Cycle 1 Accepted Science Programs

<table>
<tr><th>PID</th><th>Title</th><th>PI</th><th>Country</th></tr>
<tr><td rowspan="2">5</td><td>The frequency distribution of Quiet-Sun Ellerman Bombs</td><td>Gerry Doyle

Co-Is

Juie Shetye (US), Ignacio Ugarte-Urra (US)</td><td>UK</td></tr>
<tr><td colspan="3">Abstract

Quiet Sun Ellerman Bombs (QSEBs) are transient brightenings that are ubiquitously observed in the lower solar atmosphere in H-beta. As they are believed to pinpoint sites of magnetic reconnection, understanding their occurrence and detailed evolution will quantify their energy budget and explore their role in chromospheric and coronal heating. It is estimated that about half a million QSEBs could be present in the lower solar atmosphere at any given time. With DKIST's superior spatial resolution, we will be able to study their flaring structure and evolution, plus number density.</td></tr>
<tr><td rowspan="2">12</td><td>Mapping the magnetic field of small-scale structures in the sunspot penumbra</td><td>Sara Esteban Pozuelo

Co-Is

Luis Bellot Rubio (ES), Andres Asensio Ramos (ES), Azaymi Siu (ES)</td><td>ES</td></tr>
<tr><td colspan="3">Abstract

Magnetoconvection plays a crucial role in sunspots penumbrae. There, high spatial resolution observations reveal flow motions at small scales, such as lateral downf lows at the edges of penumbral filaments. Some investigations have shed light on essential aspects of them, but there are still open questions concerning their magnetic field vector. Besides, penumbral microjets pop up above photospheric regions where magnetic reconnections may occur due to the sheared configuration of the magnetic field. However, clear evidence of this process is still missing. We aim to study the 3D topology of the magnetic field vector of lateral down flows. This analysis is important to model the magnetic field configuration of sunspots penumbrae and to investigate the relation between penumbral microjets and the presence of lateral downflows. For this purpose, we will take advantage of the capabilities provided by the DKIST telescope to obtain high spatial resolution and temporal cadence spectropolarimetric data in the Fe
I 630 nm, Ca II 854.2 nm, and Ca II H spectral lines.</td></tr>
</table>

<table>
<tr><td rowspan="2">14</td><td>Thermodynamic Evolution of Limb Spicules</td><td>Bart De Pontieu

Co-Is

Juan Martinez-Sykora (US), Jaime de la Cruz Rodriguez (SE), Georgios Chintzoglou (US), Luc Rouppe van der Voort (NO), Tiago Pereira (NO), Joten Okamoto (JP), Akiko Tei (JP)</td><td>US</td></tr>
<tr><td colspan="3">Abstract

We propose to study the thermodynamical evolution of spicules at the limb at the unprecedented spatial resolution of DKIST. We propose to obtain high-resolution time sequences with VBI in two different chromospheric spectral lines (Ca II K and H-alpha) and compare these to synthetic observables from advanced numerical simulations of spicules. We will address the role of the dynamic substructure and formation of strands in the overall evolution of spicules and compare these to predictions of numerical simulations. We will also analyze our data to study the properties of transverse Alfvenic waves at higher frequencies than previously possible. We will apply previously developed analysis methods on our data. The data obtained and our analysis will provide strict constraints on all theoretical models of spicules. Our results will provide new insights into the thermodynamic evolution of spicules, the role of Alfven waves in their evolution, and the impact of spicules on the mass and energy balance of the low solar atmosphere. Our measurements will also provide new constraints on the properties and dissipation of Alfven waves in the solar atmosphere.</td></tr>
<tr><td rowspan="2">16</td><td>Thermodynamic and magnetic evolution of on-disk spicules</td><td>Juan Martinez-Sykora

Co-Is

Bart De Pontieu (US), Juan Martinez-Sykora (US), Jaime de la Cruz Rodriguez (SE), Joten Okamoto (JP), Tiago Pereira (NO), Georgios Chintzoglou (US), Luc Rouppe van der Voort (NO)</td><td>US</td></tr>
<tr><td colspan="3">Abstract

We aim to study the thermodynamical and magnetic evolution of spicules on the disk at the unprecedented resolution of DKIST. We will acquire ViSP Ca II 854.2 nm spectra from a fast (7s) cadence, sparse (3-step) raster that crosses disk spicules at different heights. VBI Hbeta and Ca II K imaging will serve as a reference. We will employ non-LTE inversions with the STiC code to determine temperature, velocity, and magnetic field in spicules. This will allow us to characterize waves and their propagation in spicules and explore the possibility to detect Alfvenic waves in the Stokes V signal. We will compare the observations with synthetic observables calculated from advanced radiative MHD models of spicules. The DKIST observations will allow a major advancement in the characterization of spicules and will pose strict constraints on models. This will lead to a better understanding of the mechanisms responsible for the formation and heating of these chromospheric features, the role of magnetic waves in their dynamic evolution, and get a better insight in their full impact on the mass and energy balance of the outer solar atmosphere.</td></tr>
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<table>
<tr><td rowspan="2">18</td><td>The Cold Chromosphere: Mapping CO Spatial and Temporal Inhomogeneities</td><td>Sarah Jaeggli

Co-Is

Andre Fehlmann (US), Thomas Schad (US), Serena Criscuoli (US), Bart De Pontieu (US), Alexandra Tritschler (US), Kevin Reardon (US), Juan MartÃinez-Sykora (US), Han Uitenbroek (US), Svetlana Berdyugina (DE), Valentin Martinez Pillet (US)</td><td>US</td></tr>
<tr><td colspan="3">Abstract

There have been only a fewstudies of the carbon monoxide fundamental band near 4.7 microns, but these ob
servations have sparked controversy over the thermal structure of the upper photosphere and chromosphere. Observations seem to show that there is much cooler plasma present and that this cool gas extends high into the chromosphere, inconsistent with other chromospheric diagnostics that reveal a fairly hot chromosphere. This proposal suggests the first steps that should be taken using CryoNIRSP to lay the baseline for future studies of CO with this instrument. Observations of the quiet Sun will be conducted at disk center and near the limb to confirm the properties of CO seen in previous observations and will extend our understanding further using the superior spatial resolution, time cadence, and scanning capability of CryoNIRSP.</td></tr>
<tr><td>21</td><td>Deep Cryo-NIRSP Investigations of Spicule Magnetic Field Strengths and the Chromosphere-Corona Mass Cycle Off-Limb</td><td>Thomas Schad

Co-Is

Gabriel Dima (US), Ian Cunnyngham (US), Jeffrey Kuhn (US), Isabelle Scholl (?), Patrick Antolin (UK)</td><td>US</td></tr>
</table>

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<tr><td></td><td colspan="3">Abstract

Type II spicules potentially supply non-negligible mass and energy to the corona; meanwhile, a primary constituent of the mass return flow is corona rain. These dynamic phenomena are challenging, yet critically important, targets that require multi-wavelength, high-speed, and high-resolution observations for complete characterization. That said, several open questions regarding this chromosphere-corona interface can be addressed using very deep observations that are within reach of the DKIST Cycle 1 capabilities using the Cryo-NIRSP He I 1083 nm channel, despite its lower spatial resolution in comparison to the AO-assisted instruments. Moreover, advancing high dynamic range Cryo-NIRSP observations will benefit a range of science use cases to come. We propose Cryo-NIRSP polarimetric observations, using both the spectrograph and context imager, of the solar limb that include scanned time-series observations, as well as very deep observations, so to take advantage of the unique low-scattered light and high dynamic range provided by DKIST. Our objectives include addressing whether: (1) there is a He I line width signature of a temperature increase coinciding with the rapid fading of type II spicules, (2) spicule magnetic field strengths are ubiquitously larger than earlier observations suggest, (3) missing mass in the rain drainage exists at low emissivity, and (4) magnetic fields can be obtained from coronal rain off-limb (if observed). A secondary goal (if permissible) is to explore the spicule connection with the low corona in the forbidden 1079.8 nm coronal line, which in principle fits on the detector simultaneous with He I, and could provide vital temperature diagnostics.</td></tr>
<tr><td rowspan="2">22</td><td>Joule heating in the chromosphere of plage</td><td>Jaime de la Cruz Rodriguez

