Solar Coherence Instrument:
A conceptual optical system for solar studies

Tiago E. C. Magalhães[1,2], José M. Rebordão [1,2]

[1]Departamento de Física, Faculdade de Ciências, Universidade de Lisboa, Edifício C8, Campo Grande, PT1749-016 Lisboa, Portugal
[2]Instituto de Astrofísica e Ciências do Espaço, Edifício C8, Campo Grande, PT1749-016 Lisboa, Portugal

Overview

Goal

- Design of an instrument capable of measuring the **spatial coherence** of individual **solar granular cells**.

Why?

- Study the **impact of spatial coherence** in astronomical spectra.

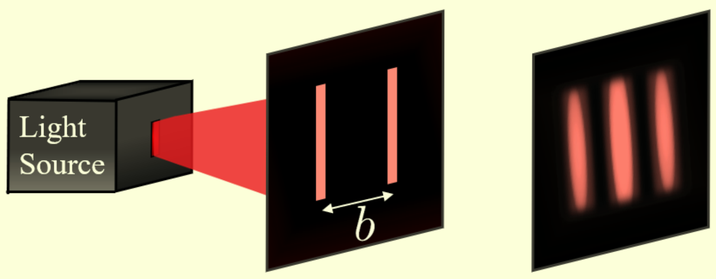
How?

- Use an already existing solar telescope as a baseline (*Hinode*).
- Use **Digital Micromirror Devices** to select light from one granule and perform **spatial coherence measurements**.

Introduction

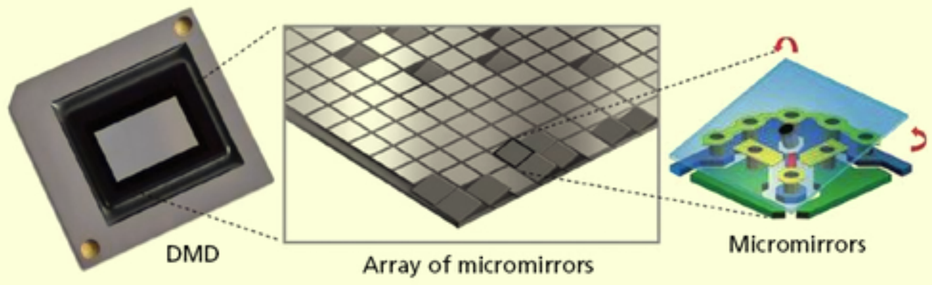
Spatial Coherence of Light

- Young's double-slit experiment measures the spatial coherence of light.



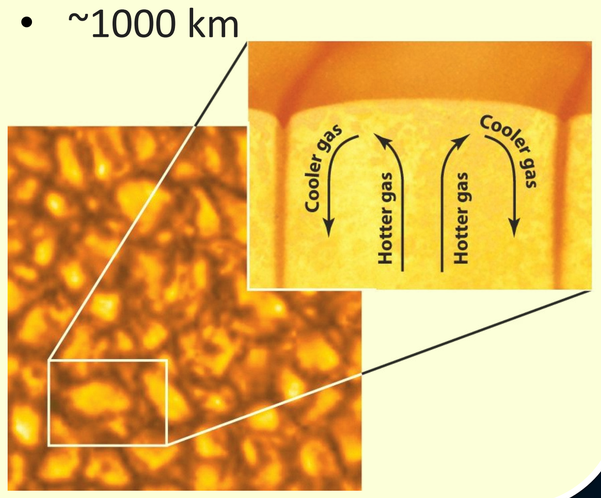
Digital Micromirror Device (DMD)

