IL NUOVO CIMENTO **42 C** (2019) 7
DOI 10.1393/ncc/i2019-19007-0

COLLOQUIA: SoHe3 2018

The Critical Science Plan for DKIST

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received 28 December 2018

Summary. — The 4-meter Daniel K. Inouye Solar Telescope is nearing completion on Haleakala, Maui, with first light expected in 2020. In preparation for early science, the National Solar Observatory is reaching out to the solar community in order to define the critical science goals for the first two years of DKIST operations. The overall aim of this "Critical Science Plan" is to be ready, by start of operations, to execute a set of observations that take full advantage of the DKIST capabilities to address critical compelling science.

1. – Introduction

The Daniel K. Inouye Solar Telescope (DKIST) is a 4-m solar telescope being built by the U.S. National Solar Observatory (NSO) on Haleakala (Maui, Hawai'i). Once completed, it will be the largest solar telescope in the world. Fig. 1 shows the telescope building, which is over 40 m tall and 20 m wide. The telescope is installed at about 23 m above the ground, while the instruments are located on a Coudè rotating platform, at about 10 m above the ground.

The DKIST has been designed with a number of innovative features. These include: *i)* a 4.24-meter primary mirror mounted in an off-axis Gregorian configuration, that provides a 4-meter clear, unobstructed aperture; *ii)* all reflective optics, enabling access to the whole spectrum from 350 nm to 28 μm; *iii)* a full characterization of the optical elements, to allow high precision polarimetry; *iv)* pointing capabilities of up to 1.5 $R_\odot$.

The 4-m aperture can achieve a nominal spatial resolution of 25 km at the surface of the Sun (in the blue), while the off-axis design ensures a low level of scattered light. This, together with the super-polished primary mirror, capabilities for its in-situ washing, the use of occulters and a site with excellent coronal sky, combines to allow routine coronal polarimetry, one of the main science goals of DKIST.

Fig. 1. – The DKI Solar Telescope on top of Haleakala, Maui, viewed from the North-East.

Five first light instruments are being built, by NSO and partners of the project. They include a high cadence broadband imager (VBI), a scanning spectro-polarimeter (ViSP), a spectro-polarimetric Integral Field Unit using fiber optics (DL-NIRSP), an imaging spectro-polarimeter based on Fabry-Perot interferometers, and a scanning spectro-polarimeter optimized for coronal observations in the infrared (Cryo-NIRSP). Most of the instruments can work together, providing a multi-wavelength, multi-diagnostics approach to the study of the solar atmosphere.

Recent descriptions of the telescope and its status can be found in [1] and [2]; up to date information is available at https://www.nso.edu/telescopes/dkist. First science light is foreseen for mid-2020.

2. – The Critical Science Plan

The DKIST has been designed to be a powerful and versatile facility that will serve the community for decades. Some unique science enabled by DKIST include the turbulent (surface) dynamo - requiring high cadence, high spatial resolution and precise measure of weak magnetic fields; the study of the darkest part of sunspot umbrae - greatly benefiting from the low levels of scattered light; the structure of chromospheric magnetic fields - requiring a large collecting area and high precision polarimetry; and coronal vector magnetometry, requiring very dark skies and low levels of scattered light in the telescope, as well as a large aperture.

To better define and organize the highest priority science to be performed during the first years of operation of the telescope, the solar community at large has been invited to participate in the so-called DKIST Critical Science Plan. The CSP overall aim is to be ready, during early operations, to execute a set of observations that take full advantage of the DKIST capabilities to address critical, compelling science. In the process, the CSP effort will also help refine data handling procedures and science operations.

The CSP is based on a comprehensive set of PI-led, Science Use Cases (SUCs), that clearly detail the scientific goals, the unique contribution that DKIST can provide, and the required DKIST configuration. To help the community in this effort, a variety of documentation on the telescope and its instruments, as well as software simulators for the instruments' performance, has been made available (see website below). Further, a series of nine thematic workshops has been organized in the 2017-18 time frame, both in the US and abroad, to inform and guide the community about this opportunity. Over 200 scientists and 40 students have taken part in the initiative.

The DKIST Science Working Group will formulate a final version of the Critical Science Plan in spring 2019. Any scientist interested in contributing to the CSP with novel science can still do so, by submitting a Science Use Case (SUCs) using the collaborative JIRA tools. Details are provided at the CSP website:
https://www.nso.edu/telescopes/dkist/csp.

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The National Solar Observatory is operated by the Association of Universities for Research in Astronomy under a cooperative agreement with the National Science Foundation.

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