Co-Is

Jorrit Leenaarts (SE), Sanja Danilovic (SE), Matthias Rempel (US), Rebecca Centeno (US)</td><td>SE</td></tr>
<tr><td colspan="3">Abstract

This proposal aims at studying the role of electrical current dissipation in plage targets. In plage regions, magnetic fields are expected to be highly concentrated in intergranular lanes in the photosphere. In the chromosphere gas pressure decreases with height much more rapidly than magnetic pressure and therefore the magnetic fields form a hot canopy above the photosphere. In the chromosphere of plage regions, enhanced radiative cooling (brightness) is detected in observations acquired in optically thick lines of H I, Mg II and Ca II. Although the exact mechanisms that transport and dissipate that energy in the chromosphere are not yet known, many theoretical models have been proposed. Our goal is to study how the presence and dissipation of electrical currents in the lower boundary of the magnetic canopy contributes to the heating of plage chromospheres. To do so, we propose to use new DKIST full-Stokes observations in spectral lines that sample the solar atmosphere from the photosphere to the upper chromosphere (Fe I 6301/6302, Ca II 8542, Ca II H) with an unprecedented S/N to derive the stratification of the magnetic field vector. We will use a new spatially-coupled version of the STiC inversion code that also allows including spatial degradation effects and regularization.</td></tr>
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<table>
<tr><td rowspan="2">25</td><td>Evolution of magnetic fields in flares</td><td>Lucia Kleint

Co-Is

Jaime de la Cruz Rodriguez (SE), Xudong Sun (US), Gianna Cauzzi (US), Graham Kerr (US), Kevin Reardon (US)</td><td>CH</td></tr>
<tr><td colspan="3">Abstract

Solar flares are the most energetic events in our solar system. While they predominantly occur in conjunction with complex sunspots and thus complex configurations of the magnetic field, their exact timing, strength,
and evolution varies from flare to flare and cannot be predicted in advance. It is therefore crucial to study the evolution of the magnetic field before, during, and after flares to better understand their physics. We propose to observe the restructuring of the magnetic field in 3D by using photospheric and chromospheric polarimetry with ViSP observations of the 6301/6302 Angstroem and 8542 Angstroem lines. We will derive temporal sequences of the evolution of the vector magnetic field in both layers. Fast photospheric and chromospheric context imaging will allow us to study the small-scale structure of the propagating flare ribbon. Our results will contribute to the understanding of the overall flare energy budget and allow us to probe the standard flare model, in terms of evolution of the flare ribbons and flare energy dissipation on the smallest spatial scales.</td></tr>
<tr><td rowspan="2">26</td><td>Building and Interrogating flare models with DKIST observations</td><td>Jaime de la Cruz Rodriguez

Co-Is

Lucia Kleint (CH), Xudong Sun (US), Gianna Cauzzi (US), Graham Kerr (US)</td><td>SE</td></tr>
<tr><td colspan="3">Abstract

Solar flares are the manifestation of energetic transient events during which the magnetic field re-configures to a lower energy state that takes place in the outer layers of the Sun. During flares complex mass flows, localized heating and the presence of accelerated particles leave a very distinct imprint in all chromospheric diagnostics and, sometimes in the continuum. During the past years great progress has been possible thanks to improvements to rMHD/rHD codes that now include many physical ingredients that are suspected to take
place during flares (e.g., latest updates to the MURaM and RADYN codes). The launch of NASA's IRIS satellite, has also provided new observations in UV diagnostics that are not observable from the ground. However, one limitation of space borne missions is the relatively large spatial resolution-gap in comparison with ground-based facilities. Resolving very small spatial scales is now considered a key observational requirement in order to resolve the scales at which energy deposition takes place during flares. In this project we propose to combine the excellent diagnostic potential of the Ca II H, Ca II 8542 and Fe I 6302 lines, observed with unprecedented spatio-temporal resolution in order to observationally constrain the atmospheric changes that very rapidly take place during the first stages of the flare. We will reconstruct empirical models from data inversions with the STiC code and we will compare them with theoretical predictions from RADYN.</td></tr>
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<table>
<tr><td rowspan="2">27</td><td>The formation and evolution of penumbral filaments</td><td>Rolf Schlichenmaier

Co-Is

Philip Lindner (DE), Sanjiv Tiwari (US)</td><td>DE</td></tr>
<tr><td colspan="3">Abstract

Sunspots play an outstanding role in astrophysical research, since they provide a direct observation of the energy transport in magnetized plasma, at all their characteristic scales, and in different magnetic environments: strong vertical fields in umbra, weaker more horizontal fields in penumbra. In this research project, we address the penumbral mode of radiative magnetoconvection. We want to infer the physical fine-structure of a penumbral filament as it forms and evolves in a sunspot. As it is known that a penumbra harbors two field 'components', one that is more vertical ('spines') and one that is more horizontal ('intra-spines'), we aim to investigate the interplay between these two components as a magnetoconvective cell, which constitutes a filament, evolves. We aim to infer the time-dependent topology of the magnetic field, as well as the flow field. Magnetic reconnection, previously observed as chromospheric micro-jets, could be a process that is relevant during the filament evolution. Our observing program consists of a time series of ViSP scans with a time cadence of less than 3 minutes, in which the slit is aligned to the filaments. ViSP records 3 spectral regions simultaneously. VBI Blue imaging in the blue continuum will allow to study the small-scale evolution of the filaments. We will analyze the data with sophisticated inversion techniques and compare our results with synthetic maps of corresponding numerical simulations.</td></tr>
<tr><td rowspan="2">28</td><td>Are chromospheric swirls torsional Alfven waves?</td><td>Andrea Francesco Battaglia

Co-Is

Oskar Steiner (DE), Michele Bianda (CH), Franziska Zeuner (DE)</td><td>CH</td></tr>
<tr><td colspan="3">Abstract

Over the past decade, various kinds of vortical plasma motions in the solar atmosphere have been acquiring increasing interest. In particular, chromospheric swirls, which occur co-spatially with the relative motion of photospheric magnetic bright points (BPs) were suggested to be an efficient mechanism for channeling energy from the photosphere to the corona. Using CO5BOLD magnetohydrodynamics simulations, we investigated the origin and evolution of these magnetic swirls. Toroidal velocity and magnetic field components of opposite sense of rotation have been found to occur during these events. Furthermore, we found that they propagate as unidirectional swirls with the local, time-dependent Alfven plus bulk speed, in the upward direction. The two findings are in perfect agreement with the corresponding properties of torsional Alfven waves. We found that they originate from the perturbation of the magnetic field at their footpoints, which, in turn, enhances the magnetic tension, causing the rotation on the magnetic field and hence the rotation of the plasma. The logic consequence is to validate these simulation results by means of observations. To do that we need image sequences with a spatial resolution similar to that of the simulations and we need polarimetry of high sensitivity. We believe that DKIST is the only telescope that can deliver data of sufficient quality.</td></tr>
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<table>
<tr><td rowspan="2">29</td><td>Properties of convective cells at the penumbra/umbra boundary</td><td>Philip Lindner

Co-Is

Rolf Schlichenmaier (DE), Jan Jurcak (CZ), Marta Garcia-Rivas (CZ), Svetlana Berdyugina (DE)</td><td>DE</td></tr>
<tr><td colspan="3">Abstract

Near the boundary between penumbra and umbra, different magneto-convective modes are present. In penumbral filament heads (FH), upflows are observed that turn into the horizontal Evershed flow with increasing distance from the spot center and inclined magnetic fields are observed. In the umbra, however, magnetic fields are more vertical and stronger and convection is reduced. One exception are upflows observed in peripheral umbral dots (PUDs), that appear close to the penumbra/umbra boundary. Due to the limits in the spatial resolution of current solar telescopes, both PUDs and FHs could only just be resolved. With the outstanding spatial resolution of DKIST data, we want to study the substructure of PUDs and FHs. One aim is to investigate whether they are more elongated in larger sunspots, where the magnetic field at the penumbra/umbra boundary is more inclined. Another aim is to study the transition of a FH into a PUD. We want to follow the evolution of the magnetic field vector and velocity during this transition from one fundamental domain into the other and whether the vertical component of the magnetic field plays a major role. Additionally, we want to examine whether there is a response to this transition in atmospheric parameters of chromospheric layers. This could be similar to penumbra microjets, where magnetic reconnection is believed to either release mass flows or shock fronts.</td></tr>
<tr><td rowspan="2">30</td><td>Internetwork magnetic field in the lower solar atmosphere</td><td>Sanja Danilovic