- Spatial Light Modulator
- 2 States: +12 and -12 degrees
- 5-14 micrometer size



Solar Granules

- ~1000 km



Optical Design

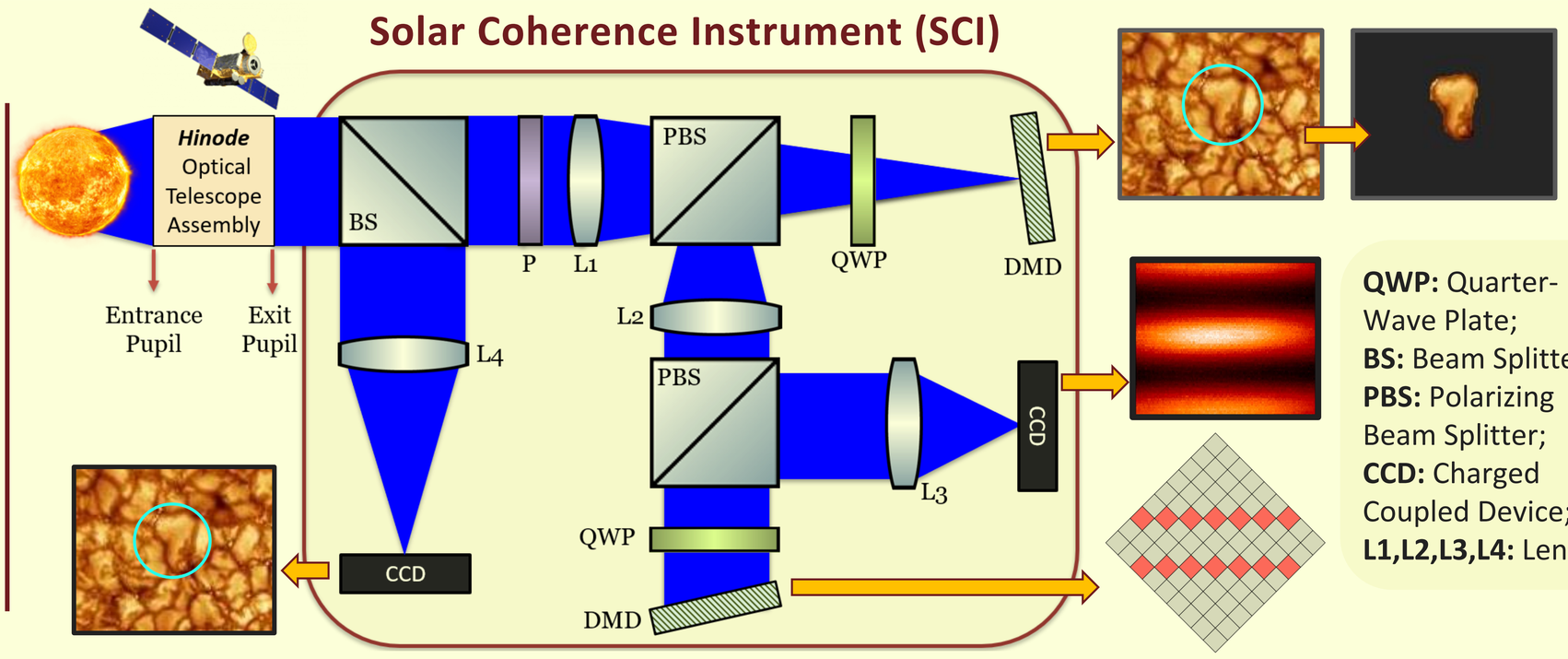
Proposed Instrument

- Space-based instrument (to avoid atmospheric contamination)
- Payload for *Hinode* Solar Optical Telescope
- Relies on polarization control to implement retroreflection
- Estimated signal-to-noise ratio: ~10^2

Three subsystems:

A. Imaging
B. Selective Imaging using 1 DMD
C. Spatial Coherence Measurements using 1 DMD

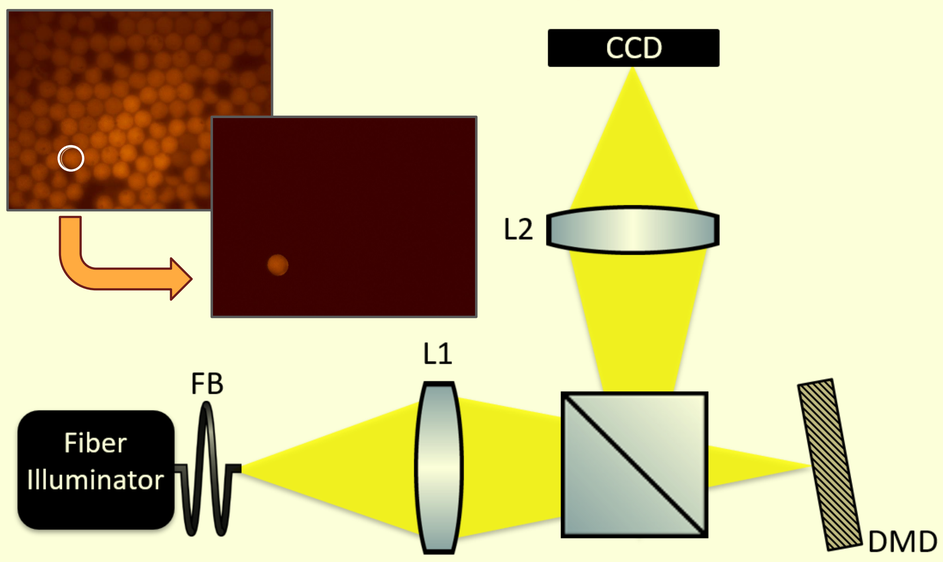
Solar Coherence Instrument (SCI)



