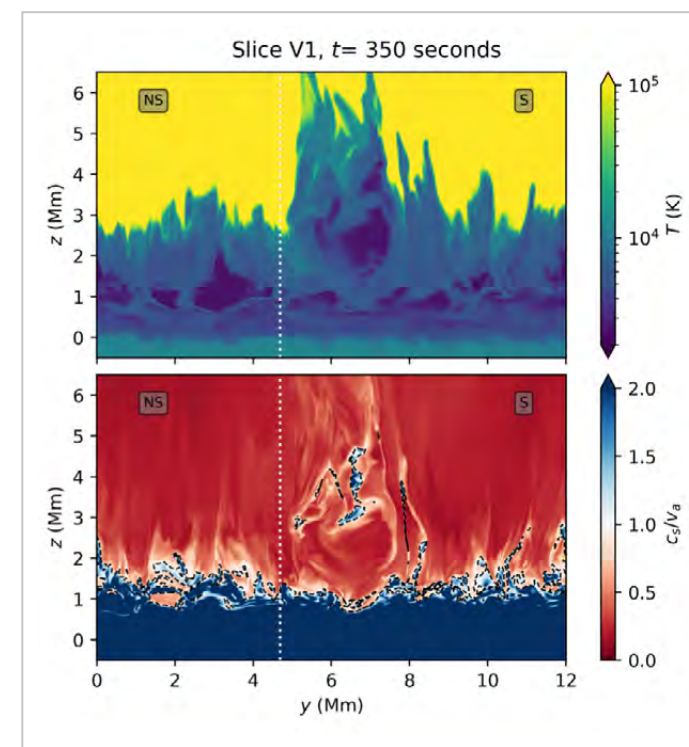


Figure 2a Upper: Temperature plot in vertical slice at time $t = 350$ s, where the slice intersects the swirl S1. The scale is set to highlight the chromospheric plasma showing characteristics of type II spicules. Lower: Ratio of sound and Alfvén speeds, with the equipartition level ($c_s/v_a = 1$) outlined by the dashed line. The vertical dotted line splits the slice into two sections (with swirl (S), without swirl (NS)), which will be used for the analysis in the study (Cherry et al., A&A 2025).

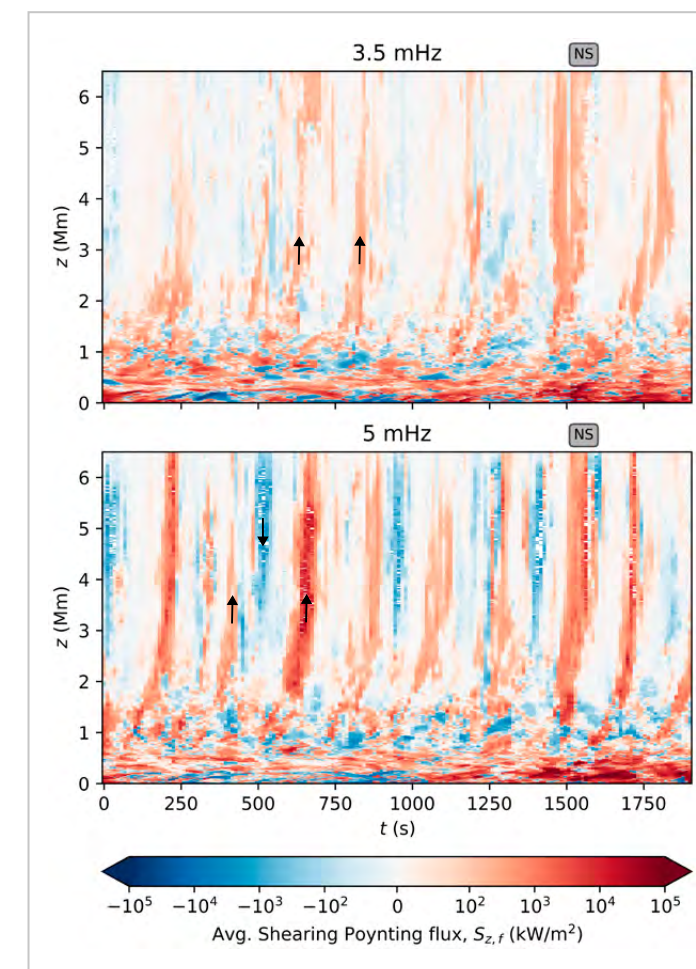


Figure 2b Horizontally-averaged shearing Poynting flux in the NS region of slice for 3.5 (top) and 5 (bottom) mHz. The arrows show the direction of energy propagation. It is clear to see relatively (much) stronger down-flows at 5 mHz than 3.5 mHz. Interestingly, downwards propagation in the 3.5 mHz signals are found lower down in the atmosphere (below $z = 3$ Mm), whereas down-flows of 5 mHz power are strongest between $z = 3-6$ Mm. Therefore, the power that reaches the corona from 3.5 mHz signals is also deposited there, whilst the circulation of power from 5 mHz signals limits the deposition into the upper atmosphere. (From Cherry et al., A&A 2025).

Acoustic waves and swirls

Acoustic waves are generated in the solar convection zone just below the photosphere, and certain frequencies manage to propagate through the photosphere and into the chromosphere, where their dissipation contributes significant heating. A study of the characteristics of acoustic-wave heating and its dependence on height and magnetic field configuration has been carried out. This study found the typical heights where acoustic waves steepen into shocks and the frequencies and wavenumbers that most efficiently dissipate wave energy through this steepening. The flux of propagating acoustic waves correlates closely with viscous dissipation in the chromosphere above the temperature minimum a few hundred kilometers above the photosphere. Acous-

tic waves with frequencies close to the acoustic cut-off frequency are found to efficiently heat the quiet Sun chromosphere at the plasma $\beta = 1$ interface and play an important role in the chromospheric energy balance (see Figure 3).

In another study, two frequencies, at 3.5 and 5 mHz, are identified that connect oscillations in the upper convection zone

to the dynamics in the solar atmosphere (see Figure 2). Distinct differences in the absence and presence of swirling structures on the upwards propagation of these oscillations are seen. The relation of energy transfer via shocks, mode conversion, and jets are discussed. The contribution of 3.5 and 5 mHz signals to the overall wave power in the domain is found to be significant, up to 50%.

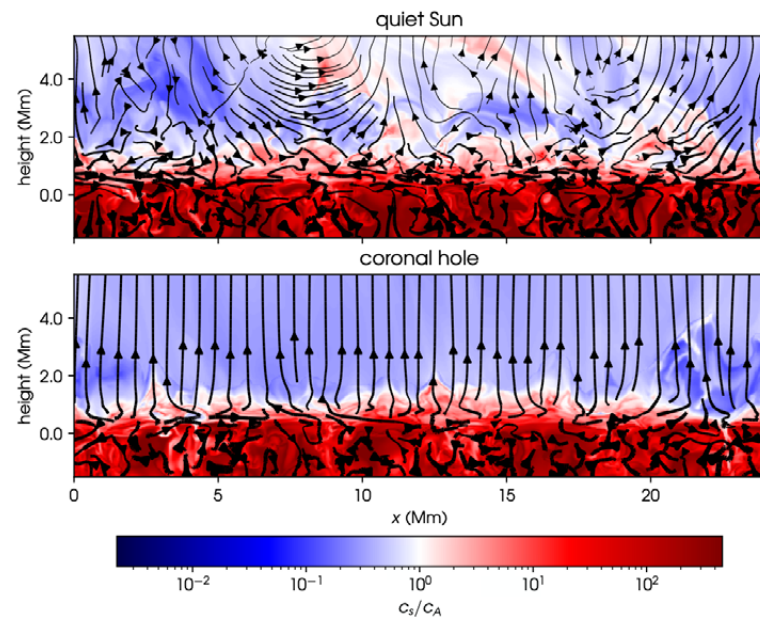


Figure 3 Ratio of sound speed to Alfvén speeds in xz cuts taken from quiet Sun and coronal hole simulations. The simulation times are taken at 140 minutes and 40 seconds and at y coordinates 3.10 Mm. Overplotted are the magnetic field lines, with the thickness of the lines being scaled by the logarithm of the field strength, $\log_{10} |B|$. From Udnæs & Pereira, A&A 2025.

Topology and emergence of magnetic fields

Of course, the topology of the magnetic field even in the Quiet Sun is not constant. Convective motions at granular and super-granular scales transport the field horizontally and, while doing so, build current sheets in the chromosphere and corona. Furthermore, field emerging from the convection zone and rising vertically into the chromosphere and corona will impact the heating rate in the outer Sun. These emerging fields offer valuable insights into how energy and mass are transferred to the upper solar atmosphere. A study has been carried out where two models of quiet-Sun-like magnetic fields generated by the Bifrost code are compared with observations from the Swedish 1-meter Solar Telescope (SST) and the Interface Region Imaging Spectrograph (IRIS). By tracking the magnetic features in both the SST and Bifrost data,

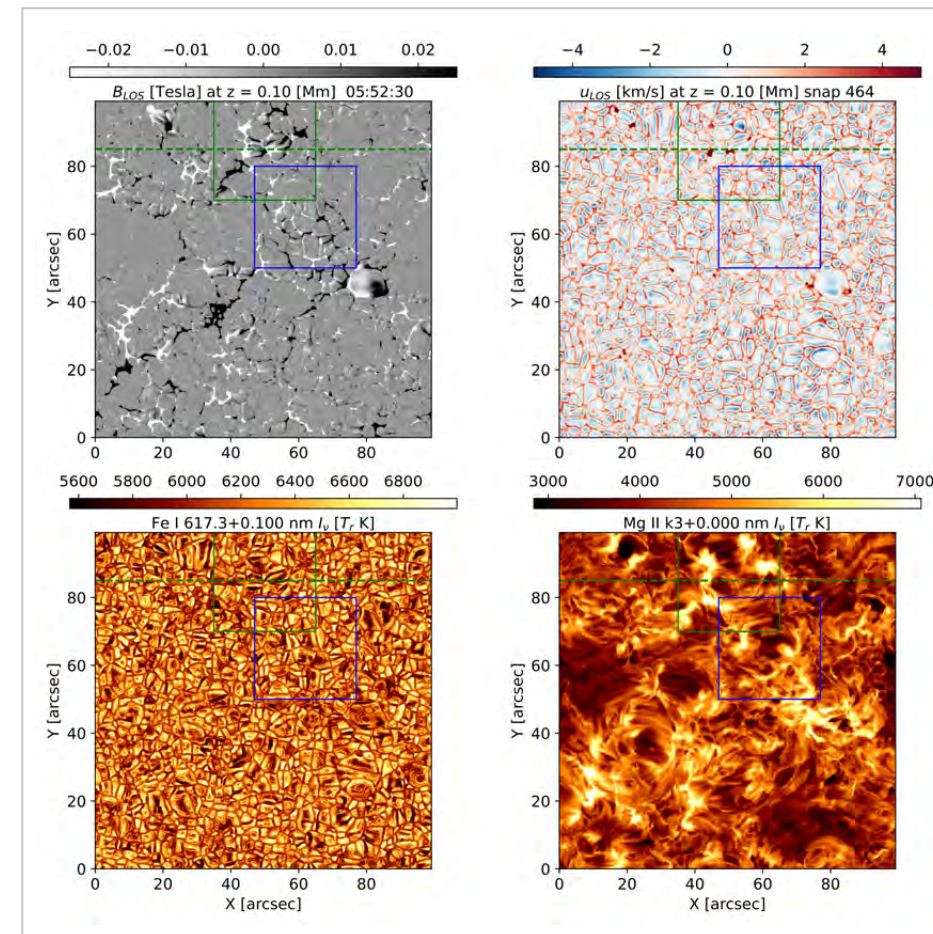


Figure 5 Overview of the Quiet Sun emerging flux model, showing the vertical component of the magnetic field and the vertical velocity 100 km above the photosphere (upper row) and the intensity in the red wing of the Fe I 6173 Å line and in the core of the Mg II k line (bottom row). This simulation and these synthetic observables are compared to SST and IRIS observations. The green and blue rectangles show regions which experience flux emergence and which are analysed in detail in the paper (Gosic et al., 2025, ApJ 2025).

the similarities and differences between the fields identified in the models and those observed are determined. A quantitative comparison of various properties, such as flux content, flux densities, horizontal and line-of-sight velocities, lifetimes, sizes, and surface interactions is carried out (see Figure 4).

Additionally, the properties of the largest emerging bipoles in the SST and Bifrost data are identified and analysed. The findings indicate that the magnetic bipoles in the Bifrost simulations are generally stronger than those observed with the SST. However, a qualitative comparison of the chromospheric and transition region responses to the emerging fields in the Bifrost models, SST, and IRIS observations shows similar heating processes occurring above and around the emerging fields.

Consistent chromospheric models: What are we missing?

In summary, these state-of-the-art self-consistent radiative MHD models provide important insights, but all currently struggle to reproduce some of the Interface Region Imaging Spectrograph (IRIS) observables. Models still predict lower temperatures than what is implied by observations, and struggle to predict, for instance, the Mg II h and k line widths and profiles observed by IRIS. One possible explanation for this discrepancy might be found in the Thermal Farley-Buneman Instability (TFBI). This meter-scale, electrostatic, multifluid plasma instability likely causes turbulence and heating throughout the coldest regions of the solar chromosphere. Therefore, a preliminary study has been carried out to survey how TFBI turbulence and heating varies across multifluid

2D, kinetic 2D, and kinetic 3D simulations, all modeling nearly equivalent physical parameter regimes. The study concludes that most likely, TFBI-driven turbulence can account for some of the discrepancy between large scale models and IRIS observations (see Figure 5). TFBI turbulent heating increases chromospheric temperatures, while at the same time TFBI-driven turbulent motions may contribute significantly to non-thermal velocities observed with IRIS, such as in the optically thin O I line and may explain the need for the microturbulence parameter inferred from inversions of observations. Once confirmed and understood, incorporating TFBI effects into large-scale models may bring model predictions closer to observations.

Author: Viggo Hansteen

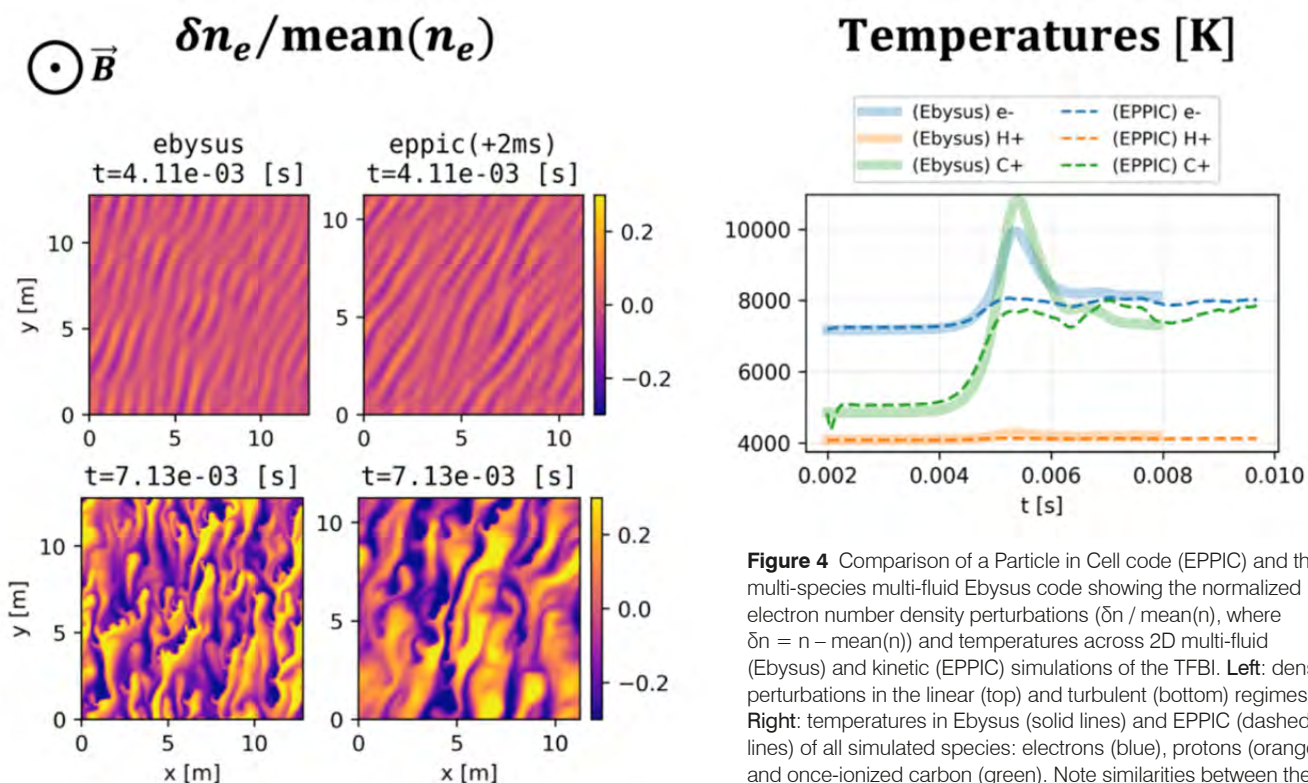


Figure 4 Comparison of a Particle in Cell code (EPPIC) and the multi-species multi-fluid Ebysus code showing the normalized electron number density perturbations ($\delta n / \text{mean}(n)$, where $\delta n = n - \text{mean}(n)$) and temperatures across 2D multi-fluid (Ebysus) and kinetic (EPPIC) simulations of the TFBI. Left: density perturbations in the linear (top) and turbulent (bottom) regimes. Right: temperatures in Ebysus (solid lines) and EPPIC (dashed lines) of all simulated species: electrons (blue), protons (orange), and once-ionized carbon (green). Note similarities between the results of the quite disparate codes. From Evans et al. ApJ 2025.

Observations with SST and IRIS

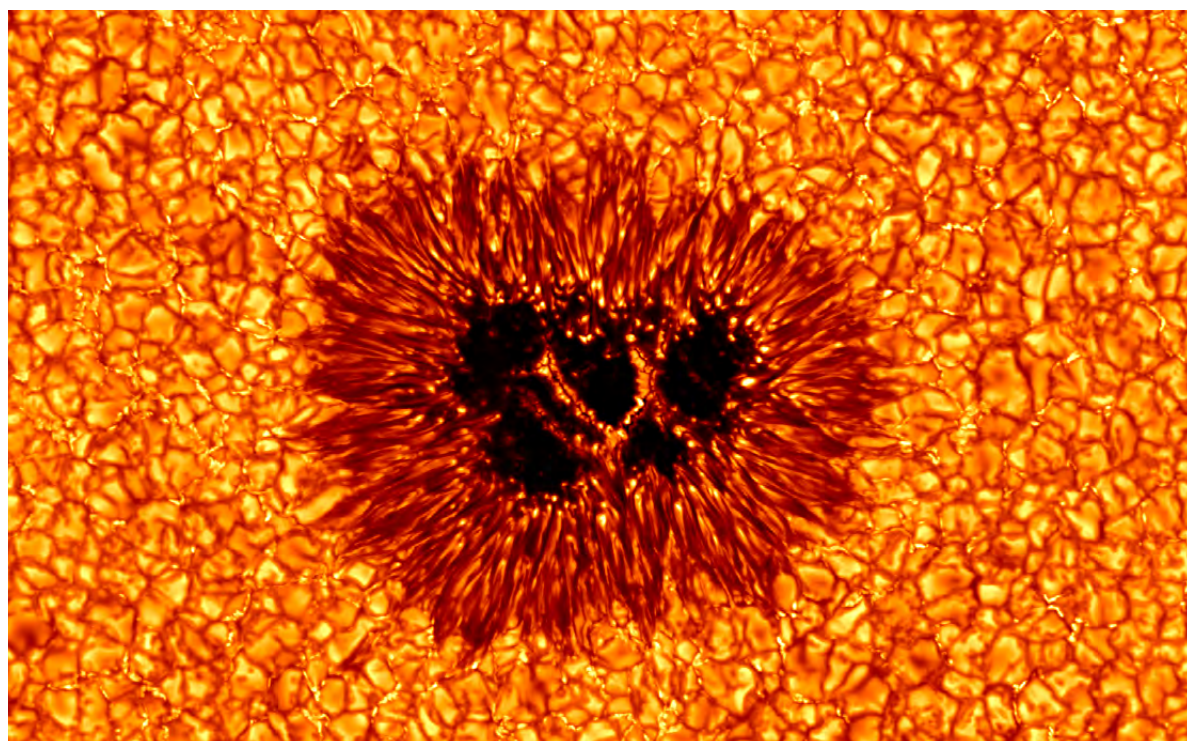
RoCS is the largest external user of the Swedish 1-m Solar Telescope (SST) at La Palma in the Canary Islands. We coordinate our observations with the IRIS satellite to achieve dense coverage of the solar atmosphere from the photosphere up through the chromosphere and transition region into the corona. This year, we also coordinated with ESA's Solar Orbiter spacecraft.

For many years, we have had an agreement with the Institute for Solar Physics in Stockholm, which gives us observing time at the SST. The observing time is usually divided over three campaigns spread over the observing season. In 2025 these campaigns were in May/June, July, and October. In total there were 9 RoCS members and one visiting PhD student from the University of Glasgow participating in the three campaigns. The photos on page 18–19 give an impression.