Co-Is

Jaime de la Cruz Rodriguez (SE), Jorrit Leenaarts (SE), Matthias Rempel (US), Maria Kazachenko (US)</td><td>SE</td></tr>
<tr><td colspan="3">Abstract

Quiet Sun regions cover most of the solar surface at any given time. The question of how much magnetic flux these regions harbor is directly connected to the coronal heating problem. The main aim of this proposal is to measure the properties of the internetwork magnetic field vector in the photosphere and low chromosphere at the highest spatial resolution using ViSP and VBI observations. Our expertise and unique approach will ensure that the best strategy will be applied and the most information will be extracted from the DKIST observations. In addition we aim to measure the properties of the internetwork magnetic canopy, the spatial distribution of horizontal magnetic field in the photosphere, as well as the Poynting flux. We will confront our results with small-scale surface dynamo MHD simulations and use the same to find any potential systematic errors in our method.</td></tr>
</table>

32	Constraining the magnetic vector and its dynamics in a quiet inter-network region at unprecedented resolution	Ryan Campbell Co-Is Mihalis Mathioudakis (UK), Valentin Martinez (US), Peter Keys (UK), Chris Nelson (UK)	UK
	Abstract The magnetic field of the solar surface has a huge influence on solar phenomena, and thus developing our understanding of this field on the smallest scales is a crucial science goal. While the vertical component of the photospheric magnetic field, which is relatively strong, has been studied extensively, the relatively weaker small-scale transverse field warrants more thorough investigation. The Zeeman effect is often blind as a diagnostic to mixed-polarity fields within the resolution limit, necessitating the highest spatial resolution. At the same time, the weak polarization signals produced by such small-scale fields are some of the weakest observable on the Sun. This proposal is concerned with using the unprecedented resolution of the DKIST to unlock our understanding of the turbulent, small-scale magnetic field in the photosphere. We intend to evaluate the strength, inclination and typical filling factors of the magnetic field, in the photosphere with the magnetically sensitive Fe I 630.15/630.2 nm line pair, and anticipate this to be possible for a large proportion of the field of view at ViSP resolution and sensitivity. Additional thermodynamic and kinematic quantities describing the atmosphere (i.e. temperature, velocities) will be derived from inversions. From deep-mode or "sit-and-stare" observations, we will additionally be able to observe the dynamics of all of these quantities.		
36	Searching for signatures of surface and body MHD modes in small-scale magnetic structures	Peter Keys Co-Is Robertus Erdelyi (UK), David Jess (US), Damian Christian (US), Mihalis Mathioudakis (UK)	UK
	Abstract Recent studies have observed a plethora of MHD wave phenomena in magnetic features of varying scales in the solar atmosphere. However, the identification of such waves in the lower solar atmosphere is a complex problem because the various eigenmodes available in the MHD Hilbert space have overlapping properties. This has limited studies to low order modes. One aspect of MHD wave modes that has only been identified in observations very recently, is the spatial characteristics of the mode across the flux tube [1]. This is a key component in understanding energy transfer from the waveguide to the quiescent environment and therefore represents a crucial step in the contribution of the various wave modes to heating the solar atmosphere. As such, this proposal is commensurate with the DKIST science objectives with respect to wave generation and heating in the atmosphere. By availing of the high-resolution observations and spectropolarimetry made possible with DKIST, our proposal aims to gain new insights into the surface and body characteristics of wave modes in the smallest of magnetic structures (i.e, magnetic bright points) at multiple heights in the solar atmosphere. This will allow us to ascertain the importance of magnetic bright points in energy transfer within the quiet Sun as well as the mechanisms involved.		

<table>
<tr><td rowspan="2">37</td><td>Statistical study of photospheric anemone jet-like structures and their effects on the chromosphere</td><td>Yuji Kotani

Co-Is

Ayumi Asai (JP), Kiyoshi Ichimoto (JP), Kazunari Shibata (JP)</td><td>JP</td></tr>
<tr><td colspan="3">Abstract

Jet phenomena with a bright loop in their footpoint, called anemone jets, have been observed in the solar corona and chromosphere. These jets are formed as a consequence of magnetic reconnection, and from the scale universality of magnetohydrodynamics (MHD), it can be expected that anemone jets exist even in the solar photosphere. Kotani & Shibata (2020) performed 3D MHD simulation of magnetic reconnection with solar photospheric parameters and showed that jet-like structures were induced by reconnection in the solar photosphere. We also pointed out that MHD waves generated by photospheric anemone jet-like structures could influence the local chromospheric heating and the formation of spicules. However, our numerical simulations did not reveal the statistical nature of the photospheric anemone jet-like structure, as the simulations were performed given typical and expected parameters. We propose to detect the anemone jet-like structures with their length of approximately 100 km in the photosphere for the first time and to investigate their statistical properties and their effects on chromospheric heating and spicule formation through the high-resolution DKIST obervations of photosphere and chromosphere.</td></tr>
<tr><td rowspan="2">38</td><td>Chromospheric Oscillations in a Flaring Active Region</td><td>David Millar

Co-Is

John Armstrong (UK), Lyndsay Fletcher (UK), R.T. James McAteer (US), Ryan Milligan (UK), Christopher Osborne (UK)</td><td>UK</td></tr>
<tr><td colspan="3">Abstract

The impact of a flare on the solar chromosphere can be detected in various ways - primarily the radiation signatures but also mechanical perturbations - pulsations or oscillations - and changes to the chromospheric magnetic field. Our recent detections of chromospheric intensity oscillations varying temporally and spatially before, during and after flares suggests a promising new line of investigation into flare energy deposition in the solar chromosphere, which we propose to develop with these DKIST observations. Oscillations or pulsations with periods around 3-minutes probe the mechanical, thermal and magnetic properties of the solar chromosphere, all of which can be strongly disrupted by the intense deposition of energy and momentum during a flare's impulsive phase. With a combination of high-cadence VBI observations through narrowband filters (on which we will also test our new machine-learning techniques for atmospheric seeing corrections) and spectropolarimetric observations in the Ca II 8542 Angstroem and Fe I 6302 Angstroem lines we will investigate the oscillatory response of the chromosphere to a flare.</td></tr>
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<table>
<tr><td rowspan="2">40</td><td>Waves in Prominences</td><td>Joten Okamoto

Co-Is

Bart De Pontieu (US), Kevin Reardon (US), Patrick Antolin (UK)</td><td>JP</td></tr>
<tr><td colspan="3">Abstract

The mechanism responsible for heating the solar corona is one of the most fundamental problems in solar physics and astrophysics in general. Recent observations by the Hinode and IRIS satellites have revealed that the solar atmosphereis filled with small-scale oscillations caused by waves that can carry sufficient energy to heat the corona. However, it is unclear whether waves actually contribute to coronal heating. In particular, we have not found out the role of high-frequency waves with small-scale oscillations. DKIST/VBI is the first instrument that can resolve extremely-small fluctuations with an amplitude of less than 0.05" up to 0.005" (half of pixel sampling). We propose high-cadence observations of active-region prominences above the solar limb to detect oscillations and waves with a variety of frequency from a few tens seconds to a few minutes. Making 2D maps of wave power and phase velocity at each frequency, we can investigate the relationship among the frequency of waves, the dynamic behaviors of the prominence, and the spatial distribution of wave power. Our proposing observations will provide critical information or clues about the mechanism of wave dissipation and thus tightly constrain wave-heating models.</td></tr>
<tr><td rowspan="2">45</td><td>Solar Oscillations at High Resolution</td><td>Markus Roth

Co-Is

Mark Rast (US), Shah Mohammad (US)</td><td>DE</td></tr>
<tr><td colspan="3">Abstract

