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Dual channel imaging system in Hα and HeI 10830A using a universal tunable filter

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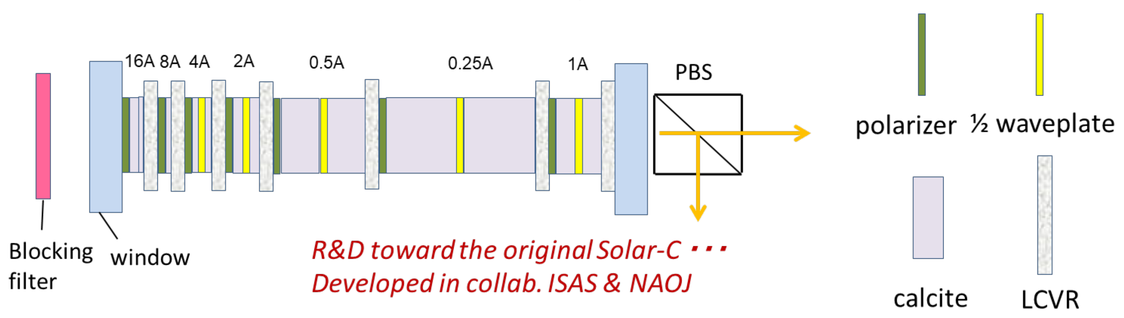
Abstract: A dual channel imaging system that enables near simultaneous spectroscopic observation in Hα and HeI 1083nm lines was constructed using a universal tunable filter at Hida observatory. The full widths at half maximum of the transmission in Hα and HeI 1083nm are 0.25A and 0.367A, while their fields of view are 248”x248” and 253"x203’ with spatial sampling of 0.121"/pix and 0.396"/pix, respectively. Time required for switching the wavelength is about 0.1 second. In this poster, we demonstrate the observing capability of the system by showing some examples of data taken by the Domeless Solar Telescope at Hida Observatory. We also discuss the advantage of combining these two lines in view of their responses to the physical condition obtained by a non-LTE calculations.

1. Introduction

Hydrogen Hα (6562A) and HeI IR triplet (10830A) are the most common spectral lines used for diagnosing the solar chromosphere. They have advantages and disadvantages; Hα is most sensitive to the density structures in chromosphere while modeling its formation is rather complex. On the other hand, HeI 10830A that forms higher in chromosphere is more simple in term of the radiative transfer and widely used for measuring the magnetic fields, while due to its shallowness, its application is limited to dens chromospheric structures. It is known that these lines show different responses in flares. We aim to investigate the scientific advantage in combining these lines in imaging spectroscopic observation.

2. Imaging system

2-1. Universal Tunable Filter; UTF-32

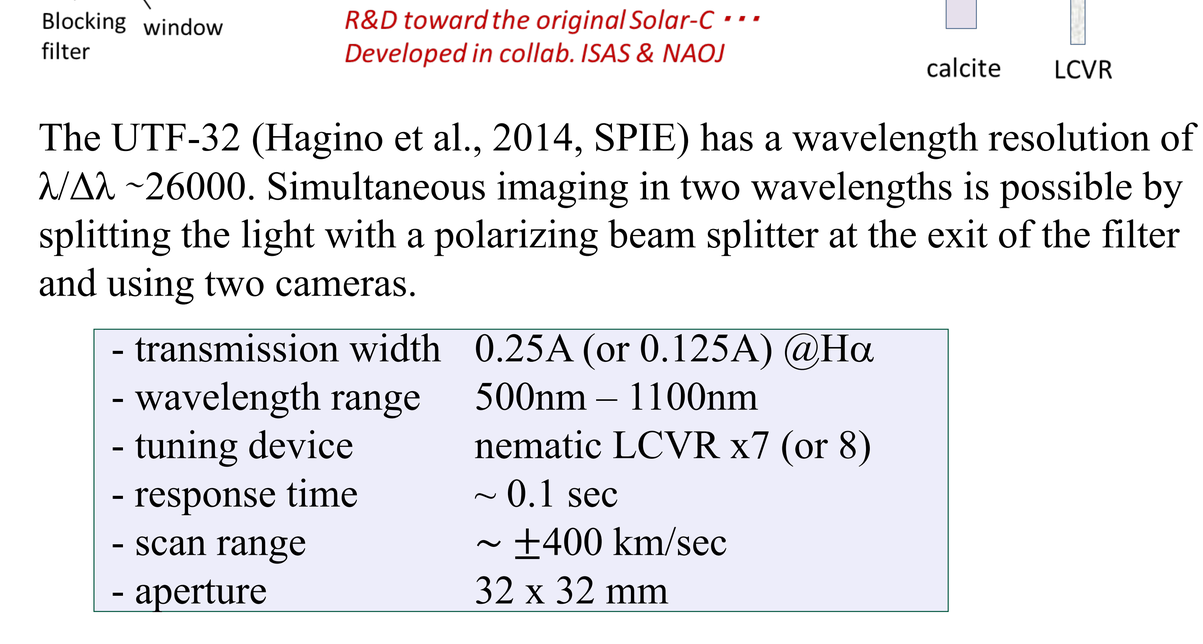


The UTF-32 (Hagino et al., 2014, SPIE) has a wavelength resolution of λ/Δλ ~26000. Simultaneous imaging in two wavelengths is possible by splitting the light with a polarizing beam splitter at the exit of the filter and using two cameras.