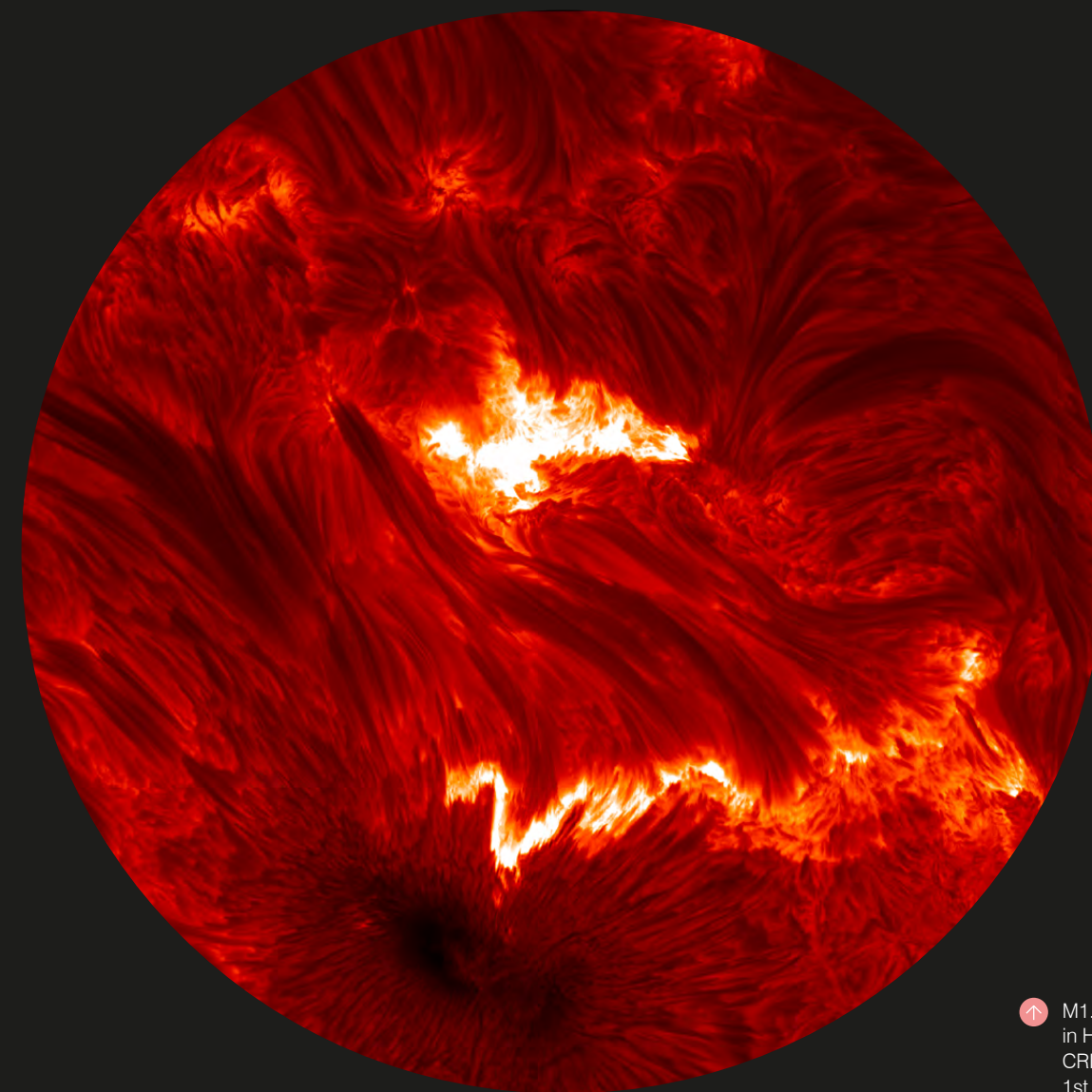
Large field of view

The main instruments at SST, CRISP and CHROMIS, had a major upgrade during the 2025 season, which resulted in a considerable increase of the observed field of view. New cameras were installed for CHROMIS at the beginning of the season, which give a square field of view of almost 80 x 80 arcseconds. CRISP was replaced by a completely new instrument, CRISP2, which has a circular field of view of about 120 arcseconds in diameter. Both

instruments continue to have high resolution in the spatial, temporal, and spectral domains so that full spectral profiles can be acquired in a matter of a few seconds. These capabilities, combined with the new large field of view, and the excellent La Palma seeing characteristics, make it possible for SST to capture large-scale dynamic phenomena like flares and the full magnetic connectivity of active regions.



Large sunspot observed with the SST/CHROMIS WB 3950Å filter on June 30th, 2025.



M1.2 flare observed in H-alpha with SST/CRISP2 on October 1st, 2025.

The image on the left shows a large sunspot observed with the wideband channel of CHROMIS during the July campaign. The seeing was excellent for about 25 minutes, and we captured a very nice time sequence of the evolution of the sunspot and its surroundings in the Ca II H and H-epsilon spectral lines.

Solar flare

On the first day of the October campaign, we captured a M1.2 class flare with the new CRISP2 instrument. We were pointing at another target but were alerted by the sound of the flare alarm system that a flare was going off close to a large sunspot in the active region close to disk center. We managed to quickly point the

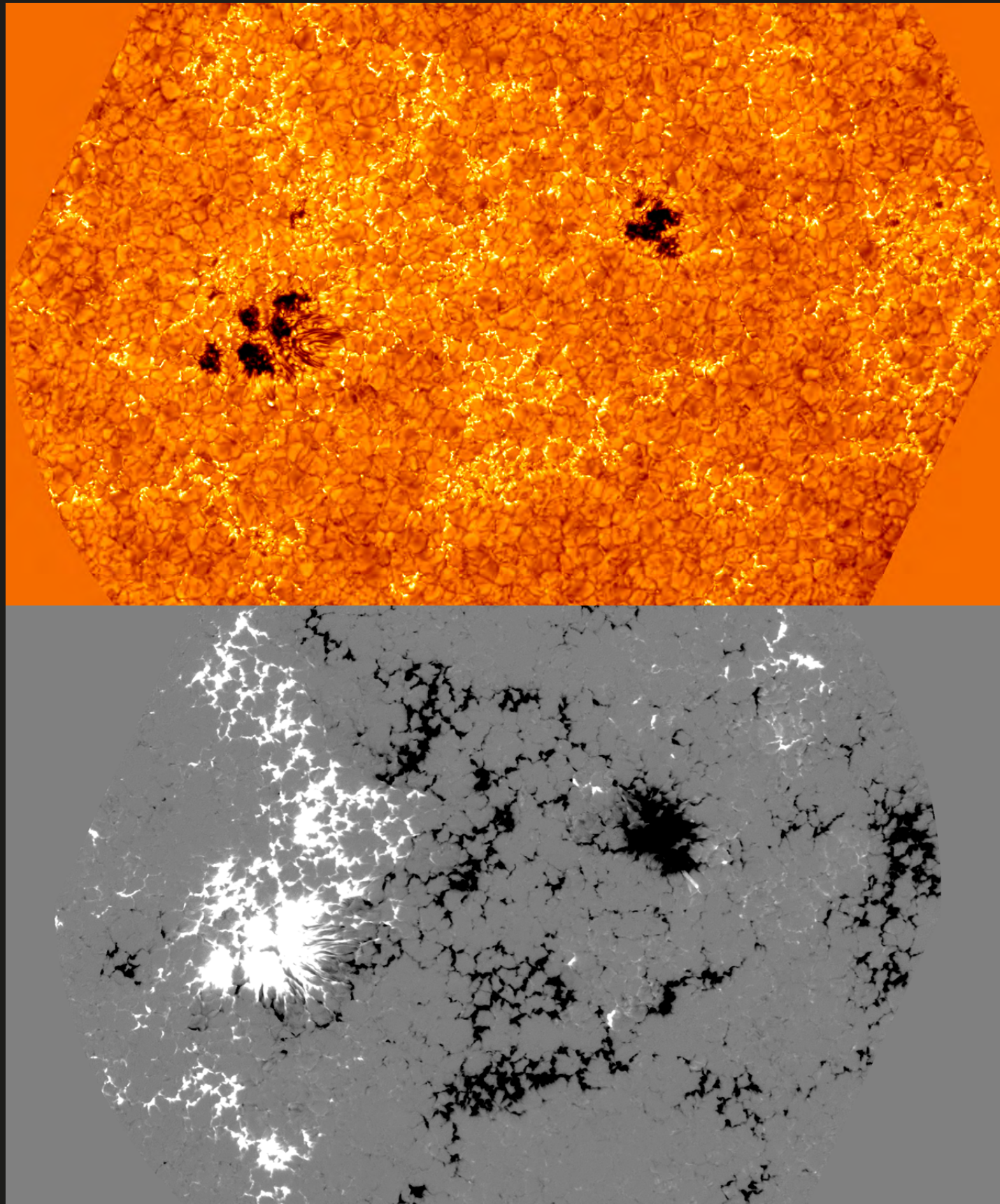
telescope at the rapidly evolving flare ribbons that are so prominent in H-alpha line center (see image above). The large field of view of CRISP2 nicely covers the full extent of the flare ribbons. Over the past three seasons, the flare alarm system has enabled us to observe more than 22 strong flares (C-class and stronger).

Active Region

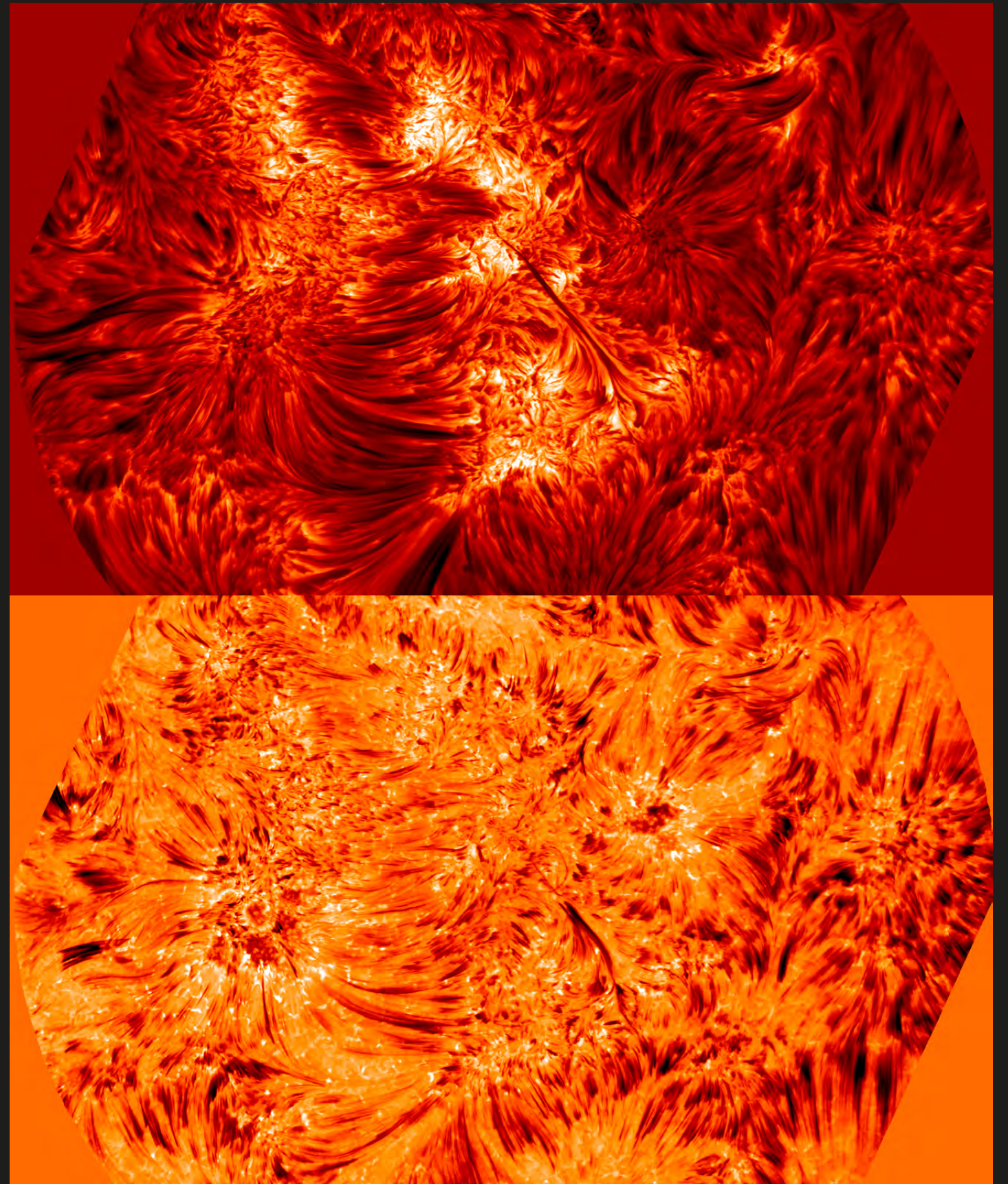
Later in the October campaign, we observed an active region with the CRISP2 instrument under excellent seeing conditions. This was an observation we coordinated with the IRIS satellite. The images on the next pages were taken in different spectral lines: the chromosphere in H-alpha, photospheric magnetic field from inver-

sions of Fe I 6173 Å, and the photosphere in the CRISP2 wideband filter at 8542 Å. The large field of view of CRISP2 allows us to cover the full active region, which has a large leading pore with negative magnetic polarity and a complex collection of trailing pores with positive magnetic polarity. The full coverage of the magnetic fields in this active region will allow us to do magnetic field extrapolations to infer the magnetic field topology in the corona. Some of the magnetic connectivity in the higher layers of the atmosphere can also be inferred from the large chromospheric fibrils visible in the H-alpha line core.

Author: Luc Rouppe van der Voort



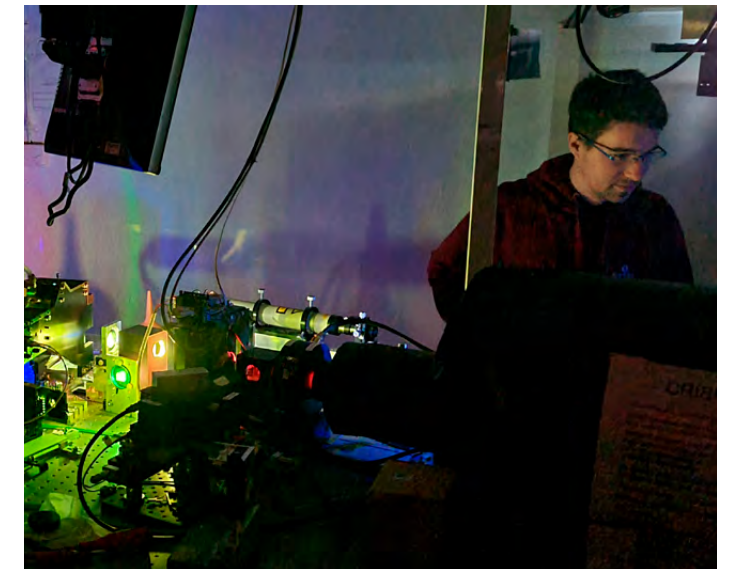
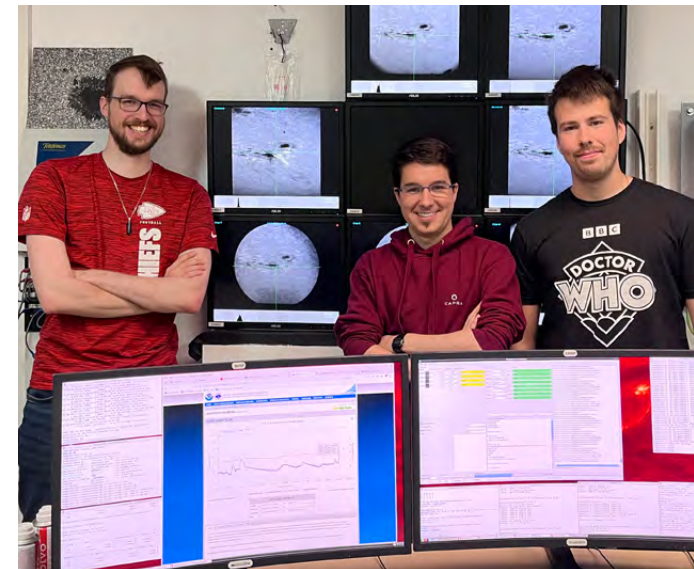
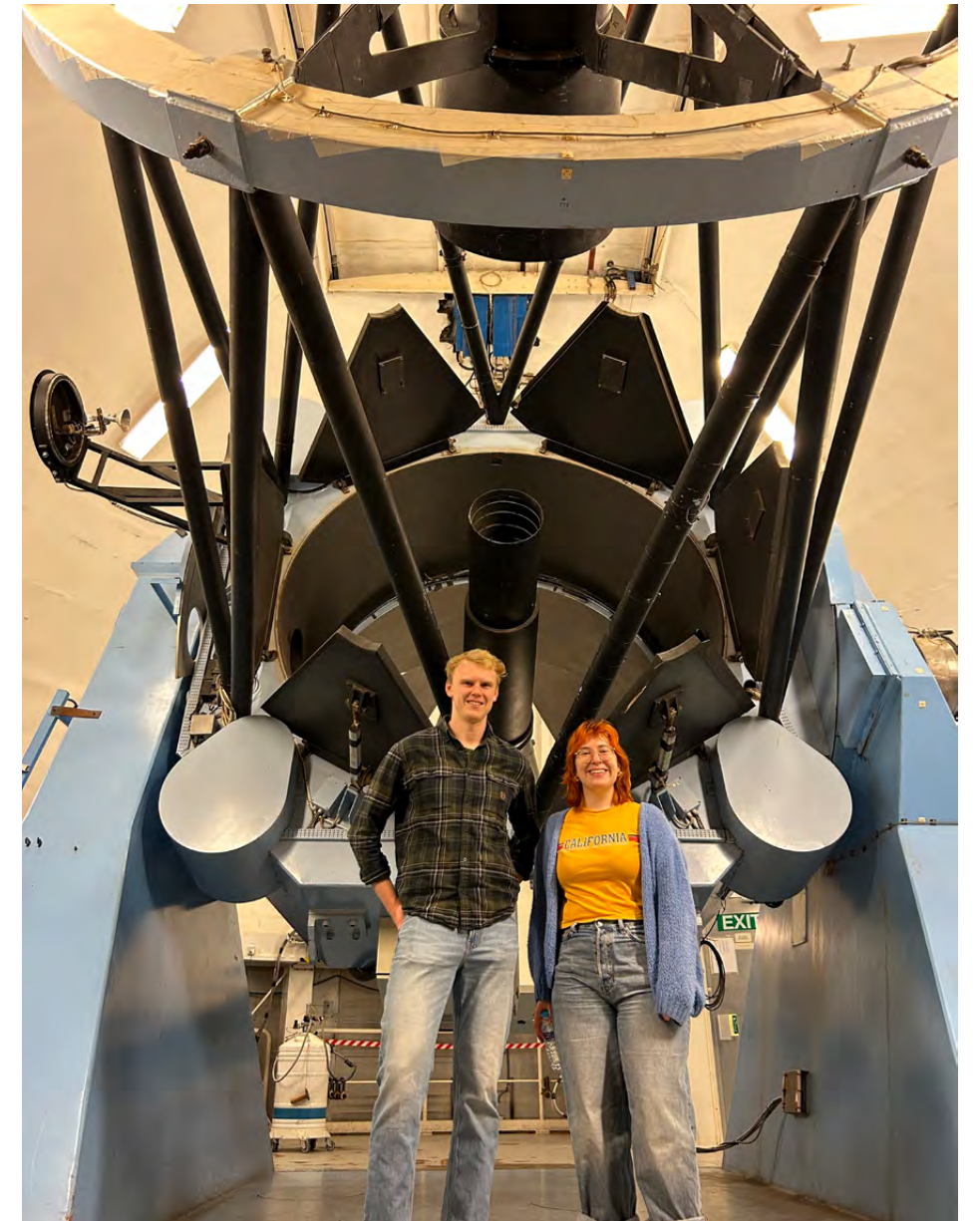
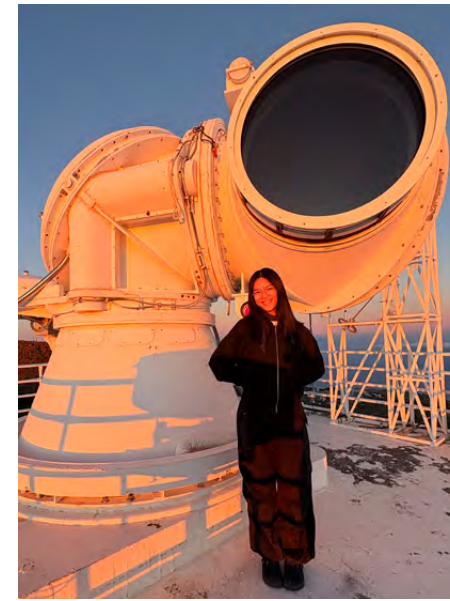
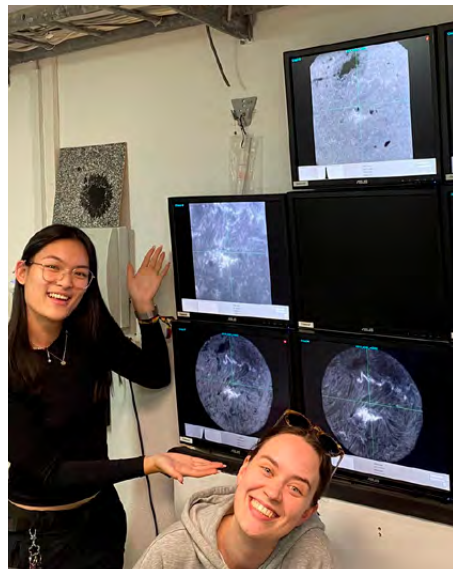
AR14247 observed with SST/CRISP2 on October 10th, 2025. The top image shows the photosphere in WB 8542Å and the bottom image the line of sight magnetic field in the photosphere (from Fe I 6173Å). Black shows negative magnetic polarity, white positive polarity (saturated at 500 Gauss).



AR14247 in H-alpha line core (top image) and H-alpha blue wing at -600 mÅ.

Life at the SST

In 2025, we conducted three observation campaigns in May/June, July and October. Nine RoCS members participated, including a master student, PhD students, postdocs, and PIs.



Science at long wavelengths – ALMA, AtLAST, and beyond

In 2025, core activities focused on exploring future observing capabilities with the Atacama Large Aperture Submillimeter Telescope (AtLAST) and the Atacama Large Millimeter/submillimeter Array (ALMA), with the aim of advancing our understanding of solar and stellar activity at millimeter wavelengths and preparing future developments in solar monitoring and operational studies related to the solar origins of space weather.

Solar observing with AtLAST

The AtLAST2 project, which formally began in spring 2025, will advance and consolidate the design of the Atacama Large Aperture Submillimeter Telescope – the proposed 50m aperture telescope for observations at (sub)millimeter wavelengths. In this phase, testing and prototyping at existing facilities will support the maturation of key technological components.

Solar observations with AtLAST, which form an integral part of the Science Reference Plan, require dedicated observing strategies and suitably adapted instrumentation. As part of his Ph.D. thesis

project, Mats Kirkaune investigated and published the technical requirements and potential scan strategies for obtaining full-disk solar images at high cadence using the maria simulation framework

Figure 1 Simulated observations of the Sun with AtLAST for a double-circular scan pattern and a first-generation multi-pixel-detector. The resulting full-disk map of the Sun at a frequency of 220 GHz features a flare. The figure uses elements from Mroczkowski et al. (2025) and Kirkaune et al. (2025).