Even though much knowledge has been gained on the processes and structure of the Sun by the study of resonant and travelling waves, the excitation, propagation and energy dissipation of these solar magneto-acoustic-gravity waves and their coupling and mutual conversion in the solar atmosphere is an open issue. Nevertheless, knowledge on these mechanisms is highly needed to understand the convective processes, to improve the helioseismic techniques, and to properly understand the thermal structure of the solar atmosphere. In this proposal we aim to use the unprecedented spatial, spectral, and temporal resolution of DKIST to overcome the limitations of previous studies on the excitation of waves on the Sun, and to derive the properties of the acoustic source function.</td></tr>
<tr><td>48</td><td>Interaction of granular lanes with magnetic fields: The small-scale dynamo in operation</td><td>Catherine Fischer

Co-Is

Oskar Steiner (DE), Vigeesh Gangadharan (DE)</td><td>DE</td></tr>
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<tr><td></td><td colspan="3">Abstract

Granular lanes are believed to be the observational signature of underlying tubes of vortical flow with their axis oriented parallel to the solar surface. They consist of a dark lane preceded by a bright rim that move together from the boundary of a granule into the granule itself. We have recently found associated with these horizontal vortex tubes significant signal in linear polarisation, located at the trailing dark edge of the granular lane. We concluded, with the assistance of 3-D MHD simulations, that the vortical flows of granular lanes are capable of transporting magnetic flux to the solar surface within granules - process termed as “shallow recirculation” by Rempel [2018ApJ...859..161R]. Supposedly, this mechanism is an important component of the small-scale dynamo acting at the solar surface and generating the quiet Sun magnetic field. We propose to undertake the first systematic study of granular lanes and their fine structure with high-cadence photospheric G-band images at unprecedented spatial resolution. Spectropolarimetric co-observations for part of the field-of-view will reveal the interaction of granular lanes with the magnetic field, enabling us to study details of the shallow recirculation process.</td></tr>
<tr><td rowspan="2">49</td><td>Contribution to Solar Brightness of small-size magnetic elements</td><td>Serena Criscuoli

Co-Is

Alexandra Tritschler (US), Courtney Peck (US), Irina Kitiashvili (US), Matthias Rempel (US), Mark Rast (US), Martin Snow (US), Viacheslav Sadykov (US)</td><td>US</td></tr>
<tr><td colspan="3">Abstract

Magneto hydrodynamic simulations of the solar photosphere and chromosphere show that the magnetic field is organized at spatial scales that have not been accessible so far with the 1 meter class telescopes. We will utilize observations acquired with the DKIST to investigate the contribution of these small-size magnetic elements to the radiative emission at different spectral ranges. By spatially degrading our observations to mimic the spatial resolution of full-disk images typically employed for irradiance variation studies, we will evaluate the impact of such “hidden” fields to estimates of solar irradiance variability. Our results will be used to compare and validate the use of 3D MHD simulations in the study of spectral irradiance variability. Comparisons between the observed and simulated solar atmospheres obtained with two different MHD codes will be undertaken.</td></tr>
<tr><td>50</td><td>Electric field associated with magnetic reconnection driving a jet in the chromosphere</td><td>Tetsu Anan

Co-Is

Kiyoshi Ichimoto (JP), Sanjiv Tiwari (US), Hiroaki Isobe (JP), Thomas Schad (US), Sarah Jaeggli (US), Ayumi Asai (JP), Maria Kazachenko (US), Kevin Reardon (US) , Yukio Katsukawa (JP), Jiong Qiu (US), Jeffrey Reep (US)</td><td>US</td></tr>
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<tr><td></td><td colspan="3">Abstract

A key signature demonstrating the existence of magnetic reconnection is an intense electric field. The spectro-polarimeters of the DKIST, in principle, allow us to do the first measurement of an electric field associated with chromospheric reconnection, which drives chromospheric jets, provided plasmoids or turbulence enlarge the spatial scale of the magnetic diffusion region, which has been suggested in models. We request observing time to obtain Stokes profiles of chromospheric jets in Ca ll lines and H l 397 nm using ViSP while also obtaining context images using VBI-Blue. The H l line is near the Ca ll H line and within the same spectral window of the ViSP. At first, we will derive anti-parallel magnetic fields associated with magnetic reconnection at the root of the jets using the Stokes profiles of the Ca ll lines. Based on the magnetic configuration, we will interpret the H l Stokes profiles with the Zeeman effect, the Hanle effect, the Stark effect and electric Hanle effect (Casini 2005) and measure the reconnection electric field.</td></tr>
<tr><td rowspan="2">51</td><td>Electric field associated with ambipolar diffusion in prominences</td><td>Tetsu Anan

Co-Is

Kiyoshi Ichimoto (JP), Sanjiv Tiwari (US), Hiroaki Isobe (JP), Thomas Schad (US), Sarah Jaeggli (US), Ayumi Asai (JP), Maria Kazachenko (US), Kevin Reardon (US), Yukio Katsukawa (JP), Jiong Qiu (US), Jeffrey Reep (US)</td><td>US</td></tr>
<tr><td colspan="3">Abstract

Solar prominences are made of partially ionized plasma. It has been suggested that prominence plasma is supported against gravity by the Lorentz force, and neutral atoms are supported by the frictional force between them and the ions. Relative flow causing the frictional force corresponds to a diffusion of the magnetic field from the neutral atoms, which is called ambipolar (Pederson) diffusion. Khomenko et al. (2016) detected the relative flow velocity in a prominence, as shown by the difference in Doppler velocities of spectral lines in the range of +/- 11 km/sec. On the other hand, Anan et al. (2017) claimed the difference of Doppler velocities as being a result of the motions of different components in the prominence along the line of sight, rather than ambipolar diffusion. In order to interpret the relative flow velocity, we request observing time to obtain Stokes profiles of solar prominences off the solar limb in H I 397 nm, Ca II H and Ca II 854 nm, with the Visible Spectro-Polarimeter (ViSP). The H I line is near the Ca II H line and within the same spectral window of the ViSP. Based on the magnetic configuration derived from the Stokes profiles of the Ca II lines, we will interpret the H I Stokes profiles with the Zeeman effect, the Hanle effect, the Stark effect and the electric Hanle effect (Casini 2005) in order to measure the electric field associated with the ambipolar diffusion.</td></tr>
<tr><td>52</td><td>Configuration of magnetic fields and plasma evolution in multiple heights of the lower solar atmosphere along the polarity inversion line.</td><td>Eleni Nikou

Co-Is

Suman Dhakal (US), Jie Zhang (US)</td><td>US</td></tr>
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<table>
<tr><td rowspan="1"></td><td colspan="3">Abstract

This proposal is aimed to obtain advanced DKIST data to investigate the magnetic structure and plasma flows along and surrounding the PIL of an active region. PILs are special locations where non-potential magnetic energy is accumulated and eruptive magnetic structures are formed. However, it remains a mystery how such an energetic state is achieved. It has been proposed that it may be formed through flux cancellation due to shearing and converging motions in the photosphere, or mainly through the emergence of helical flux tubes already residing in the sub-photosphere. This proposal seeks to diagnose the vector magnetic field in multiple heights that covers the photosphere, chromosphere and upper chromosphere, in order to discern different models on the formation of energetic structures in active regions. The proposal requires the observation of an active region that is located close to the disk center within E30 to W30 and follow it for entire day hours for two consecutive days using ViSP, Cryo-NIRSP and VBI. The unprecedented spatial resolution of ~0.1 arcsec and multiple-height spectropolarimetry in FeI (630.2 nm), CaII (854.2 nm) and HeI (1083 nm) will provide unique data to address the issue of magnetic field structure along PILs. Further, this proposal and the analysis of the obtained data is a critical part of the dissertation of the PI which focuses on the study and understanding of the origin and evolution of solar eruptions. The DKIST data will play a major role in this study, through addressing the initial conditions of source regions.</td></tr>
<tr><td rowspan="2">53</td><td>The Fine Structure and Connectivity of Flows and Magnetic Fields in Sunspots: From Deep to High and Inwards to Outwards</td><td>Alexandra Tritschler

Co-Is

Thomas Schad (US), Kevin Reardon (US), Friedrich Woeger (US), Meetu Verma (DE)</td><td>US</td></tr>
<tr><td colspan="3">Abstract

