

Filament Threads

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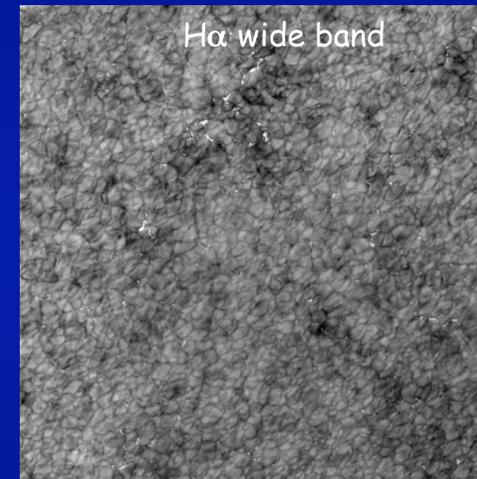
The Swedish 1-m Solar Telescope (SST)



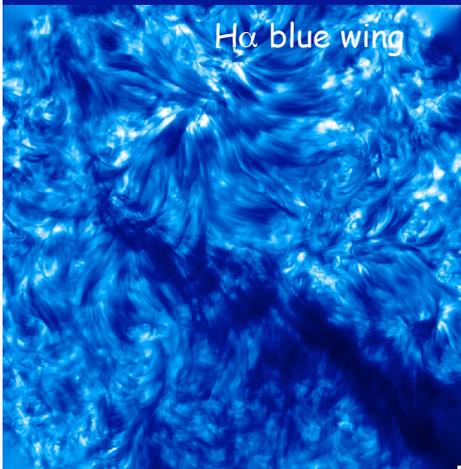
- Crisp Imaging SpectroPolarimeter (CRISP)
 - A dual Fabry-Pérot tunable filter system
- Post data reduction: MOMFBD

2008 June 15 Observations

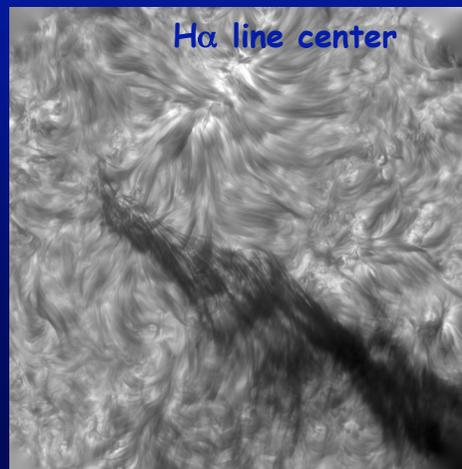
- FOV: 74 " x 74 "
- Pixel size: 0.072 "
- Cadence: 1.25 s (for 5 λ positions)