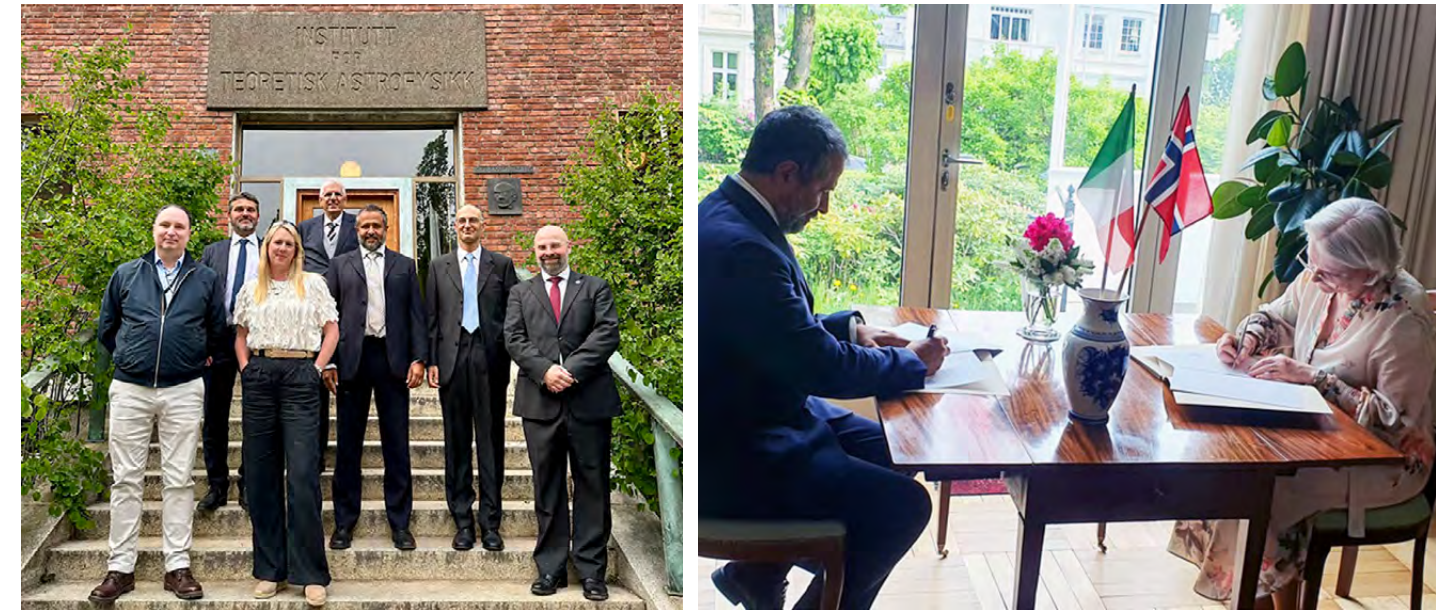
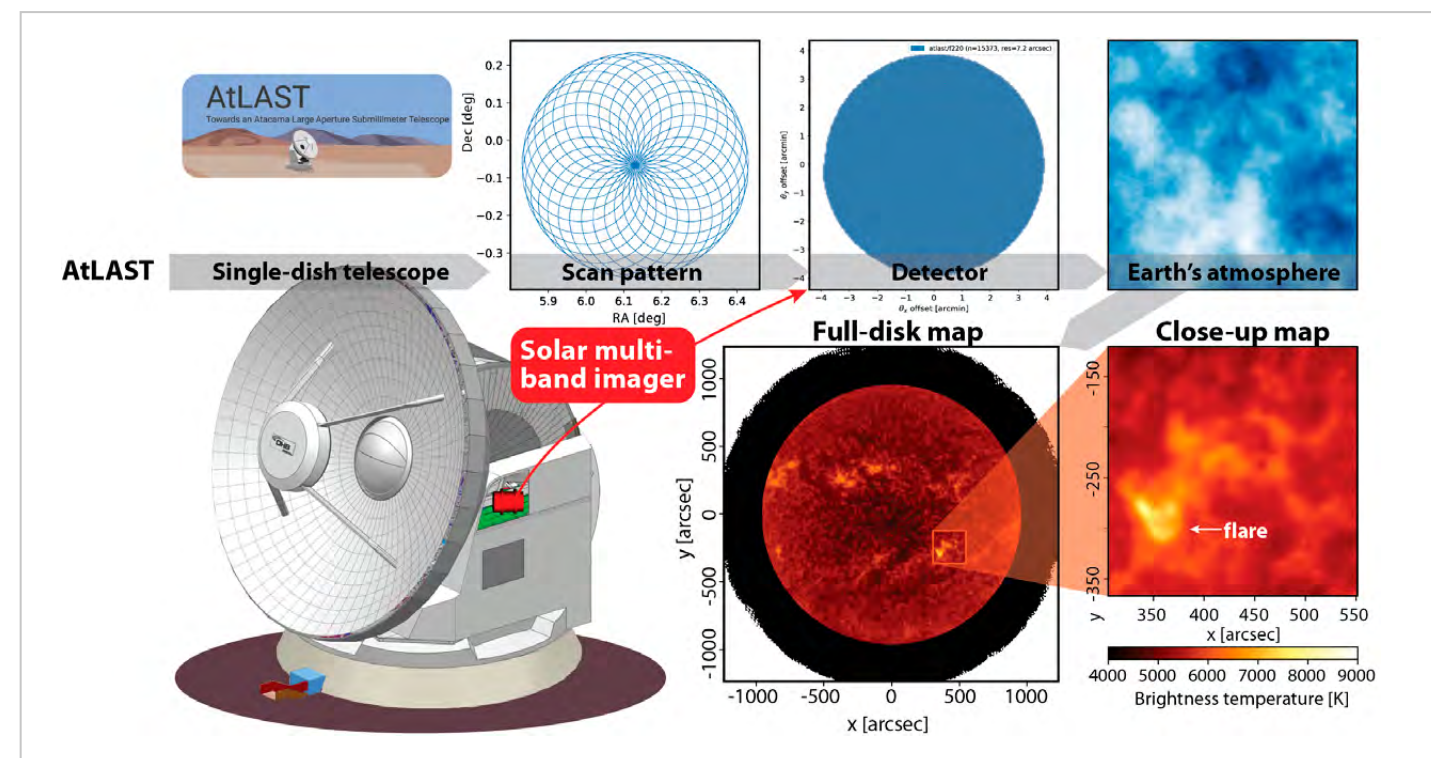


Figure 2 In May 2025, a Memorandum of Understanding for the Solaris project was signed in Oslo. **Left picture:** Front row from left to right: Dag Lorentzen (UniS), Lisa Badeley (UniS), Alberto Pellizzoni (INAF, Italy), Marco Potenza (University of Milan, Italy), Magnar Gullikstad Johnsen (Tromsø Geophysical Observatory). Back row from left to right: Sven Wedemeyer (RoCS), Mauro Messerotti (INAF/University of Trieste, Italy). Photo: Martina D'Angelo. **Right picture:** Alberto Pellizzoni and the dean of the UiO's Faculty of Mathematics and Natural Sciences, Solveig Kristensen, are signing the document at the Italian Embassy in Oslo. Credit: Sven Wedemeyer.

(Kirkaune et al. 2025). Subsequent work started in 2025 is extending these studies to time-dependent observations of solar flares, yielding tentative yet promising results that demonstrate the feasibility of capturing flares across the solar disk during full-disk scans without requiring dedicated pointing (Fig. 1).

New detector technologies

A key requirement for enabling rapid full-disk scans with AtLAST is the implementation of focal-plane arrays or multi-pixel cameras, which would provide a substantial increase in diagnostic capability compared with traditional single-pixel detectors that rely on time-consuming scanning. In 2025, Wedemeyer participated in the Focal Plane Array Workshop at the Max Planck Institute for Radio Astronomy in Bonn, Germany, where the scientific requirements and future prospects of next-generation detector technologies were discussed. Observations of the Sun stood out as a science

case that would particularly benefit from the current technological developments.

A first-generation instrument offering four to eight simultaneous continuum channels at different frequencies, combined with several tens of thousands of pixels at the highest frequency, appears feasible, enabling multi-frequency scans of the full solar disk in approximately 30 seconds. A second-generation system could increase the pixel count to the order of several hundred thousand, potentially reducing the scan time to mere seconds.

The future of astronomy

With the first light of the Extremely Large Telescope (ELT) approaching, ESO issued a call for White Papers outlining key scientific questions, aimed at guiding the next generation of large observatories that will shape astronomy in the 2040s, an initiative shortly termed Expanding Horizons. RoCS is contributing through its involvement in AtLAST and ALMA,

with Wedemeyer serving as co-lead of the Sun & Stars scientific working group for the ALMA2040 initiative. Although both projects respond to the ESO call, their scientific cases are complementary. AtLAST's proposed multi-band full-disk fast scanning mode would be crucial for capturing flares and CMEs, providing key data for investigating the solar origins of space weather. An upgraded ALMA, in turn, would enable high-cadence, high-resolution observations of the solar chromosphere, offering new insights into the small-scale structure, dynamics, and heating of the solar atmosphere. Two corresponding White Papers presenting these solar science cases were submitted to ESO in 2025.

Space Weather

By signing a Memorandum of Understanding between Italy and Norway in May 2025, RoCS officially joined the Italian-led Solaris project for millimeter observations of the Sun (Fig. 2). It is



Figure 3 Impressions of the Solaris project in Antarctica – Solar observations at millimeter wavelengths. An Arctic counterpart is now in preparation. Credit: Marco Potenza/Solaris.

planned to extend the operational stations in Antarctica (Fig. 3) with sites in the Arctic, including locations near Tromsø and/or on Svalbard. Although these telescopes are small compared with facilities such as AtLAST or ALMA, Solaris's continuous solar monitoring can provide valuable input for future space-weather forecasting. In this context, PhD student Massimiliano Oranges from the University of Venice/University of Milan, Italy, visited RoCS in 2025 to launch a collaboration focused on advancing observing and post-processing strategies.

Stellar Activity

Mohan et al. (2025) show that the quiescent millimeter emission of the young M dwarf AD Leo significantly exceeds predictions from 1D chromospheric models, indicative of a persistent non-

thermal component powered by supra-thermal electrons, unlike in older cool stars. Mohan et al. also report a frequency-rising double-hump flare with second-scale variability, indicative of repeated particle acceleration episodes (Fig. 4).

Evolved stars

One of the long-lasting questions in stellar physics, for which we have few clues, is the heating mechanism of the chromospheric layers of stars and how it evolves and impacts stellar evolution. The uncertainties are significantly higher for evolved solar-type stars in the asymptotic giant branch (AGB) phase, for which only very limited observations are available. In 2025, we started a pilot study to analyse the atmospheric structure of the nearby bright AGB star R Leo. We analysed the UV spectra taken

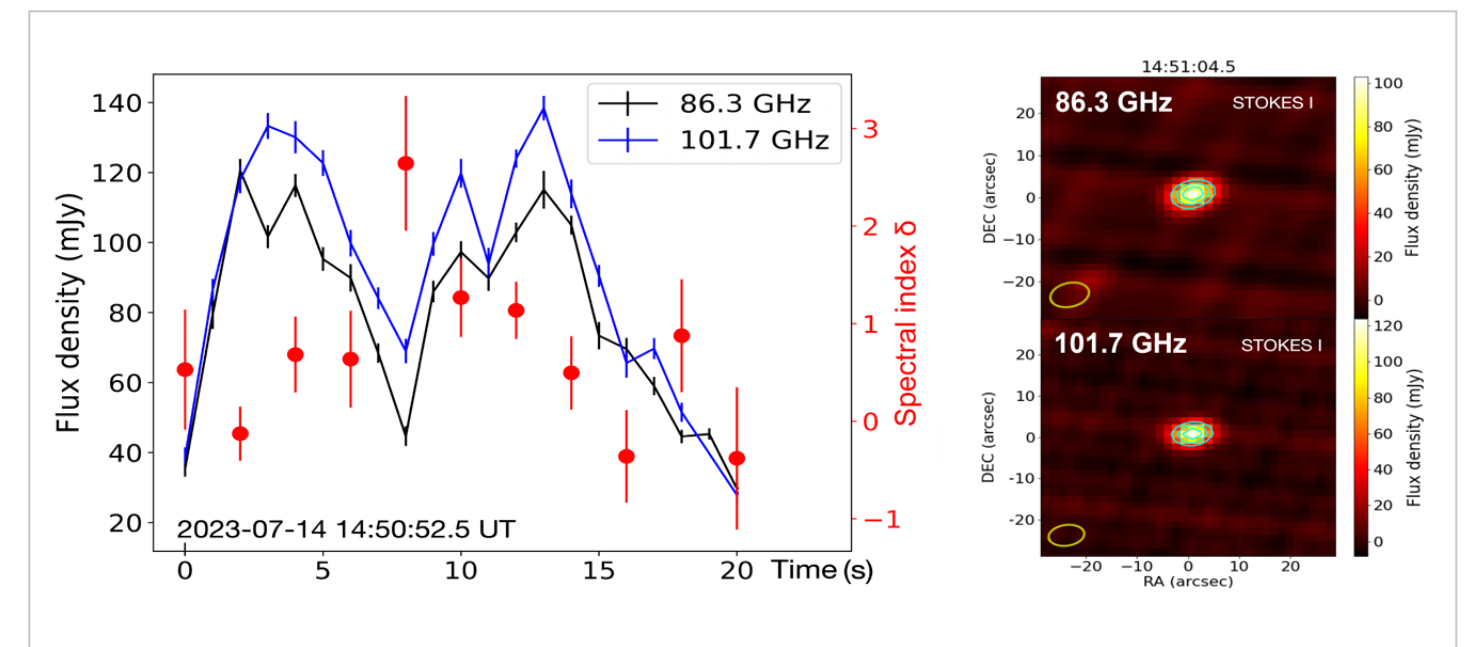


Figure 4 Observations of a flare on the active star AD Leo with the Northern Extended Millimeter Array (NOEMA) at millimeter wavelengths, exhibiting a double-hump profile. Adapted from Mohan et al. (2025).

by the Hubble Space Telescope (HST) using the NLTE RT code RH (Sabeti et al. in prep). Additionally, we applied for complementary optical data from the Nordic Optical Telescope (NOT). This study would provide the first detailed analysis of the atmospheric structure of an AGB star, based on more than 200 spectral lines spanning the UV and optical wavelengths.

Gorai et al. (2025a) conducted a comprehensive study of sulphur-bearing molecules and their isotopologues in oxygen-rich AGB stars using ALMA observations. Their analysis provided new insights into sulphur abundances at late evolutionary stages, including precise measurements of column densities, excitation temperatures, and isotopic ratios for SO and SO₂. We initiated a pilot survey to investigate

aluminium monofluoride (AlF), a key species in AGB chemistry. Using IRAM 30-m observations, complemented with data from the ALMA archive, we searched for multiple AlF transitions across different AGB types (C-, M-, and S-type stars) to identify in which evolutionary stages AlF is most efficiently produced. This ongoing study (Gorai et al. 2025b, in prep.) aims to clarify the detection of AlF and the evolutionary dependence of AlF in AGB.

Author: Sven Wedemeyer

Software Development

Simulation inventory

Our ability to produce high-fidelity simulations of the solar atmosphere has continued to improve over the last decade, driven by algorithmic advances and increased compute capacity. Bifrost's modular architecture makes it relatively straightforward to add or swap physical modules such as radiative transfer, partial ionization, and advanced equations of state. Historically, however, many users have created bespoke simulation setups that included only the physics required to study a single problem. That approach produced useful results but led to fragmentation: there was no single place to discover what simulations already existed, what physics they included, or what diagnostics were produced. In 2025, we designed and implemented an automated pipeline that extracts standardized metadata and key diagnostics from completed runs and uploads them to a central database to address this gap. The metadata schema records solver configuration, which physical modules are enabled, domain size and resolution, runtime and wall-time, input parameters, and a compact set of diagnostic outputs such as representative energy fluxes and synthetic observables. The database will be fully operational in early 2026 and is expected to contain approximately 70 simulations totalling roughly 1300 TB of data. With this resource in place, we can quickly locate existing simulations that meet particular science needs, reduce duplication of expensive runs, and increase the visibility and reuse of prior work. We have begun integrating simple query and preview tools so teams can find candidate runs and inspect summary diagnostics before requesting full data transfers.

Bridging the gap

Bridging the deep interior and the atmosphere remains a major challenge because the two regimes operate on very different

spatial and temporal scales and rely on different physical approximations. Interior codes such as ASH (Anelastic Spherical Harmonic) capture large-scale convective patterns and global flows over long time scales using approximations appropriate to high density and slowly varying conditions. Atmospheric codes like Bifrost require much finer spatial resolution and explicit treatment of waves, radiation, and partial ionization over much shorter time steps. Within the ERC Synergy WholeSun collaboration, we have developed a practical method for coupling these two regimes through a carefully defined overlap region. The coupling work included defining a consistent mapping of variables and boundary conditions across the overlap so that flows, thermodynamic variables, and magnetic vector components are matched, implementing interpolation and filtering strategies to avoid spurious wave reflections at the interface, and running validation tests ranging from 1D and 2D prototypes to full 3D experiments to confirm that energy and mass fluxes are conserved to acceptable tolerances. The current effort has prioritized robustness and physical consistency over throughput; tests demonstrate stable, physically plausible behaviour across the overlap. We expect the first scientifically useful coupled simulations to be available in 2026, enabling direct study of how deep convection and global-scale flows drive atmospheric structure and magnetic emergence at observable scales.

Merging Bifrost and DISPATCH

Porting Bifrost into the DISPATCH framework has been a significant coding effort this year and is now at the point where baseline Bifrost configurations reproduce expected results inside DISPATCH. DISPATCH is designed for efficiency through local time-stepping and flexible task scheduling, and it supports flexible

domain decomposition. We validated the porting by running canonical test problems and confirmed agreement with the legacy Bifrost solver within tolerances expected from discretization differences. Performance measurements on representative test cases indicate a substantial reduction in wall-time compared to the legacy runs, and that performance gain can be invested in larger domain sizes, higher base resolution, or more expensive physics. The DISPATCH/Bifrost setup now supports adaptive mesh refinement (AMR), enabling targeted resolution increases around sharp features such as current sheets, shocks, or reconnection regions. Usability and training were advanced by a transition workshop led by Mikolaj Szydlarski in 2025, which provided hands-on experience for several Bifrost users and covered build and run procedures, best practices for test cases, and performance tuning in DISPATCH. Near-term work includes broadening the validation suite to include more complex radiative-MHD benchmarks, measuring scaling to larger core counts, and publishing a set of recommended configuration templates for common science cases. We expect DISPATCH/Bifrost science runs to generate publishable results beginning in 2026.

DISPATCH multi-solver implementation

A distinct advantage of DISPATCH is its support for hybrid solver strategies, where different numerical methods operate in different regions of the domain and exchange information across interfaces. Over the last year, Michael Haahr extended DISPATCH with a particle-based solver to model macro-particle dynamics in regimes where the collisional mean free path is large and the single-fluid approximation is no longer valid, such as parts of the upper chromosphere and low corona. The development

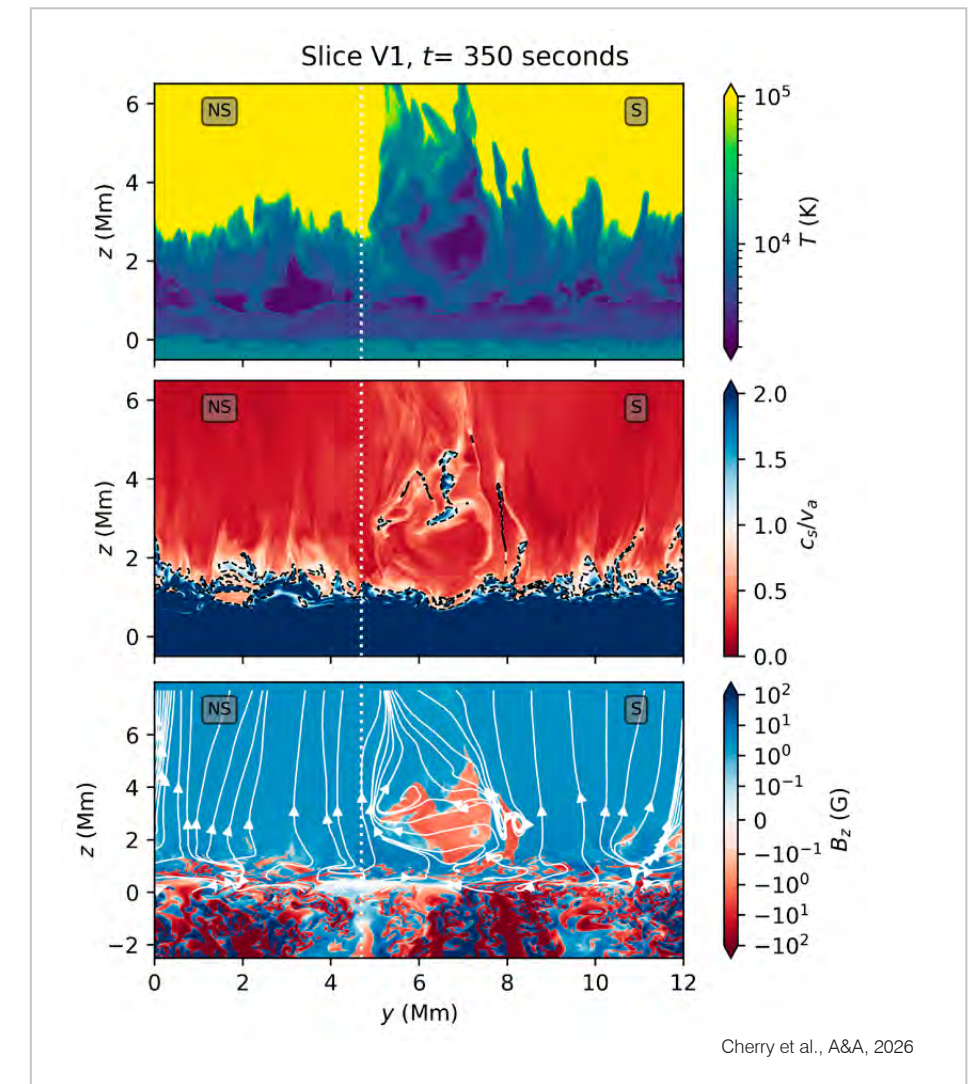
work included implementing particle pushers, ensuring consistent field interpolation on DISPATCH grids, and designing particle-field coupling terms that conserve momentum and energy to the solver's order of accuracy. Michael validated the solver on test problems relevant to particle energization, published methodological details and early results as part of his PhD work (defended in 2025), and brought the solver to a state suitable for hybrid test setups. The next steps are extended validation against kinetic benchmarks and integration of the particle solver into selected science runs. This development provides a practical path to include particle physics where needed and directly supports the project objective of moving beyond single-fluid MHD.

Identifying accelerated particles

Complementing in-situ solver development, Eilif Sommer Øyre has developed a particle post-processing toolkit that traces single-particle trajectories through previously computed simulation fields. The toolkit is optimized to follow millions of particles efficiently by using scalable trajectory integration. It produces statistical diagnostics that include time-resolved energy distributions, spatial maps of acceleration probability, and conditional distributions keyed to initial particle parameters. An enhanced version with expanded diagnostics and improved performance is under development. This post-processing approach allows us to explore particle energization hypotheses rapidly without requiring full kinetic runs for every case, thereby focusing more expensive particle-solver simulations on the most promising scenarios.