We propose to study the fine-structure and connectivity of photospheric and chromospheric flows and magnetic fields in (and around) a sunspot. The emphasis of this investigation is on the photospheric and chromospheric (inverse) Evershed effect and its relationship to the sunspots magnetic field structure. The photospheric Evershed flow and its inverse counterpart are the most conspicuous and vigorous flow pattern observed in and above sunspot penumbrae but the (magnetized) structures hosting the flows remain spatially unresolved in contemporary observations. The DKIST will allow us to obtain spectropolarimetric and imaging observations of unprecedented resolution and sensitivity. Those observations are expected to resolve the penumbral and super-penumbral fine structure in intensity and polarization to the extent necessary for significantly advancing our understanding of the structures harboring the flows. We will apply standard spectroscopic and spectropolarimetric data analysis techniques to establish relationships between different physical parameters and the spatial scales they are detected on. This will be complemented by the use of inversion techniques to deduce the magnetic field and its geometry. Finally we intend to compare our (photospheric) results with three dimensional radiative MHD simulations of a sunspot.</td></tr>
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<table>
<tr><td rowspan="2">59</td><td>The Cold Sunspot Atmosphere</td><td>Alexandra Tritschler

Co-Is

Andre Fehlmann (US), Han Uitenbroek (US), Thomas Schad (US), Sarah Jaeggli (US), Svetlana Berdyugina (DE)</td><td>US</td></tr>
<tr><td colspan="3">Abstract

We propose to investigate the large-and fine-scale thermal and magnetic (and dynamic) structure of a sunspots umbra and penumbra. For our study we request a unique and pioneering set of observations combining spectroscopy in the CO fundamental band with spectropolarimetry in the He I 1083 nm diagnostic obtained both with the DKIST's CryNIRSP. Main objectives of this investigation will address (among others) and focus on the spatio-temporal characteristics of penumbral flows as detected in different lines of the CO band and their relationship to the magnetic field, and the umbral structure within the layers where the CO lines form. We will apply standard spectroscopic and spectropolarimetric techniques (including inversion techniques) to analyze this rich data set. As existing observations in the CO fundamental band are limited in resolution and rare (specifically sunspot observations) to begin with, we expect that the significant leap in spatial and temporal resolution of these first observations will allow for a lot of discoveries to be made.</td></tr>
<tr><td rowspan="2">60</td><td>Zooming in on Kilogauss Magnetic Elements in the Solar Polar Region</td><td>Xudong Sun

Co-Is

Ivan Milic (US), Sarah Jaeggli (US), Bryan Yamashiro (US)</td><td>US</td></tr>
<tr><td colspan="3">Abstract

The magnetic fields in the solar polar field region root in photospheric flux elements a few arcseconds across with an intrinsic field strength in the kilogauss range. Their exact nature remains unclear due to the limited spatial resolution and polarimetry sensitivity of the existing facilities. We propose to obtain high-resolution observations (~0.1”) of these magnetic elements in the polar coronal hole using DKIST/ViSP with the Fe I 630.2 nm, Ca II 854.2 nm, and the Ca II H lines. We aim to address the following questions: (1) what is the nature of the fine-scale field vectors inside the elements? (2) how much magnetic flux do they provide? (3) How much do the flux tubes expand in the lower chromosphere? These observations will help correct several systematic biases in the magnetic field inference process, allowing for a better understanding of the polar fields.</td></tr>
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62	Magnetic Setting and Twisting of Sunspot Penumbral Jets	Sanjiv Tiwari Co-Is Navdeep K. Panesar (US), Bart De Pontieu (US), Alexandra Tritschler (US), Yukio Katsukawa (JP), Tetsu Anan (US), Alphonse Sterling (US), Luc Rouppe van der Voort (NO), Ronald Moore (US), Nour E. Raouafi (US)	US
	Abstract Sunspot penumbral jets are dynamic small scale events, seen in the chromosphere. Penumbral jets are ubiquitous. Their formation mechanism is not fully understood. PJs were proposed to form from component (acute angle) reconnection of the magnetic field in spines with that in interspines and were proposed to contribute to transition-region and coronal heating above sunspots. In a recent investigation, it is proposed that penumbral jets form as a result of reconnection between the opposite polarity field at edges of filaments with spine field, and it is found that most of these jets do not significantly directly heat the corona above sunspots, but could indirectly drive coronal heating via generation of MHD waves or braiding of the magnetic field. However, there exist larger jets, repeatedly forming at tails of penumbral filaments, which directly display their signature in coronal wavelengths. Some of the larger penumbral jets are also found to show twisting motion. By using DKIST unprecedented resolution data we propose to investigate the formation mechanism of penumbral jets, and twisting in them.		
67	The Structure of small-scale Magnetic Elements from Photosphere to Chromosphere	Han Uitenbroek Co-Is Brian Harker (US), David Orozco (ES), Ricardo Gafeira (PT), Alexandra Tritschler (US), Basilio Ruiz (ES), Carlos Quintero (ES), Serena Criscuoli (US), Gianna Cauzzi (US)	US
	Abstract We propose to determine the physical structure of small scale magnetic elements in the solar atmosphere at heights ranging from the photosphere to the chromosphere by employing multi-line spectropolarimetry combined with non-LTE spectral inversion techniques. By designing our experiment to obtain strictly simultaneous spectra CaII H and 854.2 nm and FeI 630 with the three arms of the ViSP and in the blue continuum with VBI we optimize the retrieval of physical parameters. Observed spectra will be compared with forward modeling from state-of-the-art simulations that include chromospheric physics and retrieved physical quantities will be compared to those in the simulation, to judge the realism of the modeling. Our requested spatial resolution undersamples the DKIST theroretical PSF to strike an optimal balance between polarimetric sensitivity and spatial resolution.		

<table>
<tr><td rowspan="2">69</td><td>Using Infrared Extreme Limb Spectrpolarimetry with DKIST and CryoNIRSP to Understand the Photospheric Shear Layer</td><td>Jeffrey Kuhn

Co-Is

Thomas Schad (US), Andre Fehlmann (US), Gabriel Dima (US), Ian Cunnyngham (US), Isabelle Scholl (?)</td><td>US</td></tr>
<tr><td colspan="3">Abstract

The photospheric rotation rates measured by Doppler and magnetic tracers are not consistent (ref. 1,2). This has been attributed to an otherwise unobserved photospheric radial rotation gradient with an “effective” anchor-depth for magnetic rotation tracers (like sunspots) that is below the photosphere, so they appear to rotate faster. Such a photospheric rotation gradient has not been directly seen in Fraunhofer Doppler measurements. Further
more the decreasing rotation rate at all latitudes in the outer 5% of the Sun, inferred from p-mode oscillations, is not explained by global solar convection models (ref. 3) and, in any case, does not account for the presumed photospheric rotation gradient evident from sunspot tracers and plasma Doppler data. Measuring and confirming the outer photospheric gradient and the Poynting-Robertson effect (ref. 4) in the photosphere will help solve each of these puzzles.</td></tr>
<tr><td rowspan="2">70</td><td>Exploring the diagnostic potential of high-cadence narrowband flare imaging</td><td>Graham Kerr

Co-Is

Jiong Qiu (US), Paulo Simoes (BR), John Armstrong (UK), Lyndsay Fletcher (UK), Hugh Hudson (US)</td><td>US</td></tr>
<tr><td colspan="3">Abstract

VBI Imaging observations of a solar flare at high cadence, in strong hydrogen lines and in the red and blue continuum, will be used to derive detailed values for the magnetic reconnection rate and its relationship to the brightenings in flare ribbons that reveal flare energy deposition. Chromospheric properties, including constraints on flare energy input models, will be obtained by comparing observed intensities and their ratios with numerical modeling. We will also attempt to discover a continuum “black-light flare”.</td></tr>
<tr><td>72</td><td>Spatio-temporal evolution of magnetic reconnection in partially ionized plasma</td><td>Ayumi Asai

Co-Is

Kiyoshi Ichimoto (JP), Tetsu Anan (US), Hiroaki Isobe (JP), Yukio Katsukawa (JP), Friedrich Woeger (US)</td><td>JP</td></tr>
</table>