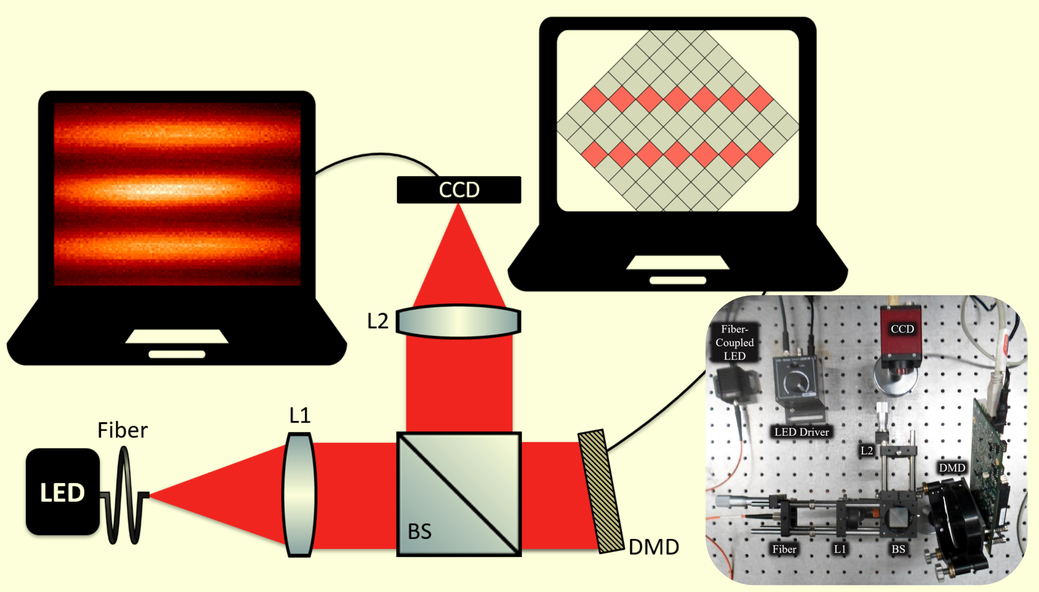
QWP: Quarter-Wave Plate;
BS: Beam Splitter;
PBS: Polarizing Beam Splitter;
CCD: Charged Coupled Device;
L1,L2,L3,L4: Lenses.

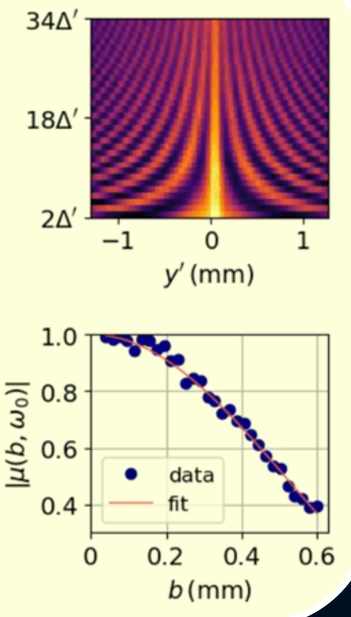
Experimental Validation

Selective Imaging



Coherence Measurements





Conclusions

- First-order design of a space-based instrument to measure spatial coherence of solar granular cells.
- Can be easily adapted to other solar telescopes.
- Successful validation of the subsystems.

Reference article:
[*Accepted Paper*] Tiago E. C. Magalhães, José M. Rebordão. "Spatial coherence mapping of structured sources: a flexible instrument for solar studies", Applied Optics, 2019.

Tiago E. C. Magalhães acknowledges support from Fundação para a Ciência e a Tecnologia through the grant (PD/BD/105952/2015), under the FCT PD Program PhD::SPACE (PD/00040/2012). This work was supported by FCT/MCTES through national funds (PIDDAC) by this grant UID/FIS/04434/2019.