Wave propagation through the solar atmosphere

Understanding how wave energy generated at the solar surface propagates into and through the atmosphere remains



an open problem due to the medium's complexity and inhomogeneity. George Cherry developed a new mathematical method to identify and characterise transmitted wave signatures in both simulations and observational data. The method combines robust signal decomposition with physics-informed filtering to enhance transmitted wave components while suppressing local, non-propagating noise. Applied to a simulation, the method yields quantitative measures of transmitted wave power as a function of

height, frequency, and local magnetic field and flow conditions. Two papers describing the method and its initial physical results were published in 2025, and distribution of the method as part of a community analysis toolkit is under preparation. This diagnostic tool supports project goals by quantifying energy transport by waves and enabling more direct model-observation comparisons.

Author: Boris V. Gudiksen

Ongoing projects at RoCS in 2025

A number of externally funded projects exist as part of RoCS, in addition to the basic funding of RoCS from the Research Council of Norway and the University of Oslo.

ESGC (“Tracing the impact of Evolved Stars on the Galactic Chemical enrichment”, 2023–2027), funded by the Research Council of Norway. Aim: (A) Understand how fluorine, an element found in our bones and teeth as fluoride, is forming in the Galaxy; (B) Assess the impact of internal UV radiation on the efficiency of the stellar dust formation in oxygen-rich AGB stars; (C) Investigate the effect of internal UV radiation on the elemental isotopic ratios derived from observations of molecular lines.

Hinode Science Data Centre Europe (2004–2029), funded by the European Space Agency through a contract with the Norwegian Space Agency and the European Union through the SOLARNET project. The data centre hosts all data from the Japanese Hinode and the NASA Interface Region Imaging Spectrograph (IRIS) solar satellites and a number of Bifrost simulations.

ISSRESS (“Impact of small-scale reconnection events on the solar atmosphere”, 2021–2025), funded by the Research Council of Norway. Aim: To understand the origin and formation of small-scale magnetic reconnection events in the lower solar atmosphere and explore their role in the energy and mass transport from the lower to the upper solar atmosphere.

MultiSCORE (“Multi-Scale Structure of the Coronal Environment”, 2025–2029), funded by the Research Council of Norway. Aim: to capture the interplay between different scales in the solar corona by combining *ab initio* simulations that self-consistently model large-scale structure formation with targeted adaptive-grid simulations designed to resolve fine-scale dynamics.

Norwegian contribution to the MUSE data pipeline and archive (2025–2027), funded by the PRODEX program. The aim of the project is to assist in designing the data pipeline and archive for the MUSE project.

ORCS (“Oscillations in the Realistic Corona of the Sun”, 2021–2025), funded by the Research Council of Norway. Aim: To combine the self-consistent numerical simulations of the solar atmosphere and high-resolution solar observations to understand the generation, evolution, and dissipation of MHD oscillations in the structured and dynamical solar atmosphere.

OSCARS (2024–2026), funded by the EU. Aim: To federate solar data to make them more accessible to the solar physics community. There are eight partner institutions. The UiO part involves implementing recommendations from the International Virtual Observatory Alliance in the SOLARNET metadata recommendations for solar data and converting three data formats to comply with the new recommendations.

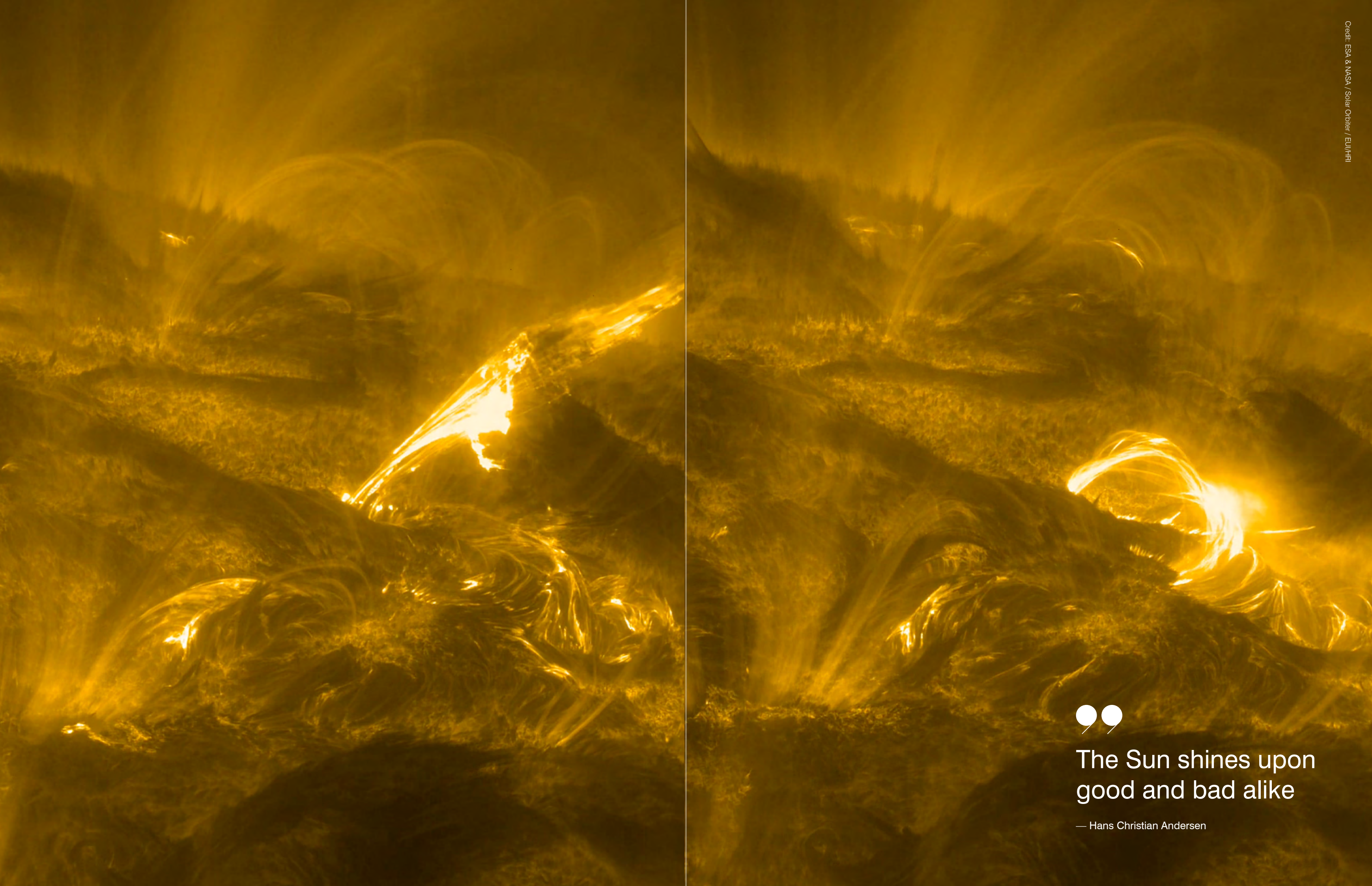
Software development for the Multi-slit Solar Explorer (MUSE) spectrograph (2025–2027), funded by Lockheed Martin through SETI. The aim of the project is to assist in the development of the Disambiguation software for the MUSE spectrograph.

SPICE on Solar Orbiter (2016–2026), funded by the PRODEX program. Finances the Norwegian contribution to the SPICE instrument on board Solar Orbiter: the software that transforms the raw binary data from the remote-sensing instrument SPICE into a format that can be analyzed by scientists.

Whole Sun (2019–2026), funded by an ERC Synergy grant. How does the Sun work? Why does it possess a magnetic cycle, dark spots, and a dynamic hot atmosphere? In the “Whole Sun” project, we aim to tackle these key questions as a coherent whole for the first time.



↑ North pole observed in H-alpha blue wing at -800 mÅ with the SST/CRISP2 instrument on October 10th, 2025. This observation was coordinated with Solar Orbiter.



The Sun shines upon
good and bad alike

— Hans Christian Andersen

Outreach 2025

Outreach is a valued part of our work at RoCS, and we participate in a variety of activities to promote science education and public access to scientific knowledge.

Media highlights

— Kan bli spennende

I en sak i NRK sier Joakim Martin i Deep Sky Exploration at kometen kan være synlig fra Sør-Norge, men ikke Nord-Norge. Den er mest lyssterk nå som den også er nærme sola.

— Man må kanskje ha en liten kikkert for å kunne se den, men det blir en spennende opplevelse, sier Martin til NRK.

Nettopp det advarer kometekspert Aditi Bhatnagar mot. Hun skriver doktorgrad på Roseland senter for solfysikk ved Universitetet i Oslo.

— Å prøve å se den med kikkert er en alvorlig sikkerhetsrisiko fordi den er så nærme sola, sier Bhatnagar.

— Det kan forårsake permanent øyeskade, legger hun til.



ADITI Bhatnagar, stipendiat ved Roseland senter for solfysikk. Foto: UIO

TV2.no

“Expert warns against attempting to view comet near the Sun”

Aditi Bhatnagar, doctoral research fellow, cautioned against observing comet C/2024 G3 (ATLAS) when it was close to the Sun and provided safety advice for observers.

12 January: Aditi Bhatnagar was interviewed as an expert by TV2.no. Credit: TV2.no (screenshot)

Teknisk Ukeblad

“Two new satellites will shed light on how solar eruptions form”

RoCS research shows the upcoming MUSE (2027) and Solar-C (2028) missions will resolve tiny magnetic “plasma blobs” in coronal current sheets, improving models of coronal heating and eruption forecasting. Article by **Øystein H. Færder**, post doctoral research fellow, for Titan.uio.no; republished in Teknisk Ukeblad.



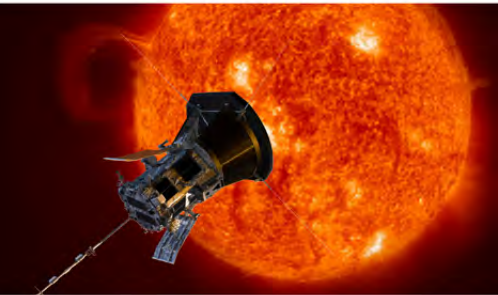
Forskere får stadig bedre data for å studere solen og koronaen. Her et koronautbrudd. Foto: NASA/ESA/ISOHO

19 January: Øystein H. Færder — how two new satellites will advance our understanding of the Sun’s dynamics. Credit: Teknisk Ukeblad (screenshot)

L’Astronomie

“Parker Solar Probe: an unprecedented mission to explore the Sun”

Nicolas Poirier, postdoctoral research fellow, wrote in the magazine’s first 2025 issue about the probe’s record close approach and its study of the Sun’s atmosphere, magnetic fields and energetic particles.



Ce 24 décembre 2024, une sonde spatiale s’approchera du Soleil à une distance encore jamais atteinte afin d’analyser en profondeur son atmosphère, un pari osé au vu des conditions extrêmes qui y règnent. Cette sonde, nommée *Parker Solar Probe* en hommage au célèbre astrophysicien Eugene Parker (décédé le 15 mars 2022 à l’âge de 94 ans), est une prouesse technologique de la Nasa, l’agence spatiale américaine.

15 January: From L’Astronomie (journal of the French Astronomical Society). Credit: L’Astronomie (screenshot)

Forskning.no

What does a star actually look like?

Professor **Luc Rouppe van der Voort**, interviewed for the piece, explains how the Sun appears through filters and high-resolution telescopes — a smooth ball of gas with 1,000 km-wide granules, dark sunspots and constantly moving plasma — and contrasts this with distant stars, which appear only as twinkling points from Earth.



17 February: Milky Way (long exposure) — reveals countless stars and the dense band discussed in the article. Credit: ESO / Y. Beletsky, CC BY 4.0 (screenshot from forskning.no)

NRK Nordland

“Solar eclipse across Norway today”

Coverage of a partial eclipse seen across Norway. Professor **Sven Wedemeyer** commented on regional variation, the scientific context, and urged use of proper eye protection.



28 March: Partial solar eclipse over Norway. Credit: NRK Nordland (screenshot)

Podcast: Curious Norway (Research Council of Norway)

“The Mystery of the Sun”

Kristopher Schou interviewed professor **Mats Carlsson** on the Sun’s life and death, aurora, solar storms, and digital twins.



Sesong 1, episode 10: Rosseland Center for solar physics ved Universitetet i Oslo

Nysgjerrige på: Mysteriet sola

7 April: Kristopher Schou interviewed Mats Carlsson for the podcast “Curious Norway.” Credit: Research Council of Norway (screenshot)

VG.no

“Weekend solar eclipse — definitely get outside”

Professor **Luc Rouppe van der Voort** urges people to watch the eclipse — this time the Moon crosses directly in front of the Sun and the event is visible from Norway — and warns to use certified eclipse glasses to avoid permanent eye damage.



28 March: Partial solar eclipse over Norway — Professor Luc Rouppe van der Voort commenting. Credit: VG Nett (screenshot)

Kragerø Blad Vestmar

“Strong northern lights over Kragerø this weekend: many solar storms”

Professor **Tiago Pereira** and doctoral research fellow **Aditi Bhatnagar** discussed the recent intense auroral display with the newspaper in southern Norway.



PEKER: Zia ur Rehman var blant mange som fanget det kraftige nordlyset over Kragerø, lørdag 18. oktober. (Foto: Zia ur Rehman, Zia The Explorer)

24. oktober 2025 | Side 32

Sterkt nordlys over Kragerø i helgen:

— Mange solstormer

Mange i Kragerø og resten av regionen fikk i helgen oppleve et sjeldent syn på himmelen. Det sterke nordlyset lyste opp lørdagskvelden og ble

24 October: Northern lights over Kragerø. Photo credit: Kragerø Blad Vestmar (screenshot)

Media highlights



6 November: Minister of Research and Higher Education Sigrun Aasland (centre) visits ITA and RoCS. At right: Professor Mats Carlsson. Credit: Klassekampen (Screenshot)

Klassekampen

“US research cuts prompt new recruitment to RoCS”

Minister of Research and higher Education Sigrun Aasland visited RoCS and the Institute of Theoretical Astrophysics, and Klassekampen covered the event. During her visit the minister said the government aims to “attract great minds to Norway” with a NOK 300 million, three-year recruitment scheme that will bring 13 international researchers — ten from the United States — to Norway. Director **Mats Carlsson** (RoCS) said the hires strengthen RoCS’s international profile and help secure stable academic careers in Norway.

13 nye internasjonale toppforskere til Norge

Regjeringen har satt av 300 millioner kroner for å tiltrekke seg internasjonale toppforskere. Nå kommer astrofysiker Souvik Bose til Universitetet i Oslo.

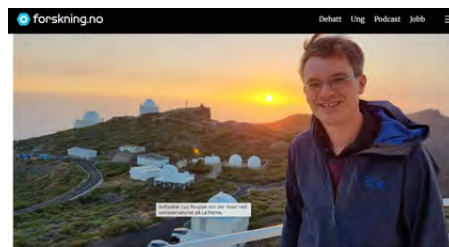


6 November: Khrono wrote the feature “13 new international leading researchers to Norway” with a photo of the US-based researcher Souvik Bose, who will join RoCS in January 2026. Credit: Khrono (screenshot)

Forskning.no

“The biggest disturbance since I started working on this”

An article on Forskning.no reported intense solar activity and major eruptions late in 2025; Professor **Luc Rouppe van der Voort** was interviewed and called it “the biggest disturbance since I started working on this,” warning of continued strong flares and increased auroral activity.



22 December: Solar physicist Luc Rouppe van der Voort at the solar observatory on La Palma. Credit: Lasse Bjørnstad/forskning.no (screenshot)

sol.no

“It’s about to turn”

Doctoral research fellow **Jonas Thoen Faber** explained the winter solstice – when the Sun appears to “turn” and why daylight increases thereafter.

Snart snur det

21. desember er det vintersolv. Fra da går det mot lysere tider.



21 December: Article on Sol.no about the winter solstice — brighter days ahead. Credit: Sol.no (screenshot)

Europhysics News

“Space-Weather Effects on Critical Infrastructure on Earth”

Professor **Sven Wedemeyer** co-authored an outreach piece on how solar space weather — flares, CMEs and energetic particles — threatens critical infrastructure (especially power grids, satellites and navigation) and urges better monitoring, modelling and stakeholder collaboration.

22 December

Personal outreach



Rebecca Nguyen (MSc student) gave a talk on solar research at the Solar Observatory at Harestua on 30 August, explaining what solar research is, why it matters, and how we study the Sun. She also participated as a role model in the national “Girls and Technology” two-week tour in October, sharing her journey as an astrophysics student to inspire girls and support the organisation’s aim of increasing the share of women in technology. The campaign visits towns and communities across Norway to engage girls in 9th and 10th grades; the three-hour shows use personal, motivating stories to highlight the many exciting opportunities within technology. On 30 October Rebecca also participated in the Girl Tech Fest, where she and fellow students conducted a workshop introducing programming and its applications in lunar mission planning.



Rebecca Nguyen (centre) at Girl Tech Fest. She and fellow students ran a workshop for 5th-grade girls on programming and lunar-mission planning. Credit: Private



Credit: Private

Adjunct professor **Lyndsay Fletcher** took part in several outreach activities, including public presentations to local astronomy clubs and community groups, and interviews designed to broaden public understanding of solar and space science.

She was appointed a Member of the Order of the British Empire (MBE) on 14 June 2025 and received the insignia at an investiture at Palace of Holyrood House, Edinburgh, presented by Princess Anne.



Credit: Private

Valeriia Liakh, postdoctoral research fellow, gave a talk at an open DScience Lunch Seminar for a mixed audience at the University of Oslo on 9 October, titled “Modeling Solar Prominences: A Space Weather Perspective.”



Credit: JASON 2025 (screenshot)

Adjunct professor **Guillaume Aulanier** spoke at JASON 2025, “Les événements solaires extrêmes,” on 22 June about “Solar eruptions and extreme events.”

Exhibition

An exhibition in April at the Faculty of Mathematics and Natural Sciences' library showcased works from the REAL ART guest-artist programme, which included participation from RoCS. The exhibition was covered both by Titan.uio.no and Forskning.no with the article: "Art and science: Emotions versus hard facts — or two sides of the same coin? What happens when artists and scientists collaborate? Today the exhibition opens, offering some answers to exactly that."

Project and collaboration

Doctoral research fellow **Mats Ola Sand** initiated the project in autumn 2023 and collaborated with the programme's first artist, Laila Kongevold, who visited the solar observatory on La Palma and produced a handmade book of solar images and field photographs. Mats Ola Sand noted that working closely with an artist brings completely different perspectives to the research. Kongevold also exhibited prints and the results of lino workshops, alongside book treasures from UiO and objects from the Solar Observatory at Harestua. — A real highlight is a letter from Carl Fredrik Fearnley to Professor Hansteen with the original drawing of the 1852 solar eclipse, she said.



Kunstner Laila Kongevold og forsker Mats Ola Sand blar i boka kunstneren har laget med bilder fra solobservatoriet på La Palma. (Foto: Eivind Torgersen)

↑ Artist Laila Kongevold and PhD student Mats Ola Sand browse the book the artist made, containing images from the La Palma solar observatory. Credit: Eivind Torgersen (screenshot of photo).



Astronomy Olympiad

The National Olympiad in Astronomy and Astrophysics 2024/2025 showcased the exceptional talents of students with a strong interest in astronomy and astrophysics. Held in week 12 in March, the event comprised four days of training followed by a final competition on the last day. It was organised by the Institute for Theoretical Astrophysics (ITA) in collaboration with RoCS — the Rosseland Centre for Solar Physics.

From Classroom to IOAA

Twenty-five upper-secondary students participated in lectures and practical sessions covering a wide range of topics, including solar and stellar physics, exoplanets and habitability, and problem-solving techniques. RoCS contributors included **Aditi Bhatnagar**, **Tiago Pereira**, **Sven Wedemeyer**, **Mats Kirkaune**, **Rebecca Nguyen**, **Mats Ola Sand** and **Eilif Sommer Øyre**.

Five outstanding participants were named winners of the Norwegian Olympiad and advanced to represent Norway at the IOAA (International Olympiad on Astronomy and Astrophysics) 2025 in Mumbai, India.

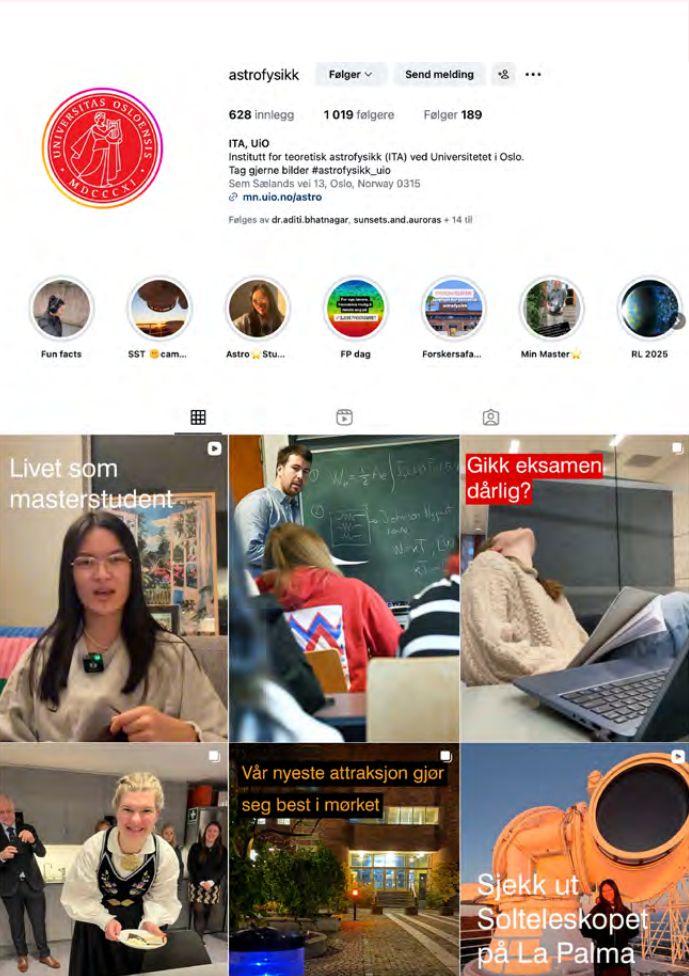
← Professor Tiago Pereira teaches a workshop on stellar spectra. Credit: Martina d'Angelo

School visits

On 5 May, postdoctoral research fellow **Maryam Saberi** met with 9th-grade students visiting ITA, presenting her research on how evolved stars contribute to the Galaxy's chemical enrichment and sharing insights into life as an astrophysicist.

On 24 November, doctoral research fellow **Mats Ola Sand** gave a presentation on solar physics and career opportunities to two groups of second-year high-school students.