	Abstract The lower atmosphere of the sun, the photosphere and chromosphere, is partially ionized. The physics related to partial ionization (Hall and ambipolar effects for the photosphere and the chromosphere, respectively) becomes important only in the small scales (<~10 km) where different behaviors of neutral and plasma fluids become significant. These scales can only be resolved by the extremely high spatial resolution with the large aperture of DKIST. For events of such small scales, the dynamical time scale is also small, 0.1-1 second. Exhaustive use of the DKIST's capability may provide a unique opportunity to explore the spatio-temporal structure and variability of magnetic reconnection down to the scale where non-ideal MHD effects come into play. We propose to observe plage regions and detect small scale jets occurring in the lower atmosphere, such as chromospheric anemone jets, Ellerman bombs and spicules with extremely high spatial and high temporal resolutions.		
75	The Connection between Filaments and the Photospheric Magnetic Field	Shuo Wang Co-Is Thomas Schad (US), R.T. James McAteer (US), Jason Jackiewicz (US), Ivan Milic (US), Valentin Martinez Pillet (US)	US
	Abstract Filaments are dense plasma structures, suspended above photospheric magnetic polarity inversion lines, and their threads are along magnetic field lines. Their connection with the photospheric magnetic field is still unclear. Taking advantage of the DKIST's unprecedented high sensitivity polarimetry and spatial resolution, we propose to observe part of a filament, including filament barbs to address the connection question. We will use the ViSP to infer the photospheric magnetic field vector below filament barbs, and use the VBI to study the motions and oscillations of filament fine structures. We use the synoptic filament observing program of the DST to make observations of the same filament. Coordination on the DKIST side is not required, and notification of target position immediately after the DKIST observation or earlier is preferred. Combined DKIST and DST observations provide us opportunities to investigate filaments over time-scales comparable to their lifetimes.		
76	Poynting Flux and Velocity Inversions in the Photosphere and Chromosphere of the Quiet Sun	Dennis Tilipman Co-Is Benoit Tremblay (US), Maria Kazachenko (US), Ivan Milic (US), Valentin Martinez Pillet (US), Sanja Danilovic (SE)	US

<table>
<tr><td></td><td colspan="3">Abstract

How much magnetic energy that heats the Sun's outer atmosphere is transported across the photosphere and processed through the chromosphere? In principle, the rate of transport of magnetic energy, the Poynting flux, can be estimated as a cross-product of vector magnetic and electric fields. Limited studies quantified Poynting flux in active regions using the PDFI method and HMI/SDO data (Kazachenko et al. 2014). The PDFI method relies on Faraday's law and spectropolarimetric inversions of high-cadence vector magnetic fields to estimate the electric fields. The properties of the energy fluxes in the quiet Sun (QS) have not yet been characterized due to the paucity of high signal-to-noise observations with high spatial and temporal resolutions. To that end, we propose to use ViSP to invert QS magnetograms that will allow us to obtain Poynting fluxes in the photosphere using PDFI. ViSP presents an opportunity for drastic improvements: previous Hinode vector magnetic field observations have insufficiently high cadence to allow us to use the PDFI method, whereas IMaX QS maps do not have the spatial resolution we hope to achieve with ViSP. To complement ViSP magnetograms, we propose to use VBI intensity maps in the photosphere and the chromosphere to 1) correlate energy fluxes with optical features, and 2) derive optical flows using FLCT and DeepVelU methods and compare these with physics-based PDFI quantities. We also plan to test several B-field disambiguation methods in the QS regime. This study will improve our understanding of energy transport in the QS in quantitative terms.</td></tr>
<tr><td rowspan="2">77</td><td>Mapping the Cool Alter-Ego of the Hot Solar Corona</td><td>Patrick Antolin

Co-Is

Thomas Schad (US), Ramon Oliver (ES), Joten Okamoto (JP), Seray Sahin (UK), Cooper Downs (US), S.-P. Moschou (US), Jeffrey Reep (US)</td><td>UK</td></tr>
<tr><td colspan="3">Abstract

The solar corona is shaped and mysteriously heated to millions of degrees by the Sun's magnetic field. The elusive coronal heating mechanism(s) do not only dictate how the corona gets heated but also how it cools. An increasing number of numerical results indicate a narrow correspondence between the heating and the cooling properties, suggesting an alternative and powerful way at investigating the coronal heating problem. Coronal rain is the main observable characteristic of thermal instability in the solar corona and as such is the most pronounced evidence for coronal cooling. A growing amount of observational evidence suggests that this phenomenon is ubiquitous, recursive and even highly periodic in the solar corona, and particularly in active regions. Such reports suggest that a large but yet uncertain number of coronal structures are in a state of thermal non-equilibrium and are therefore bound to specific spatiotemporal properties of the heating. We hereby propose a Cryo-NIRSP program tailored at capturing the amount of coronal rain over an active region, thereby elucidating the coronal volume in thermal non-equilibrium and providing a major constraint for coronal heating mechanisms.</td></tr>
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78	Exploring spectral signatures of Ellerman bombs in the H-epsilon and Ca II H lines	Jayant Joshi Co-Is Luc Rouppe van der Voort (NO), Viggo Hansteen (US), Bart De Pontieu (US)	NO
	Abstract For most dynamic and transient events in the solar atmosphere, magnetic reconnection is the fundamental physical mechanism. Ellerman bombs are a small-scale magnetic reconnection phenomenon observed in the lower solar atmosphere. Ellerman bombs appear both in the magnetically active solar regions as well as in quiet Sun. Recent observations suggest that Ellerman bombs are ubiquitous and nearly uniformly distributed throughout the solar surface; at a given time, as many as half a million Ellerman bombs could be present on the solar surface. In the second half of the last decade, remarkable advances have been made in our understanding of Ellerman bombs thanks to the high-resolution observational facilities and state-of-the-art MHD simulations. However, there are several fundamental questions remain to be answered regarding the origin, formation, and magnetic field topology of Ellerman bombs. Given the ubiquitous nature, It will be of great interest to study the origin of quiet Sun Ellerman bombs and explore their role in chromospheric and coronal heating. With high spatial and spectral resolution observations with unprecedented polarimetric accuracy, 4m DKIST telescope will be instrumental in advancing our understanding of this smallest scale magnetic reconnection phenomenon in the lower solar atmosphere.		
79	Properties of internetwork magnetic fields at 1 ^-4 sensitivity	Luis Bellot Rubio Co-Is David Orozco (ES), Valentin Martinez Pillet (US), Roberto Casini (US), Karin Muglach (US), Thomas Schad (US), Azaymi Siu (ES)	ES
	Abstract The main goal of this proposal is to determine the properties of quiet Sun internetwork magnetic fields in the photosphere and the chromosphere by means of Zeeman-sensitive lines. We will take advantage of the unprecedented photon collecting power of DKIST to measure the elusive linear polarization signals produced by the weak internetwork fields at high polarimetric sensitivity (~10^-4), high spatial resolution (~75 km) and high cadence (~10 s). These data will be used to: 1. Determine the three components of the vector magnetic field in the internetwork, by inverting the four Stokes profiles of several spectral lines simultaneously. 2. Determine whether or not internetwork fields are "turbulent", as usually assumed to explain spatially and temporally unresolved Hanle measurements. 3. Determine the total flux content of the quiet-Sun internetwork, both in the photosphere and in the chromosphere. 4. Determine the 3D topology of internetwork fields: are they low-lying structures, or do they reach the chromosphere? 5. Study the short-term evolution of internetwork fields, to shed light on their origin.		