- transmission width	0.25A (or 0.125A) @Hα
- wavelength range	500nm – 1100nm
- tuning device	nematic LCVR x7 (or 8)
- response time	~ 0.1 sec
- scan range	~ ±400 km/sec
- aperture	32 x 32 mm

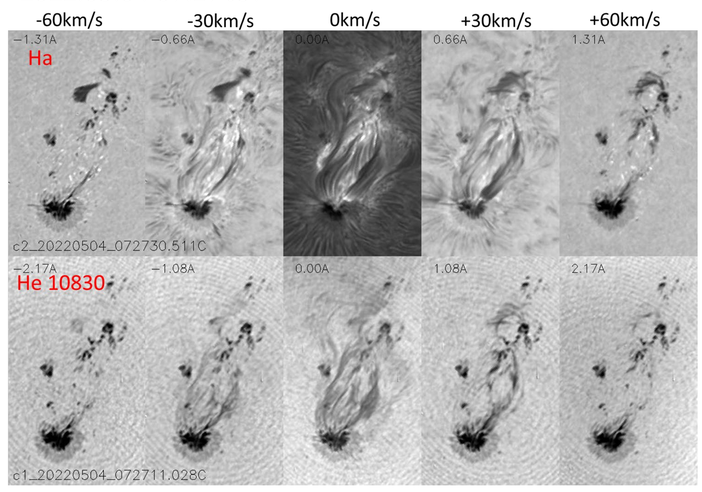
2-2. Dual beam system

System is installed on the Domeless Solar Telescope at Hida Observatory

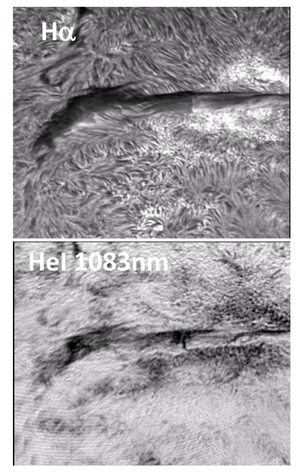


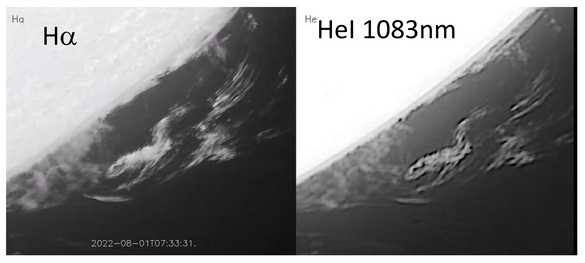
3. Data examples

Growing sunspots with arch filaments
2022.05.04 07:27 JST



Dark filament on 2022.05.29





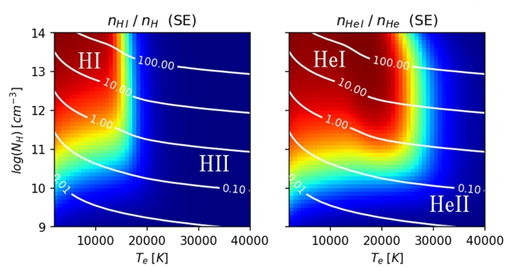
← Disrupting prominence on 022.08.01

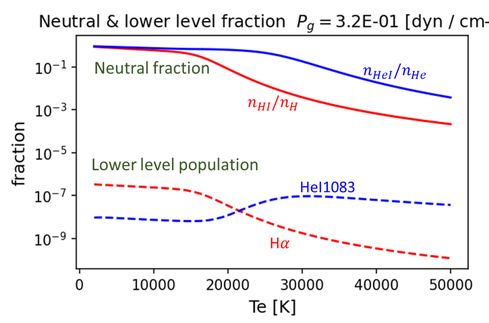
Though appearances in the two lines are different, we don’t see significant difference in the dynamic behaviors of these phenomena, so far.

4. Discussion and summary

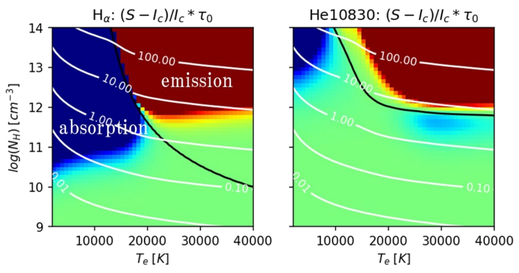
To understand the possible advantage of combining Hα and HeI 1083nm, we calculated responses of the two lines against electron temperature (T_e) and hydrogen density (N_H) using a non-LTE code (Huang and Ichimoto 2023, Tech.Rep.Astron.Obs.Kyoto U., 7-1).

Ionization vs. T_e and N_H w/ iso-pressure contours (dyn/cm^2)





Line intensity vs. T_e and N_H



HeI1083nm will continue to be detectable at high temperature compared to the Hα. It provides independent information on physical quantities and can be a better tracer of eruptions than Hα.

Conclusion: Observations of flares and high speed eruptions are highly expected.