Social media



↑ Social media: RoCS is active on Twitter, Instagram and Facebook (Instagram and Facebook via the Institute of Theoretical Astrophysics). Image credit: The Institute's Instagram account (screenshot)



Photo: Aditi Bhatnagar

International Rosseland Visitor Programme

Visits from internationally leading scientists are very important for the success of RoCS. The International Rosseland Visitor Programme facilitates international exchange by providing funds for researchers at the professor, post-doctoral, and PhD levels for short or extended visits at RoCS.

In 2025, RoCS hosted a number of international visitors who contributed to ongoing research collaborations, scientific discussions and knowledge exchange. Early in the year, **Adam Kowalski** (NSO), **Graham Kerr** (NASA Goddard) and **Joel Allred** (NASA Goddard) visited RoCS from late February to early March in connection with a RADYN workshop. In April, Professor **Stefaan Poedts** from KU Leuven visited RoCS to discuss possible future collaborations and **Han Uitenbroek** (NSO) and **Malcolm Druett** (University of Sheffield) served as opponents at the PhD defence of Kilian Krikova.

The spring and early summer period included several shorter research visits. During May, visits from **Alberto Pellizzoni** (INAF, Italy), **Marco Potenza** (University of Milan, Italy) and **Magnar Gullikstad Johnsen** (Tromsø Geophysical Observatory) took place, alongside short research stays by **Nitin Yadav** (IISER TVM) and **Andreas Korpi-Lagg** (MPS) who served as opponents at the PhD defence of Aditi Bhatnagar. Additional short visits during May and June included **Tom Histon** (Stockholm University) and **Souvik Bose** (LMSAL), contributing to focused scientific discussions and exchange.

In June, **Sacha Brun** and **Adam Finley** from CEA, Saclay, visited RoCS to discuss the WholeSun project together with Mats Carlsson.

The spring and summer months also included several longer research stays. **Samantha Cook** from the University of Glasgow was a long-term visitor from May to August, collaborating with Luc Rouppe van der Voort, Carlos Díaz Baso, and Reetika Joshi. Samantha joined our SST observing campaign

in June. Master's student **Gabin Tabellion** (ISAE-ENSMA Poitiers) joined RoCS from June through August to work on a project with Nicolas Poirier. These extended visits supported close collaboration with RoCS researchers and contributed to sustained scientific progress.

During the autumn period, further international visitors contributed to the centre's activities. **Reetika Joshi** (NASA Goddard) visited RoCS from mid-August to mid-September. In early September, **Tom van Doorselaere** (KU Leuven) visited RoCS to discuss projects related to wave identification and propagation as well as serve as an opponent at the PhD defense of George Cherry. **Katia Bechecker** (University of Béjaia, Algeria) and **Massimiliano Oranges** (University of Venice/University of Milan, Italy) visited for longer periods across September and October. **Maria Elena Innocenti** (Ruhr Universität Bochum) had a short stay at RoCS in September to exchange experiences with multi-physics codes and serve as an opponent at the PhD defense of Michael Haahr. Additional short visits during this period included **Pietro Benedusi** (IRSOL). **Damien Przybylski** (MPS) visited for collaboration work on synthetic observables from MuRAM simulations. **Alexander Russel** (University of St. Andrews) and **James McLaughlin** (Northumbria University) served as opponents at the PhD defence of Elisabeth Enerhaug and stayed a few extra days to give seminars and discuss projects of common interest.

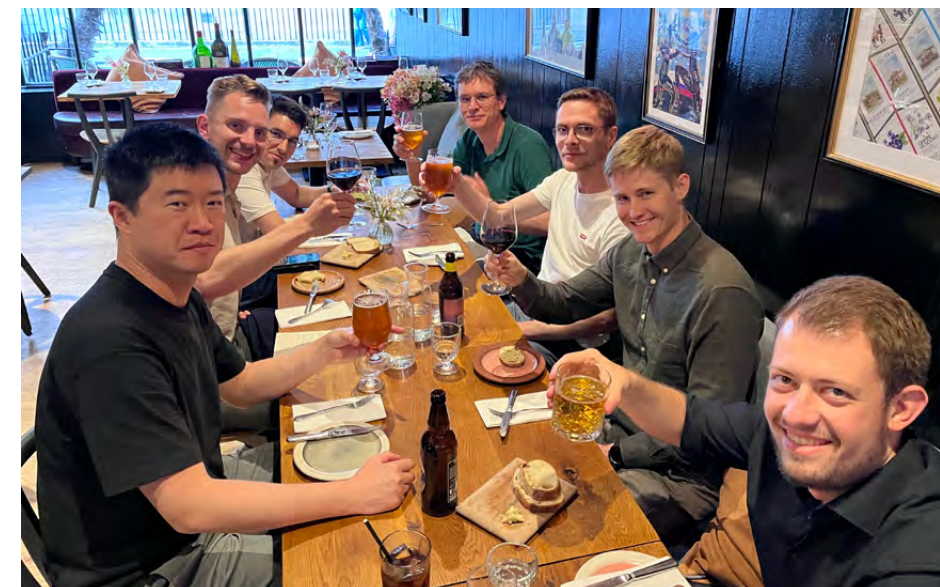
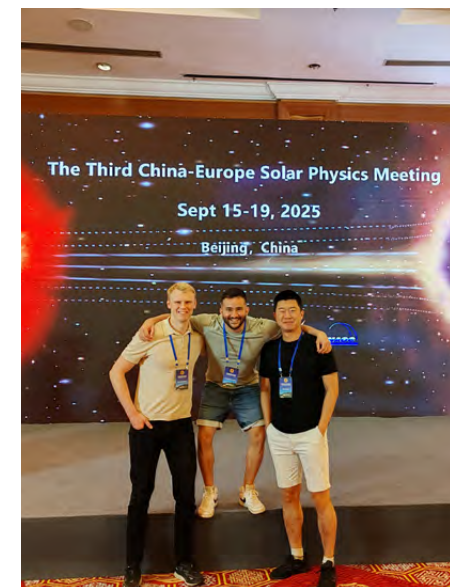
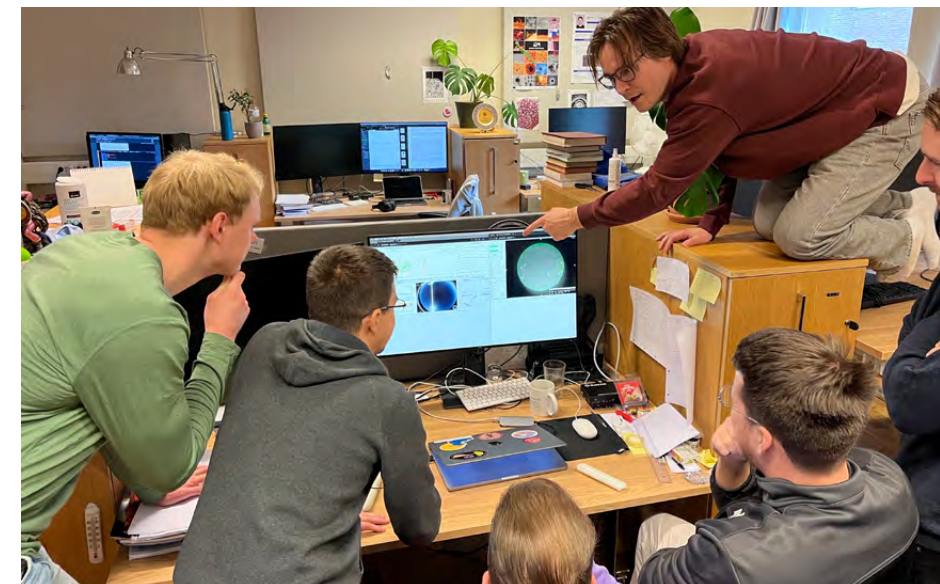
Together, these visits strengthened international collaboration at RoCS and supported the centre's scientific goals through exchange of expertise, collaboration on ongoing projects and participation in the broader research environment.



Glimpses from the life at RoCS

Social life at RoCS

Short and long-distance journeys showcase the vibrant community at RoCS, thriving with a seamless blend of work and leisure.



Behind the scenes

Reflections from the centre coordinator

When I first arrived at RoCS in February 2018, just three months after the centre opened, it felt like stepping into an entirely new world. Coming from the private and corporate sector, the university environment was unlike anything I had experienced before. One of the most striking differences was the constant ebb and flow of people. I had seen colleagues come and go in earlier jobs, but never with the same frequency or as such an integrated part of the system as in academia.

Over the years, this dynamic has shaped my core focus as centre coordinator. Budgets, accounting and project applications matter, but taking care of people has always been my highest priority. During

my time here, I have met so many remarkable individuals—arriving in Oslo to build their careers, pursue research and explore new opportunities—while also navigating the full range of human experiences: rethinking plans, facing loneliness in a new country, building families, losing loved ones, adapting to new cultures and handling challenges they never expected to encounter. Supporting them through these moments has been the most meaningful part of my work.

If it were possible, I would gladly offer permanent positions to everyone who wishes to stay. While that is not how academia functions, what is possible is meeting each person with kindness, respect and practical support – whether

they need help understanding Norwegian systems, finding housing, applying for visas or simply figuring out the mysteries of holiday pay.

Building a system of support

One of my most important long-term projects has been developing the RoCS onboarding and offboarding system. The aim is to ensure that every employee feels welcomed, supported and seen – from the moment they receive an offer, throughout their stay in Norway and up to their departure. Many of our colleagues leave families thousands of kilometres behind, and loneliness can be a real part of their experience. We strive to make RoCS a home during their time here, building a sense of belonging rooted in our shared values and the centre's broader vision.

A successful onboarding strengthens both confidence and community. My hope is that all past, present and future members of RoCS leave us knowing that they were valued, supported and truly part of something larger—what we like to call the RoCS family.

Author: Benedikte Fagerli Karlsen

Coordinator Benedikte Fagerli Karlsen has been with the centre since its inception. Credit: Ola Gamst Sæther



RoCS researcher honoured with ESPD Prize



Valeriia Liakh at the top of the Swedish Solar Telescope (SST). Credit: Private

Dr. Valeriia Liakh, a postdoctoral researcher at the Rosseland Centre for Solar Physics (RoCS), has been awarded the 2025 Giancarlo Noci Early Career Researcher Prize by the European Solar Physics Division (ESPD).

Groundbreaking research

Dr. Liakh is recognised for her outstanding work on the dynamics of solar prominences. Using advanced magneto-hydrodynamic (MHD) simulations combined with deep physical insight, she has addressed pivotal questions about the behaviour of prominences – in particular their large-amplitude oscillations and rotational dynamics. Her studies combine high-resolution numerical modelling with direct comparison to observations, enabling clearer interpretation of prominence stability and destabilisation processes. This methodological combination has produced results that are both theoretically robust and observationally relevant.

Prize significance

The prize, presented by the ESPD and carrying a €300 award, acknowledges Dr. Liakh's significant contributions to prominence dynamics and their implications for solar physics. The award highlights early-career researchers whose work shows originality and impact. Dr. Liakh commented: "This prize is meaningful recognition of my work by the solar physics community and a reminder that my research has real value and impact. It gives me even more motivation to continue."

Broader impact

Understanding prominence dynamics is important for predicting solar activity and space weather, since eruptions and instabilities in prominences can be

linked to coronal mass ejections that affect the near-Earth environment. Dr. Liakh's results therefore contribute to both fundamental solar physics and practical efforts to improve forecasting of solar events.

Background

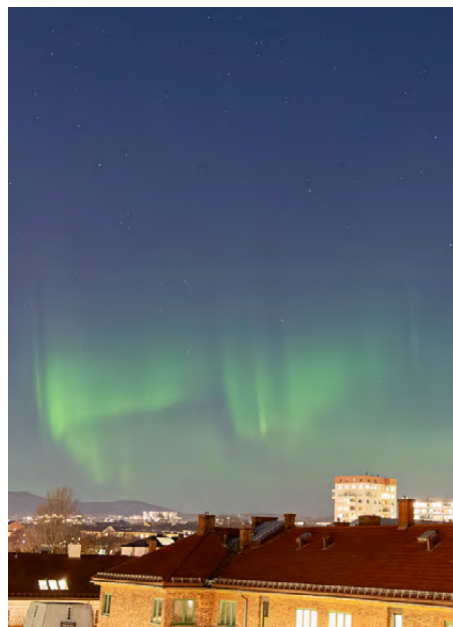
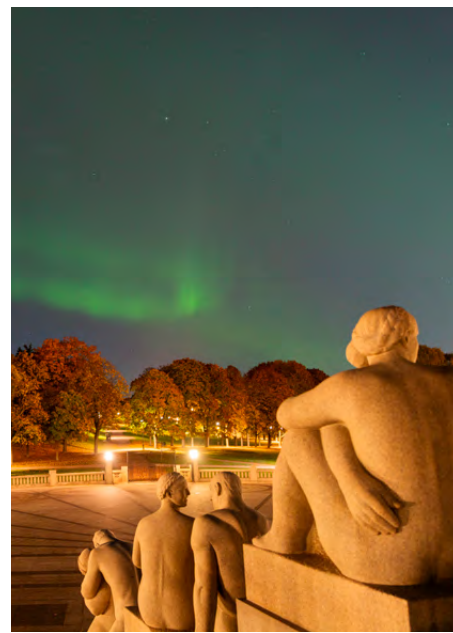
Originally from Ukraine, Valeriia Liakh completed an MSc in 2017 at the Faculty of Physics, Taras Shevchenko National University of Kyiv and earned a PhD in Astrophysics from the Instituto de Astrofísica de Canarias and the University of La Laguna (defended 2021). She held a postdoctoral position at KU Leuven before joining RoCS as a postdoctoral fellow in December 2024.

Author: Eyrun Thune

Vivid auroral displays across the city

Over the past year, auroral activity has been strong and frequent, allowing the Northern Lights to be observed and photographed from within Oslo. These images show vivid auroral displays above city landmarks and residential neighbourhoods.

Author: Aditi Bhatnagar





Alberto and me with San Francisco in the background. Credit: Private



Ignasi by the Golden Gate Bridge. Credit: Private

Research visit to Lockheed Martin, Palo Alto

During the last academic year I had the opportunity and support from RoCS to undertake a long-term visit to colleagues at Lockheed Martin in Palo Alto, California, US.

The main goal of the visit was to develop a scientific collaboration with the Palo Alto solar physics team. It was a great opportunity – I’m really glad I went.

The science

I went to Palo Alto to learn techniques used in their solar research. More specifically, I worked on my second PhD project, studying Ellerman bombs with combined data from SST and IRIS, expanding previous studies to new spectral ranges.

The people

The team in Palo Alto is outstanding, and they made me feel included from the very first moment I arrived.

Alberto Sainz Dalda was my supervisor – or, as he liked to say, a collaborator. Beyond solar physics, he taught me many practical skills for working with data, how to tackle and overcome new problems, and how to think things through calmly and methodically. I also learned VIM from him.

I also had a great social life thanks to other members of the solar team. I quickly got along with Gabriele – he is Italian, so the cultural gap with me was quite small. As someone once said, “Italy is Spain with marketing.” Shortly after, Juraj and Nabil joined us, forming a group that was very important throughout my visit.

The place

Palo Alto, Mountain View, and San Francisco were the main places where I stayed. It was very nice to get to know them.

I had the chance to visit many places in the country, including San Francisco, Washington, D.C., and New York. I was amazed by them. I also took a road trip, which was fantastic: it started in Las Vegas and finished in San Francisco, driving through many national parks such as the Grand Canyon, Death Valley, and Sequoia National Park. My collection of magnets grew a lot!

I will never forget this experience and I cannot thank RoCS enough for giving me this opportunity. Everything I learned is invaluable. All the science, the people, and the places made the visit a unique life experience.

Author: Ignasi Josep Soler Poquet

An early approach to advanced solar research

During summer 2025, master student Rebecca Nguyen and bachelor student Yuman Böttcher collaborated with PhD student George Cherry and postdoctoral researcher Quentin Noraz to study small-scale dynamics in the lower solar atmosphere. Using state-of-the-art Bifrost simulations, they aimed to uncover new clues about solar energy transfer.

“I started knowing almost nothing about solar physics, but once we began detecting many tornadoes, the project became even more exciting. We could finally examine how they transport energy”, Yuman added.

Successful outcomes

Rebecca successfully implemented turbulence-modified conduction in Bifrost and found a suppression of thermal energy transport in the solar atmosphere. Yuman generalised and validated the tornado-tracking algorithm, enabling quantitative estimates of heating and energy flow in magnetic vortices.

Together, their work strengthened our understanding of how magnetic fields organise and energise the Sun’s atmosphere, developing tools that will help to understand the Sun’s constantly shifting magnetic landscape and its influence on Earth and the wider heliosphere.

Author: Quentin Noraz, Rebecca Nguyen

Bifrost, developed at RoCS, models the layers just above the Sun’s surface, where energy flows from the interior toward space. This region controls how energy is transported, dissipated, and released into the interplanetary medium.

Exploring conduction

Different layers of the solar atmosphere require distinct physical processes, and Bifrost must include them accurately. One key mechanism is thermal conduction, recently shown to be strongly affected by microturbulence in the corona.

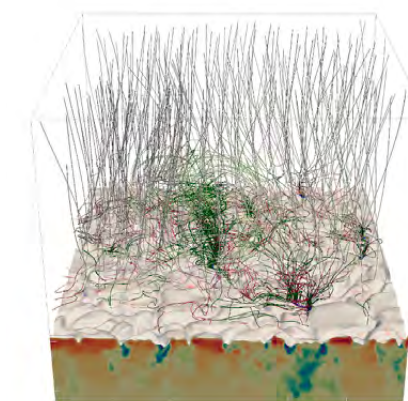
Rebecca updated and expanded Bifrost’s thermal-conduction module to reflect these findings. She wrote new Fortran90 routines based on turbulence theory and analysed their effects in 1D, 2D, and 3D using Python.

“I began the internship unsure of what to expect, but I thoroughly enjoyed it. It was a great chance to gain hands-on experience in code development and a clear preview of research life”, Rebecca said.

Hunting solar tornadoes

In parallel, Yuman investigated a striking phenomenon: solar tornadoes. These are magnetic vortices that may help explain how the solar atmosphere is heated and how magnetic energy escapes into space.

To study these motions, Yuman adapted a recently developed detection algorithm to identify swirling patterns in simulations. It’s like designing a detective that spots hidden vortices in a pot of boiling water, except the fluid is a magnetised plasma here.

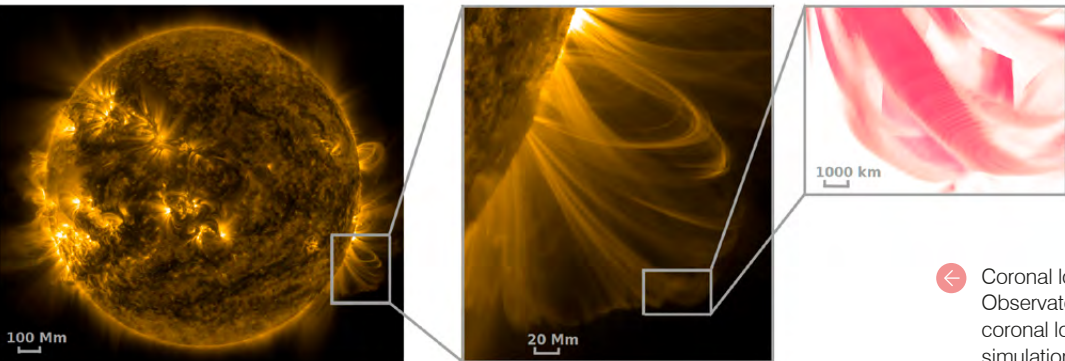


3D rendering of a Bifrost simulation showing magnetic swirling events. Credit: Q. Noraz

NASA SDO observation of similar structures in the solar atmosphere, as well as bright magnetic field loops along which thermal conduction occurs. Credit: NASA/SDO

MultiSCORE: Multi-Scale Structure of the Coronal Environment

The MultiSCORE project is funded by the Research Council of Norway and is focused on investigating the multi-scale structure of the solar corona.



Coronal loops observed by the Solar Dynamics Observatory and complex dissipation regions in coronal loops in a convection-zone-to-corona simulation. Credit: P. Kohutova, RoCS & NASA/SDO

Structure of the solar corona

The solar corona, the outermost layer of the solar atmosphere, is the source of some of the most energetic space weather events that impact Earth's technology and communication systems. Recent state-of-the-art solar simulations suggest a paradigm shift in our view of the basic building blocks of the solar corona. Previously thought to be composed of simple, compact strands of hot plasma, the self-consistently formed corona in realistic models of the Sun instead consists of much more complex, turbulent structures. The structure of the corona spans a vast range of scales, making it challenging to capture its complexity with a single model.

Challenges in modelling the solar corona

The disconnect between various modelling approaches which focus on different spatial scales means that the multi-

scale nature of the solar corona is not adequately addressed by current models. Large-scale models, such as Bifrost, realistically model the large-scale structure of the corona, including magnetic connectivity and coronal evolution on large scales, but tend to 'smooth out' the structuring and dynamics at finer scales. On the other hand, models aimed at capturing turbulent processes in the corona are better suited to studying coronal evolution at fine scales, but often use very idealised configurations for modelling coronal structures.

Combined approach to modelling supported by multi-instrument observations

MultiSCORE will, for the first time, capture the interplay between different scales in the solar corona by combining ab initio simulations that self-consistently model large-scale structure formation with targeted adaptive-grid simulations

designed to resolve fine-scale dynamics. The simulations will be complemented by novel data from the Solar Orbiter spacecraft, which offer unprecedented resolution, and, combined with data from near-Earth solar observatories, enable reconstruction of the three-dimensional structure of the corona. By bridging the gap between different modelling approaches and integrating novel observational data, the project aims to reveal the fundamental structure of solar coronal loops and determine how the interplay between different scales influences structure formation and the transport of mass and energy in the corona. The project will also pave the way for the next generation of solar models, with broad implications for both fundamental solar physics and practical applications in space weather prediction.