<table>
<tr><td rowspan="2">80</td><td>Unveiling origin of spectral line broadening in the solar photosphere with DKIST</td><td>Yukio Katsukawa

Co-Is

Alfred de Wijn (US), Marc DeRosa (US), Mark Rast (US), Takayoshi Oba (JP), Carlos Quintero (ES), Tino L. Riethmueller (DE), Ryohtaroh Ishikawa(JP)</td><td>JP</td></tr>
<tr><td colspan="3">Abstract

Small-scale flows driven by turbulent convection are critical in creating fine magnetic structures through a local dynamo mechanism as well as in generation and injection of Poynting flux into the upper atmosphere. It is expected that turbulent cascade creates significant power in the flow fields smaller than 100 km. The unprecedented spatial resolution achieved with DKIST allows us to examine velocity and magnetic fields at that spatial scales for the first time. It is also possible that there are significant contributions of unresolved flows, such as micro-turbulence and LOS velocity gradients, even with the DKIST resolution. The most powerful approach to diagnose micro-turbulence and the LOS velocity gradient is to use spectral line profiles, especially line broadening and asymmetry, which contain information on the flow fields smaller than the spatial resolution. Using the Hinode spectro-polarimeter, we found that small-scale enhancements of line broadening often happened in a fading phase of granules (Ishikawa et al. 2020) although it has not been clarified yet why the line broadening is enhanced. Thus, the primary objective of the proposed observation is to reveal the origin of the spectral line broadening by investigating small-scale flow fields and their association with magnetic fields. To achieve this, we will obtain spectro-polarimetric profiles of the Fe I 630 nm and Ca II 854 nm lines with ViSP to get micro-turbulence, LOS velocity gradients, and magnetic fields in the photosphere and the chromosphere together with horizontal velocities inferred from a time series of blue-continuum images taken with VBI-B.</td></tr>
<tr><td>81</td><td>Properties and variations of quiet Sun internetwork fields throughout the solar atmosphere</td><td>Milan Gosic

Co-Is

Bart De Pontieu (US), Juan Martinez-Sykora (US), Alberto Sainz Dalda (US)</td><td>US</td></tr>
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	Abstract With this observational proposal we aim to determine the properties of the quiet Sun (QS) internetwork (IN) fields and their morphology as they transit from the photosphere to chromosphere. Recent observations show that these weak, small-scale fields continuously emerge, and per day, bring more magnetic flux to the solar surface than active regions. This promotes IN fields as the main driver of the QS magnetism. It is believed that IN fields may completely cover the QS photosphere, harboring a significant amount of magnetic energy. They are expected to have a crucial role in transferring this energy through the solar atmosphere. Because all of this, it is important to address the following questions: 1) What is the magnetic flux budget in the IN? 2) How the vector magnetic fields vary with height? 3) How are the photospheric and chromospheric magnetic fields connected inside IN regions and what is their role in the energy transport? We propose to address these questions using DKIST observations that will be compared with the latest Bifrost QS models with ~5 km spatial resolution. To achieve these goals, we need spectropolarimetric DKIST maps taken at high cadence of about 20 s, reaching a sensitivity of ~10^-4. With such sensitivity, DKIST is expected to show measurable circular, and more importantly, linear polarization signals which will make it possible to accurately characterize IN fields and their impact on the chromospheric dynamics and energetics.		
82	Magnetic Structure and Motions of Prominences	Shuo Wang Co-Is Thomas Schad (US), R.T. James McAteer (US), Ivan Milic (US), Valentin Martinez Pillet (US)	US
	Abstract Studying fine structure, mass transfer, motions, and magnetic fields in solar prominences allows us to probe the still mysterious prominence formation process and magneto-hydrodynamic instabilities. Studying the evolution of the magnetic field and motion of prominences simultaneously was impossible before the DKIST. Now, Cryo-NIRSP is the only instrument that can observe the He I 1083.0 nm line with both spectrograph and context imager simultaneously. For the first time, we are able to study the relationship between the magnetic field and the motion of prominences simultaneously in the bright neutral helium line. We propose to obtain spectropolarimetric observations of the prominence in order to infer magnetic field configuration of the prominence in the plane of the sky. Furthermore, the analyzer of the context imager provides line integrated polarized measurements which will help us to investigate the evolution of the magnetic field with the cadence of seconds for the first time.		
84	The Origin of Extreme Broadening of the Hydrogen Emission Lines in Solar Flares	Adam Kowalski Co-Is Gianna Cauzzi (US), Alexandra Tritschler (US), Yuta Notsu (US), Isaiah Tristan (US)	US

	Abstract We propose to use high-cadence ViSP spectroscopy in the Ca II H region to investigate the relative broadening of hydrogen and calcium in bright solar flare kernels. High-cadence imaging with VBI will be used to identify the white-light kernels and to compare/contrast the evolution and structure of the kernels at an unprecedented spatial resolution. We will determine whether the narrow Ca II H and broad hydrogen epsilon lines occur at different locations and times within the flaring area. These high resolution spectra will provide much-needed constraints on the current modeling approach for stellar flares. We will compare model spectra calculated from a new semi-empirical flare modeling code to determine the electron charge density and optical depth in chromospheric condensations. Then, the ViSP spectra will be used to test the detailed time evolution of the pressure broadening of hydrogen predicted in RADYN/RH simulations of high-flux electron beam heating. The ViSP polarimetry of the continuum near Fe I will be used in a novel search for nonthermal synchrotron radiation from a population of ultra-relativistic electrons.		
85	Exploring the propagation and dissipation of high-frequency waves throughout the lower solar atmosphere	Momchil Molnar Co-Is Kevin Reardon (US), Steven Cranmer (US), Stephen Keil (US)	US
	Abstract The solar chromosphere is dominated by radiative losses, which are a few kW/m^2 larger than the sum of all of its heating sources. There are have been many proposed theoretical explanations for the origin of the heating, but none have satisfactory observational constraints. One of the most prominent candidates for chromospheric heating is the dissipation of high-frequency waves driven from the convective overshoot at the base of the photosphere. Recent work has provided evidence in both directions, as authors disagree if high-frequency waves could provide the required energy flux to sustain the quiescent chromosphere. We propose observational program with DKIST that could provide better observational limits to the high-frequency flux carried in the chromosphere. Furthermore, the polarimetric capabilities of DKIST could provide us with the first observational estimate of the role of the magnetic field in the propagation and dissipation of waves in the lower solar atmosphere.		
87	CryoNIRSP observations of faint diffuse HeI 1083 coronal emission	Gabriel Dima Co-Is Andre Fehlmann (US), Jeffrey Kuhn (US), Thomas Schad (US), Isabelle Scholl (?), Ian Cunnyngham (US)	US

<table>
<tr><td></td><td colspan="3">Abstract

The existence of a diffuse coronal component to neutral helium emission, discovered during eclipse observations, has shown promise for diagnosing the helium abundance of the inner corona and the coronal magnetic field. Yet, the nature and extent of this emission remains incompletely characterized. We propose to leverage the unique capabilities of DKIST and the Cryo-NIRSP to observe the He I 1083 nm triplet line to advance forward this direly needed characterization step for the diffuse coronal helium signal. Previous measurements have determined the signal to be quite faint (<1 x 10-6 Idisc), yet it exists from diffuse sources at elongations between 1 - 1.5 Rsun. Thanks to the larger, unobscured, off-axis design of DKIST, and the the significantly reduced scattered light if provides, DKIST is uniquely positioned to map out the faint triplet HeI 1083 nm emission in order to better understand the origin of this signal, and to develop it further as an essential tool that support multi-messenger and lower coronal science. The goal of this proposal is to obtain well calibrated spectropolarimetric observations of faint He I 1083 emission at multiple locations around the limb and to comparison these observations with predictions with two models of the emission source: desorption from an inner dust source or as an equilibrium population in the million degree corona.</td></tr>
<tr><td rowspan="2">89</td><td>High-Resolution Observations of the Sun's Polar Fields</td><td>Gordon Petrie

Co-Is

Valentin Martinez Pillet (US), Serena Criscuoli (US), Alexandra Tritschler (US), Xudong Sun (US), Sanjay Gosain (US)</td><td>US</td></tr>
<tr><td colspan="3">Abstract