Author: Petra Kohutova

Origin and evolution of Solar eruptions

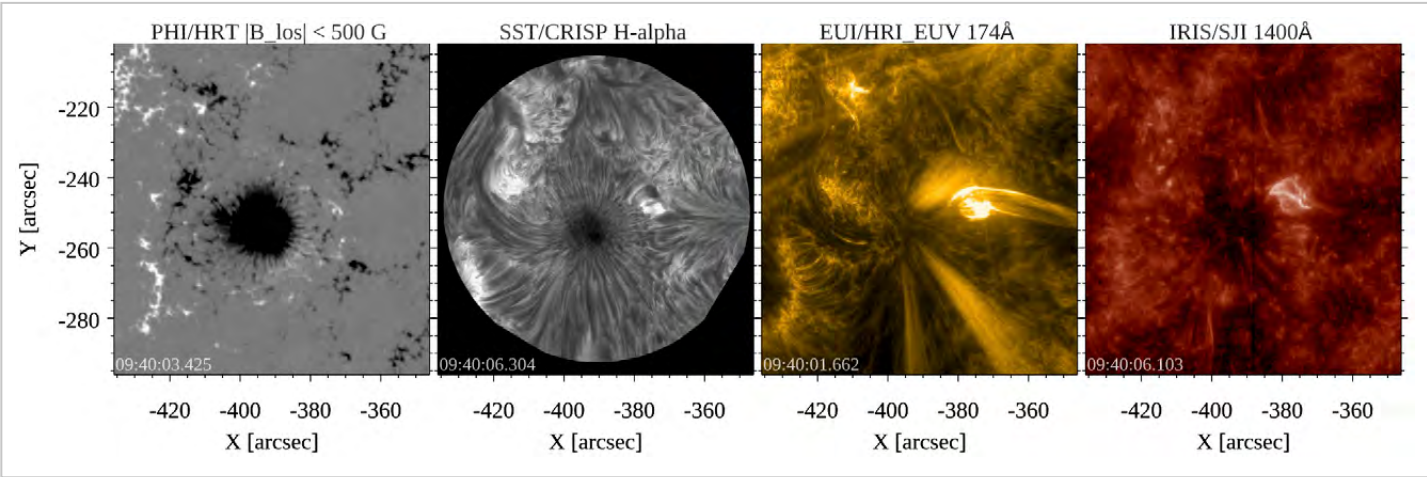
The project "Origin and Evolution of Solar Eruptions (OESE)" is funded by the Research Council of Norway as part of the Space Research Programme in the thematic call of 2025.

Solar eruptions, including solar flares and jets, are among the most energetic events in the solar system, driven by the complex interplay of magnetic fields in the solar atmosphere. Their origin lies in the long-term evolution of the magnetic field, where energy is gradually stored through flux emergence, cancellation, and shear motions in the photosphere before being released via magnetic reconnection. Understanding the mechanisms leading to these eruptions is crucial for predicting space weather and its impact on Earth's space environment.

The OESE project will investigate the origin and evolution of solar eruptions by combining high-resolution observations from space- and ground-based telescopes: ESA's Solar Orbiter, the Swedish 1-m Solar Telescope (SST) on La Palma, NASA's Interface Region Imaging Spectrograph (IRIS), and the upcoming Multi-slit Solar Explorer (MUSE) mission. The EUV instrument onboard Solar Orbiter is imaging the hot coronal component of jet eruptions at unprecedented spatial and temporal resolution.

Magnetic field extrapolations using vector magnetograms from the SST will help identify key magnetic structures, such as flux ropes and null points, that play a role in eruption onset. Additionally, advanced numerical simulations using the Bifrost radiative MHD code will be employed to model the pre-eruptive magnetic environment and compare it with observations using synthetic observables.

Authors: Luc Rouppe van der Voort & Reetika Joshi



Large jet observed during a coordinated campaign in October 2023 involving SST, Solar Orbiter, and IRIS. From Solar Orbiter, both the PHI and EUV instruments participated. From Joshi, Rouppe van der Voort, Aulanier et al. (2025).

Magnetic reconnection workshop

The year began at the blackboard for several of our PhD students, post-docs and professors as RoCS revived the tradition of intensive classroom learning.

From January 21-27, the Reconnection Workshop was a theory-focused deep dive into magnetic reconnection taught by professor Guillaume Aulanier.

Talks of a workshop on the fundamentals of our research emerged years ago, when several students felt the need to properly understand the most energetic process in the solar atmosphere: magnetic reconnection. It took some years (including the 2020 pause), but finally the initiative was reignited by three eager PhD students and professor Guillaume Aulanier from Paris in 2024.

From basic to advanced topics

A discussion started and it grew large: null-points, quasi-separatrix layers, fan-spine topology: all concepts that desperately need equations, drawings, and drawing of equations to be properly explained. The students asked, and Guillaume enthusiastically agreed to give a series of lectures. The organizing committee consisted of Guillaume Aulanier, Ignasi Josep Soler Poquet, Elias Roland Udnæs and Eilif Sommer Øyre.

Lectures ranged from fundamental magnetohydrodynamics to advanced topological and observational perspectives.

Program highlights

- Fundamentals of MHD: continuity and momentum equations, Ohm's law, frozen-in flux, energy balance, and characteristic timescales.
- Coronal conditions: orders of magnitude, force-free fields, and simple arcade models.
- Local current-sheet formation: Harris sheets, X-point collapse and shearing, and resistive/thermal balance.
- Reconnection physics: breaking field lines, electric-field views, reconnection regimes (Sweet-Parker, Petschek, tearing), and rates.
- Global topology and visualization: separatrices, nulls, QSLs, spines and fans, and reconnection proxies.
- Connections to observations: standard flare model, ribbons and hard X-ray sources, jets, Ellerman bombs, and 3D models of eruptive flares.

The format combined blackboard lectures, examples, and lively discussions. Participants left with clearer theoretical foundations and practical tools to interpret simulations and observations—a reminder that focused, collegial teaching remains essential for advancing our field.

Author: Elias Roland Udnæs

Students and the teacher after a successful workshop. From left to right: Jonas Thoen Faber, Sascha Ormig, Quentin Noraz, Ignasi Josep Soler Poquet, Carlos José Díaz Baso, Guillaume Aulanier (the workshop teacher), Reetika Joshi, Eilif Sommer Øyre, Aditi Bhatnagar, Elias Roland Udnæs and Michael Haahr. Credit: Luc Rouppe van der Voort



Joint IRIS/MUSE science team meeting



Group photo of the Joint IRIS/MUSE science team meeting including RoCS members, former RoCS members and close collaborators. Credit: Private

RoCS had a strong participation at the Joint IRIS/MUSE science team meeting at the SETI Institute in Mountain View, California in October. The aim of the meeting was to bring together modelers, observers, and inversion experts to test and improve the fidelity of scientific tools, observing programs, instrumental decisions, and data processing techniques in preparation for the upcoming MUSE mission.

The Multi-slit Solar Explorer (MUSE) is a NASA mission that aims to advance our understanding of the solar corona and the origin and evolution of the unstable solar atmosphere that drives impactful events such as solar flares. MUSE is scheduled for launch in the summer of 2027.

RoCS contributions

Numerical simulations are a critical part of the IRIS and MUSE missions. They are used to assist with the science planning, data calibration, and data pipeline aspects of the space missions. They are further essential for the interpretation of complex observations. RoCS members are deeply involved in the continuous development of numerical simulations, as well as the development of machine learning techniques for processing the complex observations from the array of slits from the MUSE spectrograph. RoCS is further involved in preparing for coordinated observations from the ground with the SST on La Palma.

Author: Luc Rouppe van der Voort



Members of the centre

Members of the centre

The main resource of RoCS and its most important contributor is our staff. Everyone at our centre – scientific, administrative, and technical – is handpicked for their excellent qualifications and expertise. During 2025, we had three master's students, 14 doctoral research fellows, 15 postdocs and researchers, two research software engineers, six professors, one centre coordinator, and one communication adviser. In addition, we had seven adjunct professors, six associated members in the administrative and technical staff, and four emeriti. Our Scientific Advisory Committee consisted of four members.

Thanks to our privileged position as a centre of excellence, we are able to grow by hiring talented and exceptional researchers from a wide range of nationalities (currently representing 20 nationalities from three continents). From a small group, RoCS has grown into a thriving international community of 46 employees from: Norway, Sweden, Denmark, Lithuania, Poland, Italy, Spain, the United Kingdom, China, Ukraine, Belgium, France, Slovakia, Austria, India, Portugal, Iran, Switzerland, the Netherlands and Germany.

All our members are dedicated to strengthening our scientific achievements, setting forward new goals, and raising the standards for our research.



When the Sun kisses the horizon, that's when you see the sky blush

— Anthony T. Hincks

Phd



Aditi Bhatnagar

Aditi Bhatnagar, a doctoral research fellow, defended her thesis "Spectral and topological study of small-scale energetic events in the solar atmosphere" for the degree of Philosophiae Doctor in May 2025.



Aline R. Brunvoll

Aline R. Brunvoll, a doctoral research fellow, studies micro- and nanoflares on the Sun. Her work involves developing a machine-learning model to detect micro- and nanoflares in chromospheric observations captured by the Swedish 1-m Solar Telescope (SST).



George Cherry

George Cherry, a doctoral research fellow, defended their thesis "Quantifying energy transfer in the solar atmosphere" for the degree of Philosophiae Doctor in September 2025.



Elisabeth Enerhaug

Elisabeth Enerhaug, a doctoral research fellow, defended her thesis "Identifying magnetohydrodynamic wave modes in the solar atmosphere" for the degree of Philosophiae Doctor in October 2025.



Jonas Thoen Faber

Jonas Thoen Faber, a doctoral research fellow, analyses observations of solar flares. He studies small-scale features associated with flares, mainly utilising the Swedish 1-m Solar Telescope (SST) on La Palma, covering the photosphere and the chromosphere.



Michael Haahr

Michael Haahr, a doctoral research fellow, defended his thesis "Multi-Scale Modeling of Magnetic Reconnection in the Solar Corona" for the degree of Philosophiae Doctor in September 2025.

Phd



Mats Kirkaune

Mats Kirkaune, a doctoral research fellow, currently investigates the solar observing capabilities of various instruments considered for the future Atacama Large Aperture Submillimeter Telescope (AtLAST). This is done by utilising the general (sub-)millimetre telescope simulator, maria. Afterwards, he will search for signatures of nanoflares in solar observations obtained with the Atacama Large Millimeter/submillimeter Array (ALMA).



Kilian Krikova

Kilian Krikova, a doctoral research fellow, defended his thesis “Small-scale energetic phenomena in He: line formation and diagnostic potential” for the degree of Philosophiae Doctor in April 2025.



Semya Amouche Tønnessen

Semya Amouche Tønnessen, a doctoral research fellow, investigates the diagnostic potential of spectral lines to be observed by the upcoming EUVST telescope onboard the Solar-C satellite. She will use dynamic simulations of the solar atmosphere and develop new techniques to efficiently include all physics that are important for the synthesis of optically thick line profiles. Using synthetic line profiles from a variety of 3D simulations, she will study their potential to diagnose dynamic events.



Sascha Ornig

Sascha Ornig, a doctoral research fellow, investigates solar flares with emissions in optical wavelengths (“white light”) to understand the conditions that facilitate these emissions and identify the underlying formation mechanisms. He uses high-resolution observations from the Swedish 1-m Solar Telescope (SST) combined with state-of-the-art simulations using the RADYN code.



Ignasi J. Soler Poquet

Ignasi J. Soler Poquet, a doctoral research fellow, is a member of the CompSci PhD programme. The main goal of his thesis is to study small-scale events of magnetic reconnection in the solar atmosphere. He plans to find and classify them by exploring large observational datasets. Ignasi applies Deep Learning techniques to automatically detect these events. He uses solar observations from different solar observatories such as SST, SDO, or IRIS.



Mats Ola Sand

Mats Ola Sand, a doctoral research fellow, focuses his research on the origin of jets in the solar atmosphere, commonly known as spicules on smaller scales and surges on larger scales. His project will compare these jets on different scales by studying high-quality observations from both ground-based and space-borne telescopes, particularly examining the connection between Ellerman Bomb-like features in the quiet Sun (QSEBs) and spicules.

Phd



Elias Roland Udnæs

Elias Roland Udnæs, a doctoral research fellow, is conducting a research project that combines high-resolution observations, magnetohydrodynamic (MHD) simulations, and machine learning techniques to identify and quantify wave heating in the solar chromosphere. He aims for his work at RoCS to result in an innovative tool that links complex spectral data from current and future solar telescopes with wave heating signatures.



Eilif Sommer Øyre

Eilif Sommer Øyre, a doctoral research fellow, uses simulations to study how particles are accelerated in the solar atmosphere. This research provides an opportunity to better understand the physical processes at play in solar flare kernels.

Postdocs and researchers



Souvik Bose

Souvik Bose, an affiliated researcher, completed his PhD at RoCS in 2021. His research mainly focuses on unravelling the dynamics of the solar atmosphere through coordinated high-resolution ground and space based observations. He also works on computing synthetic observations from high-resolution MHD simulation snapshots using various radiative transfer codes. His primary affiliation is with Lockheed Martin Solar and Astrophysics Laboratory (LMSAL) where he is involved in the upcoming NASA MUSE mission.



Carlos José Díaz Baso

Carlos José Díaz Baso, a postdoctoral research fellow, has general areas of interest in Bayesian statistics, deep learning, and solar physics. His research focuses on understanding solar chromospheric phenomena (from quiet solar filaments to explosive events) and their magnetic origin. He plans to achieve this goal by investigating high-quality space and ground-based spectropolarimetric observations using novel deep learning and Bayesian inference techniques, and comparing them with numerical models of the solar atmosphere.



Pooja Devi

Pooja Devi, a postdoctoral research fellow, focuses her research on the multi-wavelength analysis of solar eruptions (flares, filaments, CMEs, and related activities) using different ground-based and space-borne instruments. She is currently working on the spectroscopic analysis of solar eruptions using the IRIS satellite and the SST ground-based telescope. Her research interests include studying the effect of solar eruptions on space weather.

Postdocs and researchers



Prasanta Gorai

Prasanta Gorai, a postdoctoral research fellow, focuses his research on the millimeter/submillimeter wavelength observations of asymptotic giant branches (AGBs) and young stellar objects (YSOs) using ground-based radio telescopes. Currently, he is working on imaging and spectral analysis of a sample of AGB stars.



Shahin Jafarzadeh

Shahin Jafarzadeh, an affiliated researcher, is primarily employed by Queen's University Belfast in the UK. He is predominantly interested in characterisation of wave activity in the lower solar atmosphere, and is a founding member of the WaLSA international science team. Shahin is an experienced observer, particularly with SST, and passionately engages in public outreach activities.



Reetika Joshi

Reetika Joshi, a postdoctoral research fellow, focuses her research on the multi-wavelength study of solar jets using ground based telescopes and space-borne satellites. Currently she is working on the imaging and spectroscopy analysis of solar jets and surges with observations from NASA's IRIS, ESA's Solar Orbiter and SST. She started as a researcher with NASA Goddard Space Flight Center in March 2025.



Petra Kohutova

Petra Kohutova, a researcher, is the PI of the RCN-funded MultiSCORE project, which focuses on the multiscale structure of the solar corona. She combines high resolution solar observations and numerical simulations.



Valeriia Liakh

Valeriia Liakh, a postdoctoral research fellow, is funded by the MSCA COFUND DSTrain program, which supports postdocs in computational and data sciences. Her research mainly focuses on the numerical modeling of solar prominences, with an emphasis on their formation, dynamics, and eruptions.



Harsh Mathur

Harsh Mathur, a postdoctoral research fellow, is funded by the MSCA COFUND DSTrain program. He focuses on improving magnetic-field diagnostics in the solar chromosphere. His work combines advanced 3D non-LTE radiative transfer modelling of the H α line with machine-learning approaches to interpret multi-line spectropolarimetric observations. He aims to strengthen the connection between observations and simulations to better understand the magnetic structure of the chromosphere.

Postdocs and researchers



Quentin Noraz

Quentin Noraz, was a postdoctoral research fellow at RoCS until November 2025, involved in the WholeSun ERC project. During his PhD, he primarily investigated the dynamics and magnetism of the Sun and solar-type stars, using global numerical models. During his time at RoCS he contributed to local numerical models of the lower solar atmosphere, exploring the chromospheric dynamics and the impact of new magnetic constraints. He has now joined the CMPA lab at KU Leuven in Belgium for another postdoc contract, to help incorporate low-atmospheric physics in Space-Weather models and forecast, in the context of the Open SESAME ERC project.



Nicolas Poirier

Nicolas Poirier was a postdoctoral research fellow at RoCS until August 2025, as a contributor to the ORCS project. During his PhD he explored various topics such as solar eruptions, the solar wind and coronal loops. During his time at RoCS he combined high-resolution observations from the ground (SST) and space (Solar Orbiter mission). He has now joined the LPC2E lab in Orléans in France for another postdoc contract, to study the impact of thermodynamic cycles in the corona on the solar wind variability.



Daniel Nóbrega Siverio

Daniel Nóbrega Siverio, an affiliated researcher and former postdoctoral researcher, now works at the Instituto de Astrofísica de Canarias (IAC) in Tenerife. Daniel's research primarily focuses on chromospheric surges and coronal bright points from both theoretical and observational perspectives.



Maryam Saberi

Maryam Saberi, a researcher, is the PI of the ESGC project funded by the RCN, which focuses on studying the impact of evolved stars on the Galactic chemical composition. She is also interested in studying solar and stellar chromospheric activity and its variation throughout stellar evolution. She has expertise in radiative transfer and chemical modelling of outflows around evolved stars.



Fan Zhang

Fan Zhang, a postdoctoral research fellow, is primarily interested in developing numerical techniques for studying fluid & plasma dynamics, typically described by nonlinear hyperbolic partial differential equations. He is currently working to improve the modeling of the solar atmosphere by (1) further exploring fundamental dynamics in the lower solar atmosphere and (2) using advanced numerical techniques such as model order reduction and uncertainty quantification.



Yixiao Zhou

Yixiao Zhou, a postdoctoral research fellow, is funded by a EU Marie Skłodowska-Curie Postdoctoral Fellowship. His research mainly focuses on asteroseismology, stellar evolution, and the numerical modeling of stellar convection. At RoCS, he aims to study the dynamics of solar and stellar convective envelopes using state-of-the-art DISPATCH simulations.

Research Software Engineers



Andrius Popovas

Andrius Popovas, a research software engineer, is developing next-generation global magnetohydrodynamic simulations of the convective regions of the Sun and other stars. This work will enable experiments on an unprecedented scale and complexity, bridging internal dynamo simulations to the surface of the Sun and stars on a global scale. These simulations are run on the LUMI supercomputer located in Finland.



Mikolaj Szydlarski

Mikolaj Szydlarski, a research software engineer, is a physicist and mathematician by education, but a computer scientist at heart. Mikolaj is interested in the application of high-performance computing (HPC) to challenging problems in solar astrophysics. His fields of expertise include MHD simulations and Solar ALMA data reduction.

Adjunct professors



Guillaume Aulanier

Guillaume Aulanier, an adjunct professor, develops 3D MHD models for flares, prominences, magnetic field topology and reconnection. He is a member of the science teams for SDO and Solar Orbiter. His home institution is the Laboratory for Plasma Physics in Paris. He is the deputy director of the astrophysics graduate school at Université PSL, chair of the Sun-Earth programme of CNRS, and policy officer for HPC at the ministry of research.



Ineke De Moortel

Ineke De Moortel, an adjunct professor, focuses her research on coronal heating, particularly the efficiency of heating by MHD waves, using a combination of numerical simulations and observational data analysis. Her home institution is the University of St Andrews (UK). In 2025, one of her PhD students, Elisabeth Enerhaug, defended her thesis as part of a joint PhD program between the University of St Andrews and the University of Oslo.



Bart De Pontieu

Bart De Pontieu, an adjunct professor, focuses on understanding how the Sun's magnetic field energizes the coupled solar atmosphere from the photosphere into the corona and heliosphere. He combines high resolution space-based and ground-based multi-wavelength observations with advanced numerical modeling. He is the PI of NASA's IRIS and MUSE satellite projects and manages the research team at Lockheed Martin Solar & Astrophysics Laboratory (LMSAL). He is also the PI of the JAXA/NASA EUVST project at LMSAL.

Adjunct professors



Lyndsay Fletcher

Lyndsay Fletcher, an adjunct professor, focuses on solar flares, specifically the transport of energy through the flare atmosphere, the energisation of the chromosphere, and the interpretation of radiation signatures. She uses data analysis to confront data with flare models. She also teaches astrophysics at her home institute (University of Glasgow, UK) and leads efforts to increase the participation of women and girls in physics and astronomy.



Juan Martínez-Sykora

Juan Martínez-Sykora, an adjunct associate professor, is based at LMSAL and SETI. He is the deputy science lead of MUSE (NASA MIDEX program) and EUVST Co-I. His major contributions are in the numerical modeling of the solar atmosphere. His main interests include chromospheric heating and dynamics, as well as multi-fluids. He uses and develops state of the art 3D radiative MHD codes and compares the models with ground-based and space-based observations.



Åke Nordlund

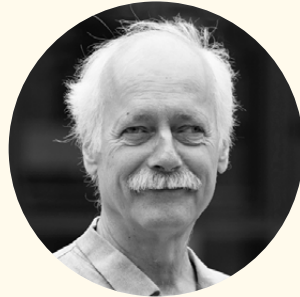
Åke Nordlund, an adjunct professor, works at the Astrophysics and Planetary Sciences group at the Niels Bohr Institute and STARPLAN at the University of Copenhagen. He is a member of the Niels Bohr International Academy, the Norwegian Academy of Sciences and Letters, and the Royal Swedish Academy of Science.



Marianne G. Omang

Marianne G. Omang, an adjunct associate professor, also works for the Norwegian Defence Estate Agency. Her fields of interest are shock and blast waves, with a focus on the effects of using reactive particles as additives. Her work combines experiments with numerical simulations using a Multi-Phase Smoothed Particle Hydrodynamics method (MP-RSPH).

Principal investigators



Mats Carlsson

Mats Carlsson is a professor and the director of RoCS. His main interests include chromospheric physics and radiation MHD. He works with both large-scale simulations and observations from ground and from space.



Boris Gudiksen

Boris Gudiksen, a professor and PI, focuses on the development of numerical codes for simulations of the solar atmosphere. His main interest is the solar corona and understanding how it maintains its high temperature.



Viggo Hansteen

Viggo Hansteen, a senior researcher at Bay Area Environmental Research Institute and a part time professor and PI, works on both simulations and observations, from the ground and from space. He is interested in how the magnetic field is formed in the deep convection zone, how it rises to the photosphere, and how it forms the outer solar atmosphere. Key areas of his research include flux emergence, coronal heating and chromospheric dynamics and energetics.



Tiago M. D. Pereira

Tiago M. D. Pereira, a professor and PI, studies dynamic processes in stellar atmospheres. He is particularly focused on the solar chromosphere, the interface between the hot corona and the dense surface. Tiago leverages space and ground-based observations with detailed radiative transfer calculations from 3D models. With an interest in computational astrophysics, data analysis and visualisation, he works with high-performance computing and big data problems.



Luc Rouppe van der Voort

Luc Rouppe van der Voort, a professor and PI, focuses on the research area of high-resolution observations of the Sun. He is a veteran observer at the Swedish 1-m Solar Telescope on the island of La Palma. For many years, he has been running coordinated observation campaigns with the SST and space-borne telescopes, such as Solar Orbiter, IRIS, Hinode, and previously TRACE and SOHO.



Sven Wedemeyer

Sven Wedemeyer, a professor and PI, coordinates research activities related to solar and stellar observations at mm/radio wavelengths with ALMA and AtLAST, as well as supporting simulations. His research primarily focuses on the small-scale structure, dynamics, and energy balance of the solar atmosphere, with implications for other stellar types.

Centre administration



Benedikte Fagerli Karlsen

Benedikte Fagerli Karlsen, the centre coordinator, is responsible for the administration of the centre and manages all practical tasks related to its activities. Her responsibilities include new employment, visitor arrangements, contracts, reporting and logistics for events.



Eyrun Thune

Eyrun Thune, the communication adviser, is responsible for communication and outreach activities at RoCS.

Technical and administrative associated staff



Martina D'Angelo

Martina D'Angelo, communication advisor at the Institute of Theoretical Astrophysics (ITA), follows up on science communication, outreach activities, and promotion on social media channels. She is the web editor for the ITA website and coordinator for the Norwegian Olympiad on Astronomy and Astrophysics.



Terje Fredvik

Terje Fredvik, an engineer in the institute's Project Related IT Services (PRITS) group, leads the development of the data pipeline for the Solar Orbiter SPICE instrument. He also contributes to the operations of the Hinode Science Data Centre Europe, is a member of the ITA FITS Working Group, and assists in the adaptation of the SOLARNET2 FITS mechanisms for both observational and simulated data.



Stein Vidar Hagfors Haugan

Stein Vidar Haugan, the technical lead for the Project Related IT Services (PRITS) group, is responsible for the Hinode Science Data Centre Europe, serving data from the Hinode and IRIS missions and from SPICE on Solar Orbiter. He leads the ITA FITS Working Group, acts as a liaison between RoCS and the SOLARNET2 project, and contributes to the data pipeline and quicklook software for Solar Orbiter SPICE.

Technical and administrative associated staff



Kristine Aa. S. Knudsen

Kristine Aa. S. Knudsen, who is the Head of Office at the Institute of Theoretical Astrophysics (ITA) cooperates closely with both the scientific, technical, and administrative staff at RoCS and the Institute.



Torben Leifsen

Torben Leifsen, the head of IT at the institute, is responsible for planning, building and running the IT systems together with the IT-group at the institute. A second server room was added in 2020 to accommodate the needs of RoCS and other projects. Torben has a background in solar physics and is a member of the Virgo team on the ESA spacecraft SOHO. He also conducts research in helioseismology in his spare time.



Martin Wiesmann

Martin Wiesmann, an engineer in the institute's Project Related IT Services (PRITS) Group, is responsible for parts of the IRIS pipeline as well as the adaptation of AIA and Hinode data to IRIS data. Martin also contributes to the Solar Orbiter SPICE pipeline and quicklook software. He is mainly a programmer, implementing requests and wishes from various scientists into the pipeline or as separate programs.

Scientific Advisory Committee



Tony Arber

Tony Arber, a computational plasma physicist, has interests that span solar physics, space weather, laser-plasmas and QED-plasmas. He has been responsible for developing MHD codes for both solar physics and laser-driven fusion as well as kinetic codes for high-power plasma interactions. For all codes, he is interested in software development methods and uncertainty quantification.



Sarah Matthews

Sarah Matthews, professor of Solar Physics at UCL's Mullard Space Science Laboratory, has an interest in energy storage and release in magnetised plasmas, particularly in solar eruptive events and space weather. Her work is mainly observational, but she also collaborates with magnetic field modelers to interpret the observations in the context of current models. She also has an interest in instrumentation and is currently the Hinode EIS Principal Investigator (PI).



Oskar Steiner

Oskar Steiner, an Emeritus researcher at the Kiepenheuer-Institut für Sonnenphysik (KIS) in Freiburg, Germany and at the Istituto ricerche Solari Aldo e Cele Daccò (IRSOL) in Switzerland, focuses his research on the numerical simulation of magnetohydrodynamic processes in the solar and stellar atmospheres. He is also interested in polarimetry and numerical methods of radiative transfer.

Emiriti



Oddbjørn Engvold

Oddbjørn Engvold, an emeritus professor, focuses on the structure and dynamics of solar prominences. He is a veteran user of the Swedish 1-m Solar Telescope on the island of La Palma, as well as the solar telescopes of the US National Solar Observatory (NSO) and solar telescopes in space. He has edited and contributed to two books related to solar activity.



Olav Kjeldseth-Moe

Olav Kjeldseth-Moe, an emeritus professor, has a special interest in the transition region into the corona. He contributed to the development of instruments and observing procedures designed to map conditions in the corona. He participated in NASAs Skylab Observatory in 1973-74, was a co-investigator on the HRTS instrument on Spacelab 2 (1985), and served for 20 years as the Norwegian co-investigator for the CDS spectrometer on SOHO.



Egil Leer

Egil Leer, an emeritus professor, has the corona, the solar wind, and the interaction of the solar wind with the local interstellar medium as his areas of interest.



Jan Trulsen

Jan Trulsen, an emeritus professor, focuses on research in plasma physics, turbulence phenomena in ionized and neutral media, and numerical simulations.



Francesca Zuccarello

Francesca Zuccarello, is a professor emerita at the University of Catania in Italy, is involved in the study of the emergence, evolution and decay of solar active regions, as well as research related to solar eruptive events. Francesca is mainly an observer and has participated in several Coordinated Observational Campaigns.

Master students



Isak Aaby

Isak Aaby, a second-year master student, is working on a master project with the working title “Hypercadence, hyperspectral: a new look at synthetic spectra” supervised by Tiago Pereira.



Jenny Holth Hartting

Jenny Hartting, a first-year student, Master title: “Astrophysical radiative transfer with GPUs and mixed precision” supervised by Tiago Pereira.



Rebecca Nguyen

Rebecca Nguyen, a second-year master student, is working on a master project with the working title “Detection of Ellerman bombs in the solar atmosphere” supervised by Luc Rouppe van der Voort and Ignasi J. Soler Poquet.



PhD og master graduates overview 2025

Dissertations for the degree of Philosophiae Doctor

Aditi Bhatnagar

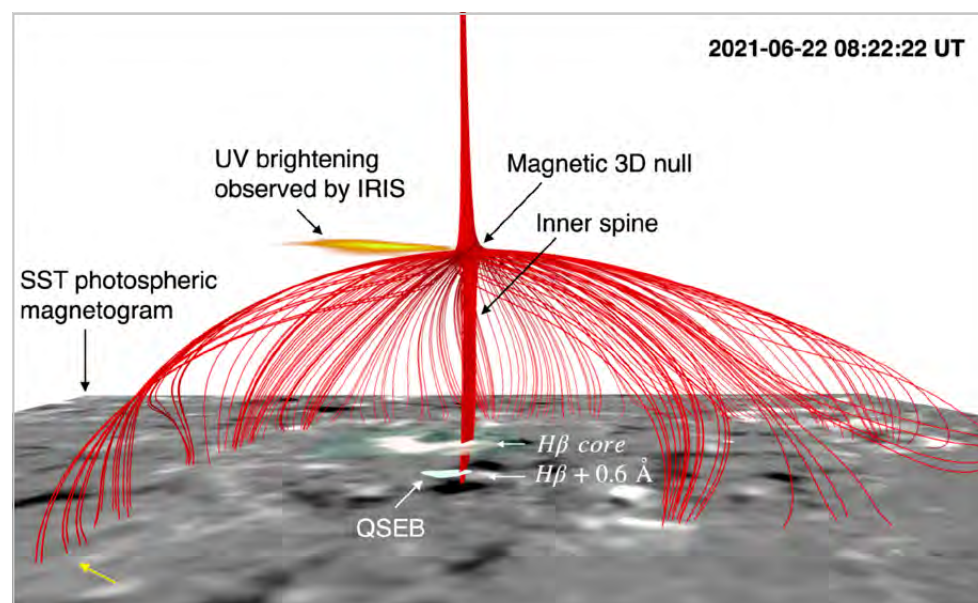
Spectral and topological study of small-scale energetic events in the solar atmosphere.

Summary: This thesis explores the connection between Quiet Sun Ellerman Bombs observed with the SST and UV brightenings observed with IRIS. Quiet-Sun Ellerman bombs are small-scale magnetic reconnection events that occur in the lower solar atmosphere. With an estimated 750,000 present on the Sun at any time, their potential contribution to atmospheric heating is an open question. The investigations highlight the importance of magnetic connectivity in driving small-scale solar dynamics.

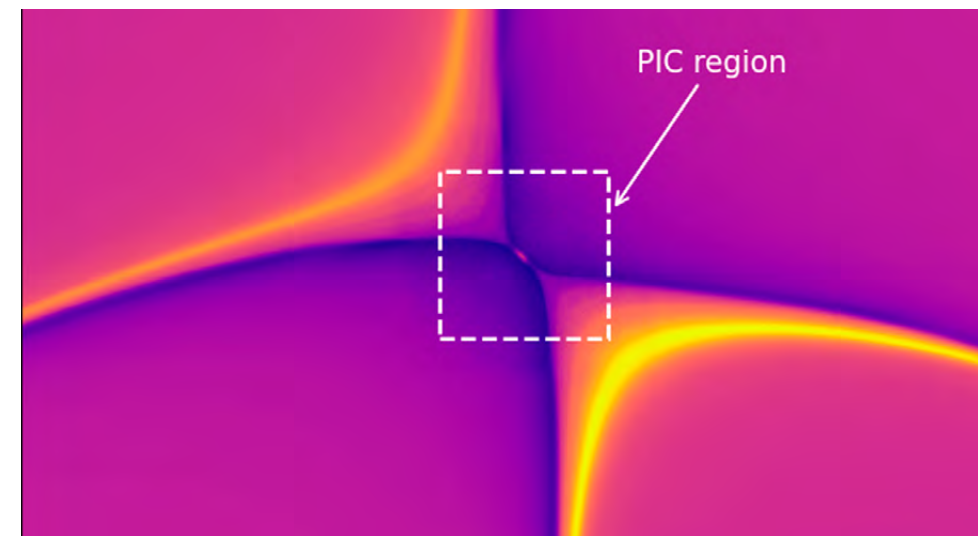
Kilian Krikova

Small-scale energetic phenomena in H ϵ : line formation and diagnostic potential.

Summary: This thesis explores the formation of the H ϵ line in the solar atmosphere. Using 3D radiative MHD simulations, the formation conditions of H ϵ are analysed, from the quiet Sun to more active parts of the Sun. In particular, we identify where the line changes to emission, and how it responds to small-scale energetic events such as Ellerman bombs, UV bursts, and small flares. We also developed new methods to calculate the source function for multi-level atoms, and better identify the role of interlocking in the formation of hydrogen lines.



← Fan-spine magnetic field topology with a QSEB and associated UV brightening from Aditi Bhatnagar's thesis.



← The hybrid particle-in-cell (PIC) and magnetohydrodynamics (MHD) model developed in Michael Haahr's thesis. PIC is used inside the dotted square, while MHD captures the global evolution.

Michael Haahr

Multi-Scale Modelling of Magnetic Reconnection in the Solar Corona.

Summary: This thesis describes the implementation of a numerical code that includes both a Magneto-Hydro-Dynamics solver and Particle In Cell solver. The goal of this code is to be able to simulate the very core of a solar flare, where the assumptions needed for the MHD to be valid are no longer true. Having these two solvers running side by side allowing disturbances to travel through the interface is a very complex problem, and is shown here to perform very well using a range of validation tests and running a simplified simulation of a solar flare.

Elisabeth Enerhaug

Identifying magnetohydrodynamic wave modes in the solar atmosphere.

Summary: This thesis is about magnetohydrodynamic (MHD) waves. These waves can be used in seismological studies of the Sun, helping us deduce information we cannot infer directly from observations. There exist different types of MHD waves, called wave modes, but it is not necessarily clear which wave mode we are looking at. Identifying the wave mode would be a valuable tool in both coronal seismology and the solution of the coronal heating problem. In this thesis, one such scheme is investigated. Both strengths and limitations are pointed out, and a proof-of-concept is provided for how the scheme can be used in observations.

George Cherry

Quantifying energy transfer in the solar atmosphere: a closer look at the displacement and deposition of energy from the photosphere to the corona through simulations.

Summary: This thesis describes a novel method to identify waves in complex 3D simulations. Until now identifying such waves have been done by looking at long timespans or large volumes. The new method invented, makes it possible to find wavelike behaviour isolated in both time and space and even makes it possible to identify areas where these waves might be damped and converted into other types of motion, change their frequency or turned into heat by friction. The method was used to explain how particular waves types are able to transfer through the solar atmosphere and possibly into the solar wind where they have been observed by in-situ instruments. Until this work it was unknown where these waves originated and how they were able to pass through the complex magnetic and thermodynamic environment of the lower solar atmosphere.

Papers in refereed journals 2025



Afonso Delgado, and 15 colleagues (among them **de Pontieu, Bart**: 2025, The Astrophysical Journal, 991, 164, Determining the Magnetic Field of Active Region Plages Using the Whole CLASP2/2.1 Spectral Window



Alanazi, Nawal and **Fletcher, Lyndsay**: 2025, Monthly Notices of the Royal Astronomical Society, 540, 2474, The relationship between solar flare ribbons and magnetic field changes in the solar photosphere



Alsina Ballester, E.; **Nóbrega-Siverio, D.**; Moreno-Insertis, F.; and Supriya, H. D.: 2025, Astronomy and Astrophysics, 700, A204, Spectropolarimetric synthesis of forbidden lines in magnetohydrodynamic models of coronal bright points



Asensio Ramos, A.; Löfdahl, M. G.; **Díaz Baso, C.**; Kuckein, C.; and Esteban Pozuelo, S.: 2025, Astronomy and Astrophysics, 703, A269, torchmfb: A flexible multi-object, multi-frame blind deconvolution code



Ashfield, William; Polito, Vanessa; Lörinčík, Juraj; **De Pontieu, Bart**; Chintzoglou, Georgios; **Bose, Souvik**; Freij, Nabil; **Roupe van der Voort, Luc**; **Joshi, Reetika**; and **Thoen Faber, Jonas**: 2025, Nature Astronomy, Spectroscopic observations of solar flare pulsations driven by oscillatory magnetic reconnection



Beck, C.; **Prasad, A.**; Hu, Q.; Yalim, M. S.; Gosain, S.; and Choudhary, D. Prasad: 2025, The Astrophysical Journal, 978, 150, Derivation and Application of a Scaling between Hinode/SP and SDO/HMI Vector Magnetic Fields to Improve Magnetic Field Extrapolations



Bhatnagar, Aditi; **Prasad, Avijeet**; **Roupe van der Voort, Luc**; **Nóbrega-Siverio, Daniel**; and Joshi, Jayant: 2025, Astronomy and Astrophysics, 693, A221, Magnetic topology of quiet-Sun Ellerman bombs and associated ultraviolet brightenings



Bhatnagar, Aditi; **Prasad, Avijeet**; **Nóbrega-Siverio, Daniel**; **Roupe van der Voort, Luc**; and Joshi, Jayant: 2025, Astronomy and Astrophysics, 698, A174, Small-scale dynamic phenomena associated with interacting fan-spine topologies: Quiet-Sun Ellerman bombs, UV brightenings, and chromospheric inverted-Y-shaped jets



Bose, Souvik; Joshi, Jayant; Testa, Paola; and **De Pontieu, Bart**: 2025, The Astrophysical Journal, 983, L7, On the Million-degree Signature of Spicules



Brchnelova, M.; **Gudiksen, B.**; **Carlsson, M.**; Lani, A.; and Poedts, S.: 2025, Astronomy and Astrophysics, 693, A74, Constraining the inner boundaries of COCONUT through plasma β and Alfvén speed



Breu, C. A.; **De Moortel, I.**; Peter, H.; and Solanki, S. K.: 2025, Monthly Notices of the Royal Astronomical Society, 537, 2835, Effect of numerical resolution on synthetic observables of simulated coronal loops



Bura, Annu; Samanta, Tanmoy; **Prasad, Avijeet**; Moore, Ronald L.; Sterling, Alphonse C.; Yurchyshyn, Vasyi; and Surya, Arun: 2025, The Astrophysical Journal, 985, L47, Formation of Chromospheric Fan-shaped Jets through Magnetic Reconnection



Chen, Huadong; Xia, Chun; Ma, Suli; Su, Yingna; Zhou, Guiping; Priest, Eric; **Fletcher, Lyndsay**; Shen, Yuandeng; Tu, Weining; Wang, Wei; and Zhang, Jun: 2025, The Astrophysical Journal, 994, 27, Magnetic Dip Found in a Quiescent Prominence Foot via Observation and Simulation



Chen, Li; Qin, Sheng-Li; Liu, Tie; Goldsmith, Paul F.; Liu, Xunchuan; Peng, Yaping; Tang, Xindi; Garay, Guido; Kou, Zhiping; Tang, Mengyao; Sanhueza, Patricio; Li, Zi-Yang; **Gorai, Prasanta**; Das, Swagat R.; Bronfman, Leonardo; Dewangan, Lokesh; García, Pablo; Li, Shanghuo; Lee, Chang Won; Liu, Hong-Li; Tóth, L. Viktor; Chibueze, James O.; Hwang, Jihye; Li, Xiaohu; Xu, Fengwei; Zou, Jiahang; Jiao, Wenyu; Zhang, Zhenying; and Zhang, Yong: 2025, Astronomy and Astrophysics, 694, A166, The ALMA-ATOMS survey: Vibrationally excited HC $_{3}$ N lines in hot cores



Cherry, George; **Gudiksen, Boris**; and Finley, Adam J.: 2025, Astronomy and Astrophysics, 700, A276, Detection of wave activity within a realistic 3D magneto-hydrodynamic quiet Sun simulation



Cosentino, G.; Jiménez-Serra, I.; Barnes, A. T.; Tan, J. C.; Fontani, F.; Caselli, P.; Henshaw, J. D.; Law, C.-Y.; Viti, S.; Fedriani, R.; Hsu, C.-J.; **Gorai, P.**; Zeng, S.; and De Simone, M.: 2025, Astronomy and Astrophysics, 693, A199, Interaction between the supernova remnant W44 and the infrared dark cloud G034.77-00.55: Shock induced star formation



Cozzo, G.; Pagano, P.; Reale, F.; Testa, P.; Petralia, A.; **Martinez-Sykora, J.**; **Hansteen, V.**; and **De Pontieu, B.**: 2025, Astronomy and Astrophysics, 695, A40, Coronal energy release by MHD avalanches: III. Identification of a reconnection outflow from a nanoflare



De Wilde, M.; Pietrow, A. G. M.; Druett, M. K.; Pastor Yabar, A.; Koza, J.; Kontogiannis, I.; Andrienko, O.; Berlicki, A.; **Brunvoll, A. R.**; de la Cruz Rodríguez, J.; **Thoen Faber, J.**; **Joshi, R.**; Kuridze, D.; **Nóbrega-Siverio, D.**; **Roupe van der Voort, L. H. M.**; Rybák, J.; Scullion, E.; Silva, A. M.; Vashalomidze, Z.; Vicente Arévalo, A.; Wiśniewska, A.; Yadav, R.; Zaqarashvili, T. V.; Zbinden, J.; and **Øyre, E. S.**: 2025, Astronomy and Astrophysics, 700, A275, Synthesizing Sun-as-a-star flare spectra from high-resolution solar observations



Devi, Pooja; Mandrini, Cristina H.; Chandra, Ramesh; Cristiani, Germán D.; Démoulin, Pascal; Mac Cormack, Cecilia; and Lloveras, Diego G.: 2025, Solar Physics, 300, 163, Partial Null-Point Reconnection of an Eruptive Filament



Di Mascolo, Luca, and 25 colleagues (among them **Wedemeyer, Sven**): 2025, Open Research Europe, 4, 113, Atacama Large Aperture Submillimeter Telescope (AtLAST) science: Resolving the hot and ionized Universe through the Sunyaev-Zeldovich effect



Díaz Baso, C. J.; Asensio Ramos, A.; de la Cruz Rodríguez, J.; da Silva Santos, J. M.; and **Roupe van der Voort, L.**: 2025, Astronomy and Astrophysics, 693, A170, Exploring spectropolarimetric inversions using neural fields: Solar chromospheric magnetic field under the weak-field approximation



Díaz Baso, C. J.; Milič, I.; **Roupe van der Voort, L.**; and Schlichenmaier, R.: 2025, Astronomy and Astrophysics, 693, A272, Spectral resolution effects on the information content in solar spectra



Dudík, Jaroslav; **Aulanier, Guillaume**; Lörinčík, Juraj; and Zemanová, Alena: 2025, Solar Physics, 300, 139, Quasi-Separatrix Layers and Three-Dimensional Magnetic Reconnection: Theory and Observations of Solar Flares (Invited Review)



Eitner, Philipp; Bergemann, Maria; Hoppe, Richard; Storm, Nicholas; Lipatova, Veronika; Glover, Simon C. O.; Klessen, Ralf S.; **Nordlund, Åke**; and **Popovas, Andrius**: 2025, Astronomy and Astrophysics, 703, A199, M3DIS -- A grid of 3D radiation-hydrodynamics stellar atmosphere models for stellar surveys: II. Carbon-enhanced metal-poor stars



Enerhaug, E.; **Carlsson, M.**; **Szydlarski, M.**; **Gudiksen, B. V.**; and **De Moortel, I.**: 2025, Astronomy and Astrophysics, 701, A137, Identifying magnetohydrodynamic wave modes in the solar atmosphere: Experiments in 2D



Evans, Samuel; Oppenheim, Meers; **Martínez-Sykora, Juan**; and Dimant, Yakov: 2025, The Astrophysical Journal, 986, 23, Multifluid and Kinetic 2D and 3D Simulations of Thermal Farley--Buneman Instability Turbulence in the Solar Chromosphere



Gorai, P.; **Saber, M.**; Khouri, T.; and Danilovich, T.: 2025, Astronomy and Astrophysics, 704, A31, Probing sulphur chemistry in oxygen-rich asymptotic giant branch stars with ALMA



Gorai, Prasanta; Taniguchi, Kotomi; Tan, Jonathan C.; Gómez-Garrido, Miguel; Rosero, Viviana; Jiménez-Serra, Izaskun; Zhang, Yichen; Cosentino, Giuliana; Law, Chi-Yan; Fedriani, Rubén; Busquet, Gemma; Gaches, Brandt A. L.; **Saber, Maryam**; and Das, Ankan: 2025, Astronomy and Astrophysics, 702, A107, The SOFIA Massive (SOMA) star formation Q-band follow-up: II. Hydrogen recombination lines towards high-mass protostars



Gošić, M.; **Hansteen, V. H.**; Sainz Dalda, A.; **De Pontieu, B.**; and **Roupe van der Voort, L. H. M.**: 2025, The Astrophysical Journal, 990, 195, Bifrost Models of the Quiet Sun. I. Comparison with Solar Observations



Guo, J. H.; Ni, Y. W.; Schmieder, B.; Guo, Y.; Xia, C.; **Devi, P.**; Chandra, R.; Poedts, S.; **Joshi, R.**; Zhou, Y. H.; Li, H. T.; and Chen, P. F.: 2025, The Astrophysical Journal, 983, 48, The Birth of a Major Coronal Mass Ejection with Intricate Magnetic Structure from Multiple Active Regions