The Sun's polar fields play a leading role in organizing the large-scale structure of the solar atmosphere and determining the interplanetary field strength. The open polar fields channel most of the fast solar wind. Furthermore, the polar fields are believed to provide the seed field for the subsequent activity cycle. However, existing observations for either the photosphere or chromosphere do not have sufficient spatial resolution or spectro-polarimetric sensitivity to resolve the dominant facular-scale magnetic vector fields all the way to the pole. The unprecedented spatial resolution and spectro-polarimetric sensitivity of the full-Stokes photospheric and low- and high-chromospheric observations from ViSP would provide a map of reliable, properly-resolved facular magnetic field measurements, including many smaller, weaker structures for the first time. This detailed picture of how the polar fields penetrate the photospheric surface and expand through the chromosphere would have multiple consequences for our understanding of global solar magnetism, interior and atmospheric. We propose to take optimally weekly observations in the Fe I line at 630.2 nm (photosphere) and the Ca II line at 854.2 nm (chromosphere) around times of favorable viewing angle, construct synoptic polar maps from the data, trace newly-detected polar field through the atmospheric layers, and explore the heliospheric consequences of the measurements using standard modeling techniques and in situ data from 1AU as well as Parker Solar Probe and Solar Orbiter. More exploratory, we would also search for polarization in Ca II H at 396.8 nm for signatures of the high-chromospheric field.</td></tr>
</table>

92	Coronal Temperature Diagnostics with DKIST	Mark Cheung Co-Is Kevin Reardon (US), Matthias Rempel (US), Kiyoshi Ichimoto (JP)	US
	Abstract We propose to take coronal observations with the DKIST Visible Broadband Imager (VBI) to constrain models of the thermodynamic structure of active region coronal loops. We will validate methods to derive temperature diagnostics from VBI observations by comparing with extreme UV observations from the Atmospheric Imaging Assembly (AIA) onboard the Solar Dynamics Observatory (SDO). The outcomes of this project will benefit other coronal investigations using DKIST.		
94	Unraveling the Physics of Reconnection Nanojets in the Solar Corona	Patrick Antolin Co-Is Paolo Pagano (UK), Bart De Pontieu (US), Paola Testa (US), Seray Sahin (UK)	UK
	Abstract The solar corona is shaped and mysteriously heated to millions of degrees by the Sun's magnetic field. It has long been hypothesised that the heating results from a myriad of tiny magnetic energy outbursts called nanoflares driven by the fundamental process of magnetic reconnection. Misaligned magnetic field lines can break and reconnect, producing nanoflares in avalanche-like processes. Recently a breakthrough has been achieved through the discovery of nanojets in the solar corona. This phenomenon corresponds to fast, bursty, very short lived, small-scale jet-like structure with an estimated energy within the nanoflare range. It was demonstrated that nanojets go hand-in-hand with nanoflares in the reconnection scenario and constitute the tell-tale signature to look for reconnection-based coronal heating in action. However, the bulk distribution of the nanojets could not be resolved and only hints of an MHD avalanche were detected. We hereby propose a DKIST observing program tailored at capturing the essential physics of nanojets and the progression of the MHD avalanche that leads to coronal heating.		
95	Formation and Magnetic Structure of On-disk Spicules	Akiko Tei Co-Is Joten Okamoto (JP)	JP

<table>
<tr><td></td><td colspan="3">Abstract

Spicules are fundamental chromospheric structures in the solar atmosphere. It is essential to reveal the formation mechanism and magnetic structure of spicules to understand mass and energy balance in the solar atmosphere. We will observe on-disk spicules in the quiet Sun around the disk center simultaneously with VBI (blue) and ViSP. In this observing proposal, the VBI observations will consist of high resolution imaging of the photosphere (G-band) and the chromosphere (Ca II K and H-beta) at ~10 s cadence, which let us to derive morphological characteristics and apparent velocity in the plane of the sky. The ViSP observations will provide spectropolarimetric diagnostics of the photosphere (Fe I 630.2nm with the Milne-Eddington approximation) and the chromosphere (Ca II 854.2 nm with the weak field approximation), which let us derive the line-of-sight velocity and vector magnetic field information. We will conduct two ViSP observing modes; one is a raster scan to cover a supergranular spatial scale range (~30Mm) in order to vidualize the overall conditions to have a spicule in the quiet Sun but with a lower cadence. The other is a sit-and-stare mode to focus on a fixed slit location with a highest temporal cadence (~10 s at best). Combining those two types of ViSP observations with VBI data, we will obtain spatial and temporal variation of vector velocity field and vector magnetic field in the two atmospheric heights. This will lead u to describe a detailed picture of the formation mechanism and magnetic structure of spicules.</td></tr>
<tr><td rowspan="2">97</td><td>Exploring the magnetic complexity of the chromospheric canopy</td><td>Ryan Hofmann

Co-Is

Ivan Milic (US), Kevin Reardon (US)</td><td>US</td></tr>
<tr><td colspan="3">Abstract

The structure and behavior of the magnetic canopy in the chromosphere is one of the great mysteries of the Sun. Previous works have indicated the existence of two components of the canopy: an inclined field that forms the fibrils observed in H-alpha, and a more vertical component that carries most of the flux from active regions into the corona. Confirmation of these two components and detailed analysis of their structure and behavior is only now becoming feasible, thanks to the unprecedented sensitivity and resolution of DKIST. To that end, we will observe the fibril arcade emanating from a plage at high spatial resolution, using ViSP to scan the fibrils and underlying supergranule in both the Fe I 6302 Angstroem line and the Ca II 8542 Angstroem line, with supplemental imaging from VBI blue in H-beta, Ca II K, and G-band filters. Using these observations, we will perform spectropolarimetric inversions to recover the vertical magnetic flux within the fibrils, from which the true nature of the magnetic canopy may be determined.</td></tr>
<tr><td>101</td><td>Spectropolarimetric diagnostics of off-limb spicules from inversions of the Ca II 8542 Angtroem line</td><td>David Kuridze

Co-Is

Kevin Reardon (US), Rebecca Centeno (US), Ramon Oliver (ES), Gianna Cauzzi (US), Matheus Kriginsky (ES), Hector Socas-Navarro (ES)</td><td>UK</td></tr>
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<table>
<tr><td></td><td colspan="3">Abstract

Spicules are one of the main constituents of the solar chromosphere. It is widely accepted that they are key to understand the dynamic and energetic balance of the lower solar atmosphere. A reliable quantitative measurement of the physical parameters in spicules is extremely challenging due to the scales of their dynamism which are very often close to the resolution limit of modern solar telescopes. Furthermore, modeling and interpretation of chromospheric spectral lines, in which spicules are emitting, are always challenging as it requires solving the complex non-LTE (i.e., departures from Local Thermodynamic Equilibrium) radiative transfer problem. We plan to study solar spicules using high-resolution full Stokes spectropolarimetric data in the Ca II 8542 Angstroem line that can be obtained with the ViSP instrument on the DKIST. Spectropolarimetric inversions using a new version of the non-LTE code NICOLE will be used to construct semiempirical models of the spicules. The models will be used to obtain height stratification of the temperature, mass density, magnetic field, velocity and optical thickness along the spicule. High-resolution imaging data with the VBI instrument will be used to identify spicule and determine mass flows (plane of sky velocities) along the structure.</td></tr>
<tr><td rowspan="2">102</td><td>Initial DKIST Investigations of the Cause of Spicules, Jetlets, and Coronal Jets</td><td>Alphonse Sterling

Co-Is

Navdeep K. Panesar (US), Sanjiv Tiwari (US), Kevin Reardon (US), Tanmoy Samanta (US), Karin Muglach (US), Qiang Hu (US), Vasyl Yurchyshyn (US), Wen He (US), Ronald Moore (US)</td><td>US</td></tr>
<tr><td colspan="3">Abstract

Jet-like features are common on the Sun and may play an important role in the energetics and mass motions in the upper atmosphere. We will study the formation mechanism of chromospheric spicules, and coronal jets and likely similar but smaller-scale jets (“jetlets”) using DKIST, with support from SDO, and optionally Hinode and IRIS if feasible. We will examine image sequences and photospheric magnetic field maps of regions likely to produce jets, to characterize the formation mechanism and rates of these features. Specifically we will examine the minifilament-eruption mechanism for coronal jets, whereby it is argued that small-scale filaments (of size ~1/3 of a supergranule) erupt in the chromosphere which subsequently produce the jets seen in higher energy diagnostics. The same data sets will include smaller-scale features, in particular spicules seen nearly ubiquitously around the magnetic network. We will examine whether the formation mechanism of these features is similar to (or the same as) that of coronal jets. Specifically we will investigate whether spicules might form via eruption of the so-far-unconfirmed “microfilaments”.</td></tr>
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The 2-letter country codes are taken from https://www.iban.com/country-codes following the ISO 3166 international standard.