Haahr, M.; **Gudiksen, B. V.**; and **Nordlund, Å.**: 2025, Astronomy and Astrophysics, 696, A191, Coupling particle-in-cell and magnetohydrodynamics methods for realistic solar flare models



Haahr, M.; **Gudiksen, B. V.**; and **Nordlund, Å.**: 2025, Astronomy and Astrophysics, 701, A130, Two-way coupled particle-in-cell and magnetohydrodynamic simulation of 2D fan-spine reconnection



Hofmeister, Stefan J.; Asvestari, Eleanna; Dissauer, Karin; Hahn, Michael; Heinemann, Stephan G.; Jercic, Veronika; Koukras, Alexandros; **Krikova, Kilian**; Saqri, Jonas; Savin, Daniel W.; Temmer, Manuela; and Veronig, Astrid: 2025, The Astrophysical Journal, 994, 190, Formation of a Coronal Hole by a Quiet-Sun Filament Eruption



Hoque, Ariful, and 27 colleagues (among them **Gorai, Prasanta**: 2025, The Astrophysical Journal, 987, 197, The ALMA-ATOMS Survey: Exploring Protostellar Outflows in HC $_{3}$ N



Howson, T. A.; **De Moortel, I.**; and Priest, E. R.: 2025, Monthly Notices of the Royal Astronomical Society, 539, 1820, Coronal heating driven by random foot point motions: the effects of magnetic field topology



Ishikawa, Ryohko, and 18 colleagues (amon them **De Pontieu, Bart**): 2025, The Astrophysical Journal, 990, 200, Determining the Magnetic Field in the Atmosphere of a Solar Active Region Observed by the CLASP2.1 Sounding Rocket Experiment



Joshi, Reetika; Dudík, Jaroslav; Schmieder, Brigitte; **Aulanier, Guillaume**; and Chandra, Ramesh: 2025, Astronomy and Astrophysics, 698, A301, Spectroscopic investigations of a filament reconnecting with coronal loops during a two-ribbon solar flare



Karki, Garima; Schmieder, Brigitte; **Devi, Pooja**; Chandra, Ramesh; Labrosse, Nicolas; **Joshi, Reetika**; and Gelly, Bernard: 2025, The Astrophysical Journal, 979, 182, Magnetic Reconnection between a Solar Jet and a Filament Channel



Karki, Garima; Schmieder, Brigitte; Démoulin, Pascal; **Devi, Pooja**; Chandra, Ramesh; and **Joshi, Reetika**: 2025, Solar Physics, 300, 98, Counter-Streaming Velocities in a Quiescent Filament



Khouri, T., and 15 colleagues (among them **Saberi, M.**): 2025, Astronomy and Astrophysics, 694, A222, ALMA observations of CO isotopologues towards six obscured post-asymptotic giant branch stars



Kou, Zhiping, and 23 colleagues (amon them **Gorai, Prasanta**): 2025, Monthly Notices of the Royal Astronomical Society, 538, 2579, ATOMS: ALMA Three-millimeter Observations of Massive Star-forming regions – XXI. A large-sample observational study of ethanol and dimethyl ether in hot cores



Krikova, K. and **Pereira, T. M. D.**: 2025, Astronomy and Astrophysics, 695, A123, Small-scale energetic phenomena in H...δ: Ellerman bombs, UV bursts, and small flares



Kuckein, C.; Collados, M.; Asensio Ramos, A.; **Díaz Baso, C. J.**; Felipe, T.; Quintero Noda, C.; Kleint, L.; Fletcher, L.; and Matthews, S.: 2025, Astronomy and Astrophysics, 699, A121, Inferring chromospheric velocities in an M3.2 flare using He I 1083.0 nm and Ca II 854.2 nm



Kumar, A.; Howson, T. A.; Pagano, P.; and **De Moortel, I.**: 2025, Monthly Notices of the Royal Astronomical Society, 541, 2843, Alfvén wave propagation, reflection, and trapping in the solar wind



Kumar, Sanjay; Kumar, Pawan; Sadashiv; Nayak, Sushree S.; Agarwal, Satyam; **Prasad, Avijeet**; Bhattacharyya, Ramit; and Chandra, Ramesh: 2025, Solar Physics, 300, 22, Data-Constrained Magnetohydrodynamics Simulation of a Confined X-Class Flare in NOAA Active Region 11166



Lamarre, Henri; Charbonneau, Paul; **Noraz, Quentin**; Strugarek, Antoine; Blaise, Alexis; Brun, Allan Sacha; **Carlsson, Mats**; and **Gudiksen, Boris Vilhelm**: 2025, Physical Review E, 112, L063202, Avalanches in magnetohydrodynamical simulations



Larsen, J. R.; Lundkvist, M. S.; Davies, G. R.; Nielsen, M. B.; Ludwig, H.-G.; **Zhou, Y.**; Rodríguez Díaz, L. F.; and Kjeldsen, H.: 2025, Astronomy and Astrophysics, 701, A92, Granulation signatures in 3D hydrodynamical simulations: Evaluating background model performance using a Bayesian nested sampling framework



Leenaarts, J.; van Noort, M.; de la Cruz Rodríguez, J.; Danilovic, S.; **Díaz Baso, C. J.**; Hillberg, T.; Sütterlin, P.; Kiselman, D.; Scharmer, G.; and Solanki, S. K.: 2025, Astronomy and Astrophysics, 696, A3, High flow speeds and transition-region-like temperatures in the solar chromosphere during flux emergence: Evidence from imaging spectropolarimetry in He I 1083 nm and numerical simulations



Li, Zi-Yang, and 35 colleagues (among them **Gorai, Prasanta**): 2025, Astronomy and Astrophysics, 697, A190, The ALMA-ATOMS survey: A sample of weak hot core candidates identified through line stacking



Liakh, V. and Keppens, R.: 2025, Astronomy and Astrophysics, 696, A158, Numerical study of solar eruption, extreme-ultraviolet wave propagation, and wave-induced prominence dynamics



Liakh, Valeriia and Jenkins, Jack: 2025, Solar Physics, 300, 147, Numerical Modeling of Prominences and Coronal Rain with the MPI-AMRVAC Code



Liu, Daizhong, and 27 colleagues (among them **Wedemeyer, Sven**): 2025, Open Research Europe, 4, 148, Atacama Large Aperture Submillimeter Telescope (AtLAST) science: Gas and dust in nearby galaxies



Lomazzi, Paul; Rouillard, Alexis P.; Lavarra, Michael A.; **Poirier, Nicolas**; Bliely, Pierre-Louis; Dakeyo, Jean-Baptiste; Pierrard, Viviane; Réville, Victor; Vocks, Christian; and Thomas, Simon: 2025, The Astrophysical Journal, 984, 198, A Parametric Study of Solar Wind Properties and Composition Using Fluid and Kinetic Solar Wind Models



Lörinčík, Juraj; Dudík, Jaroslav; Sainz Dalda, Alberto; **Aulanier, Guillaume**; Polito, Vanessa; and **De Pontieu, Bart**: 2025, Nature Astronomy, 9, 45, Observation of super-Alfvénic slippage of reconnecting magnetic field lines on the Sun



Mamonova, E.; Shan, Y.; Kowalski, A. F.; **Wedemeyer, S.**; and Werner, S. C.: 2025, Astronomy and Astrophysics, 700, A53, Flare frequency in M dwarfs belonging to young moving groups



Mathur, Harsh; Joshi, Jayant; **Moe, Thore Espedal**; **Pereira, Tiago M. D.**; and Nagaraju, K.: 2025, The Astrophysical Journal, 987, L39, The H α Line as a Probe of Chromospheric Magnetic Fields



Mathur, Savita; Santos, Angela R. G.; Claytor, Zachary R.; García, Rafael A.; Strugarek, Antoine; Finley, Adam J.; **Noraz, Quentin**; Amard, Louis; Beck, Paul G.; Bonanno, Alfio; Breton, Sylvain N.; Brun, Allan S.; Cao, Lyra; Corsaro, Enrico; Godoy-Rivera, Diego; Mathis, Stéphane; Palakkatharappil, Dinil B.; Pinsonneault, Marc H.; and van Saders, Jennifer: 2025, The Astrophysical Journal, 982, 114, Magnetic Activity Evolution of Solar-like Stars. II. S_ph–Ro Evolution of Kepler Main-sequence Targets



Mohan, Atul; Hauschildt, Peter H.; Fuhrmeister, Birgit; Mondal, Surajit; Airapetian, Vladimir; and **Wedemeyer, Sven**: 2025, The Astrophysical Journal, 989, 20, Role of Nonthermal Processes in the Quiescent and Active Millimeter Spectrum of a Young M Dwarf



Moreno-Insertis, Fernando; **Hansteen, Viggo H.**; and **Nóbrega-Siverio, Daniel**: 2025, The Astrophysical Journal, 995, 137, Magnetic Flux Cancellation in the Solar Atmosphere through 3D Realistic Numerical Modeling



Nandy, Dibyendu, and 62 colleagues (among them **Prasad, Avijeet**): 2025, Journal of Astrophysics and Astronomy, 46, 51, Indian solar and heliospheric physics vision: Fundamental science to a space weather resilient society



Nóbrega-Siverio, Daniel; **Joshi, Reetika**; Sola-Viladesau, Eva; Berghmans, David; and Lim, Daye: 2025, Astronomy and Astrophysics, 702, A188, Thin coronal jets and plasmoid-mediated reconnection: Insights from Solar Orbiter observations and Bifrost simulations



Noraz, Quentin; Brun, Allan Sacha; and Strugarek, Antoine: 2025, The Astrophysical Journal, 981, 206, Global Turbulent Solar Convection: A Numerical Path Investigating Key Force Balances in the Context of the Convective Conundrum



Orlowski-Scherer, John, and 27 colleagues (among them **Wedemeyer, Sven**): 2025, Open Research Europe, 4, 132, Atacama Large Aperture Submillimeter Telescope (AtLAST) science: Probing the transient and time-variable sky



Ornig, S.; Veronig, A. M.; and Dissauer, K.: 2025, Astronomy and Astrophysics, 702, A49, Extreme ultraviolet late-phase flares as observed by EVE and AIA on board the Solar Dynamics Observatory



Øyre, Eilif S.; **Gudiksen, Boris V.**; and **Fletcher, Lyndsay**: 2025, Astronomy and Astrophysics, 703, A97, Test particle sampling and particle acceleration in a 2D coronal plasmoid-mediated reconnecting current sheet



Poirier, N.; Danilovic, S.; **Kohutova, P.**; **Díaz Baso, C. J.**; **Roupe van der Voort, L.**; Calchetti, D.; and Sinjan, J.: 2025, Astronomy and Astrophysics, 696, A125, Coronal kink oscillations and photospheric driving: Combining SoO/EUI and SST/CRISP high-resolution observations



Popovas, Andrius: 2025, Astronomy and Astrophysics, 698, A69, DISPATCH methods: An approximate, entropy-based Riemann solver for ideal magnetohydrodynamics



Rauer, Heike, and 845 colleagues (among them **Wedemeyer, Sven**): 2025, Experimental Astronomy, 59, 26, The PLATO mission



Reche, Antonio; Pastor Yabar, Adur; and **Griñón-Marín, Ana Belén**: 2025, Astronomy and Astrophysics, 699, A340, Polar faculae and their relationship to the solar cycle



Robinson, Rebecca A.; **De Pontieu, Bart**; Steel, Simon; Harman, Pamela; Polito, Vanessa; and Jin, Meng: 2025, Frontiers in Astronomy and Space Sciences, 12, 1658638, A mission-embedded outreach program for NASA’s Multi-slit Solar Explorer (MUSE) mission: inspiring future generations of solar explorers beyond boundaries and backgrounds



Russell, Alexander J. B.; Polito, Vanessa; Testa, Paola; **De Pontieu, Bart**; and Belov, Sergey A.: 2025, The Astrophysical Journal, 990, L39, Solar Flare Ion Temperatures



Saberi, M.; **Jafarzadeh, S.**; **Wedemeyer, S.**; Gafeira, R.; **Szydlarski, M.**; Jess, D. B.; and Stangalini, M.: 2025, Astronomy and Astrophysics, 693, A19, The Sun at millimeter wavelengths: V. Magnetohydro-dynamic waves in a fibrillar structure



Sand, Mats Ola; **Roupe van der Voort, Luc H. M.**; Joshi, Jayant; **Bose, Souvik**; **Nóbrega-Siverio, Daniel**; and **Griñón-Marín, Ana Belén**: 2025, Astronomy and Astrophysics, 697, A180, Quiet Sun Ellerman bombs as a possible proxy for reconnection-driven spicules



Schmieder, Brigitte; Guo, Jinhan; **Aulanier, Guillaume**; Maharana, Anwsha; and Poedts, Stefaan: 2025, Solar Physics, 300, 132, Flare Energetics, CME Launch and Heliospheric Propagation for the May 2024 Events, as Derived from Ensemble MHD Modelling



Shields, Joshua V.; Kerzendorf, Wolfgang; Smith, Isaac G.; **Pereira, Tiago M. D.**; Vogl, Christian; Groneck, Ryan; Fullard, Andrew G.; Singhal, Jaladh; Lu, Jing; and Fontes, Christopher J.: 2025, The Astrophysical Journal, 990, 41, Introducing STARDIS: An Open and Modular Stellar Spectral Synthesis Code



Soler Poquet, I. J.; **Díaz Baso, C. J.**; **Roupe van der Voort, L. H. M.**; and Vissers, G. J. M.: 2025, Astronomy and Astrophysics, 699, A54, Automatic detection of Ellerman bombs using deep learning



Telkamp, Zoie, and 18 colleagues (among them **Gorai, Prasanta**): 2025, The Astrophysical Journal, 986, 15, The SOFIA Massive (SOMA) Star Formation Survey. V. Clustered Protostars



Thoen Faber, Jonas; Joshi, Reetika; Rouppe van der Voort, Luc; Wedemeyer, Sven; Fletcher, Lyndsay; Aulanier, Guillaume; and Nóbrega-Siverio, Daniel: 2025, Astronomy and Astrophysics, 693, A8, High-resolution observational analysis of flare ribbon fine structures



Tiwari, Sanjiv K., and 19 colleagues (among them **De Pontieu, Bart**): 2025, The Astrophysical Journal, 995, L45, A Sudden Fine-scale Bright Kernel Captured by Hi-C Flare in 11 MK Emission during an M1.6-class Solar Flare’s Postmaximum Phase



To, Andy S. H.; Burden, Abigail; Baker, Deborah; Eklund, Henrik; Brooks, David H.; Hayes, Laura A.; **Martínez-Sykora, Juan**; Testa, Paola; Reep, Jeffrey; Janvier, Miho; Imada, Shinsuke; Hernandez Camero, Julio; Long, David M.; Mihailescu, Teodora; and Weberg, Micah J.: 2025, The Astrophysical Journal, 993, 102, Systematic Nonthermal Velocity Increase Preceding Soft X-Ray Flare Onset: A Large-scale Hinode/EIS Study



Udnæs, Elias R. and Pereira, Tiago M. D.: 2025, Astronomy and Astrophysics, 699, A25, Characteristics of acoustic-wave heating in simulations of the quiet Sun chromosphere



Veronig, Astrid M.; Dissauer, Karin; Kliem, Bernhard; Downs, Cooper; Hudson, Hugh S.; Jin, Meng; Osten, Rachel; Podladchikova, Tatiana; **Prasad, Avijeet**; Qiu, Jiong; Thompson, Barbara; Tian, Hui; and Vourlidas, Angelos: 2025, Living Reviews in Solar Physics, 22, 2, Coronal dimmings and what they tell us about solar and stellar coronal mass ejections



Wang, H. P.; Guo, J. H.; Yang, L. P.; Poedts, S.; **Zhang, F.**; Lani, A.; Baratashvili, T.; Linan, L.; Lin, R.; and Guo, Y.: 2025, Astronomy and Astrophysics, 693, A257, SIP-IFVM: Efficient time-accurate magnetohydrodynamic model of the corona and coronal mass ejections



Wang, H. P.; Poedts, S.; Lani, A.; Brchnelova, M.; Baratashvili, T.; Linan, L.; **Zhang, F.**; Hou, D. W.; and Zhou, Y. H.: 2025, Astronomy and Astrophysics, 694, A234, Efficient magnetohydrodynamic modelling of the time-evolving corona by COCONUT



Wang, H. P.; Poedts, S.; Lani, A.; Linan, L.; Baratashvili, T.; **Zhang, F.**; Sorokina, D.; Jeong, H.-J.; Li, Y. C.; Najafi-Ziyazi, M.; and Schmieder, B.: 2025, Astronomy and Astrophysics, 702, A37, Time-evolving coronal modelling of the solar maximum around the solar storms in May 2024 by COCONUT



Wargnier, Q. M.; Vilmart, G.; **Martínez-Sykora, J.; Hansteen, V. H.; and De Pontieu, B.:** 2025, Astronomy and Astrophysics, 695, A262, Time-adaptive PIROCK method with error control for multi-fluid and single-fluid magnetohydrodynamics systems



Wedemeyer, Sven; Johnsen, Magnar Gullikstad; Antolin, Patrick; Rae, Jonathan; and Poedts, Stefaan: 2025, Europhysics News, 56, 22, Space-Weather Effects on Critical Infrastructure on Earth



Weitz, Ayla; Tiwari, Sanjiv K.; Cauzzi, Gianna; Reardon, Kevin P.; and **De Pontieu, Bart**: 2025, The Astrophysical Journal, 988, 133, Bright Dots and Coronal Plume Formation in Sunspot Penumbra



Xing, Chen; Cheng, Xin; **Aulanier, Guillaume;** and Ding, Mingde: 2025, The Astrophysical Journal, 986, 37, Initiation Route of Coronal Mass Ejections. II. The Role of Filament Mass



Yang, Dongting, and 34 colleagues (among them **Gorai, Prasanta**): 2025, The Astrophysical Journal, 995, 193, The ALMA-QUARKS Survey: Evidence of a Candidate High-mass Prestellar Core Aside a Bright-rimmed Cloud IRAS 18290-0924



Yang, Dongting, and 45 colleagues (among them **Gorai, Prasanta**): 2025, The Astrophysical Journal Supplement Series, 280, 33, The ALMA-QUARKS Survey. III. Clump-to-core Fragmentation and Searches for High-mass Starless Cores



Yang, Heesu; Madjarska, Maria S.; Lim, Eun-Kyung; **Nóbrega-Siverio, Daniel;** and Galsgaard, Klaus: 2025, Journal of Korean Astronomical Society, 58, 185, Structures and Properties of Fan-Shaped Jets: H α Dark Blobs and Transparent Regions



Yang, Xu; Cao, Wenda; Wang, Meiqi; Jennings, Don; Qiu, Jiong; He, Wen; Perriyil, Solomon M.; Yurchyshyn, Vasyi; **Fletcher, Lyndsay;** Simões, Paulo J. A.; Jhabvala, Murzy; Lunsford, Allen; Chen, Xingyao; and Hudson, Hugh: 2025, The Astrophysical Journal, 988, L56, High-resolution Observations of an X6.4 Solar Flare in the Mid-infrared

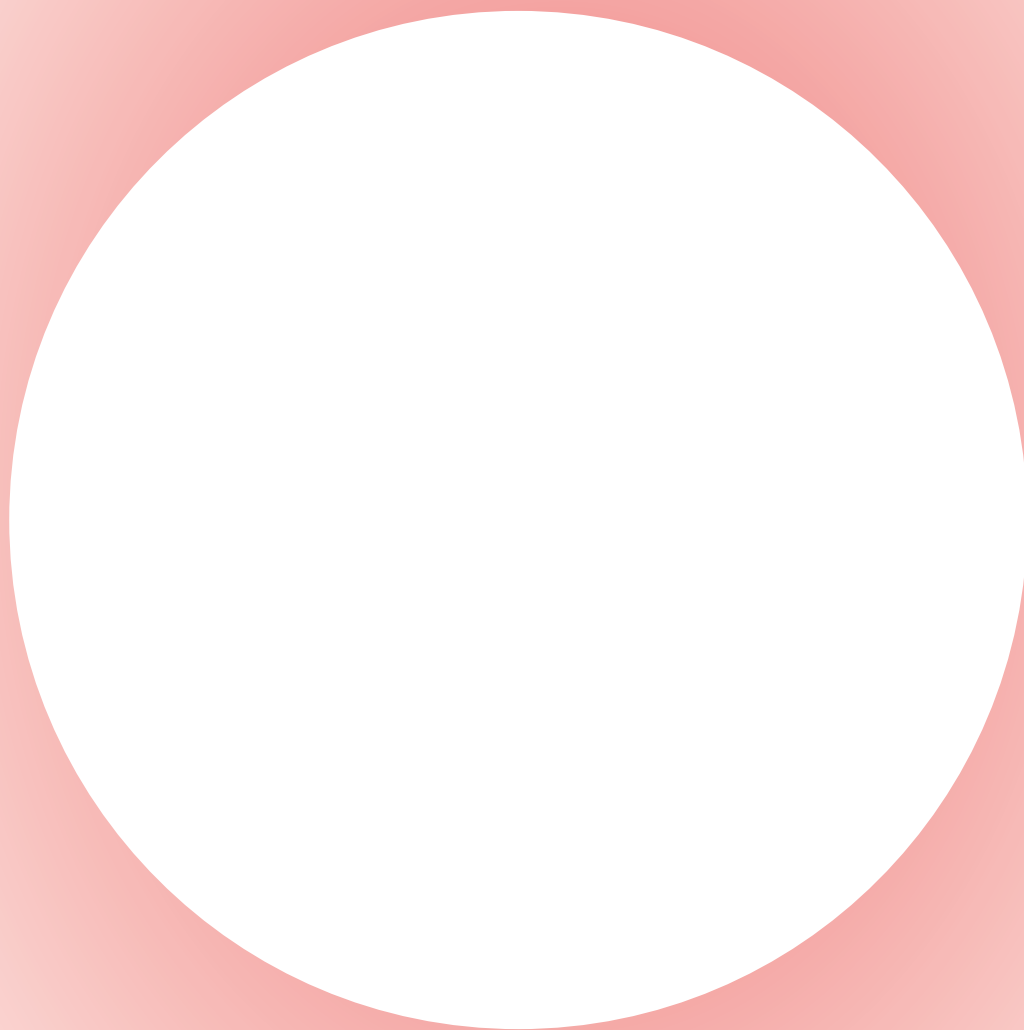


Zou, Jiahang, and 22 colleagues (among them **Gorai, Prasanta**): 2025, The Astrophysical Journal, 995, 111, The ALMA-ATOMS-QUARKS Survey: Resolving a Chemically Rich Massive Protostellar Outflow



When the Sun has set,
no candle can replace it

— George R. R. Martin



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