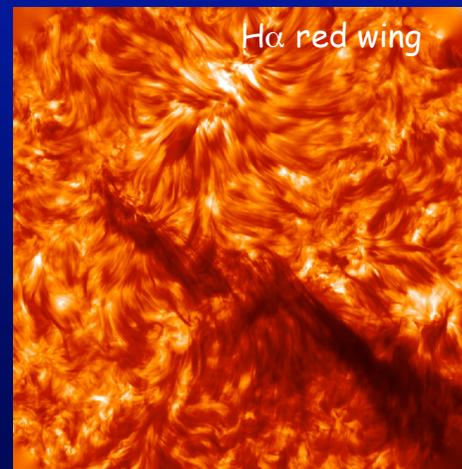
H α wide band



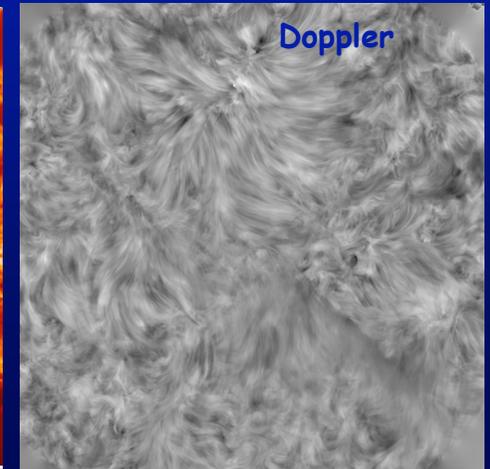
H α blue wing



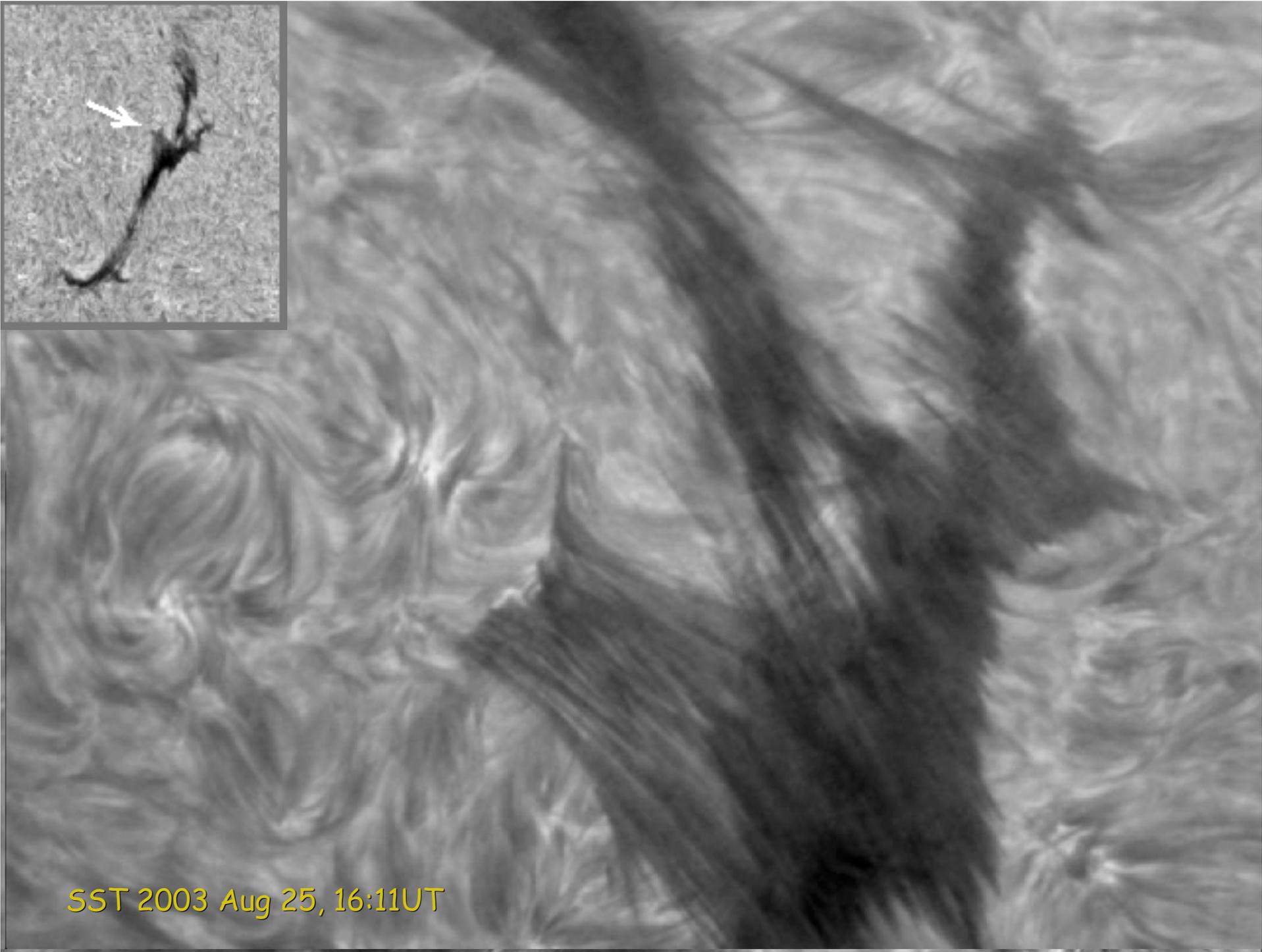
H α line center



H α red wing

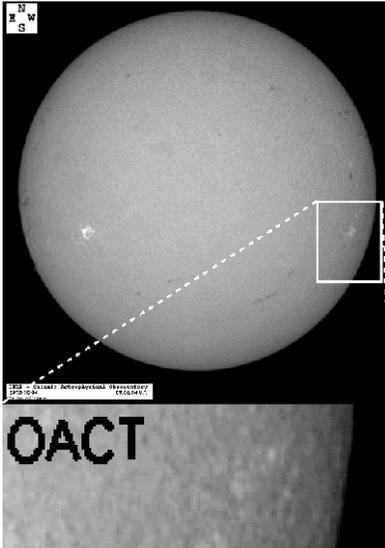


Doppler

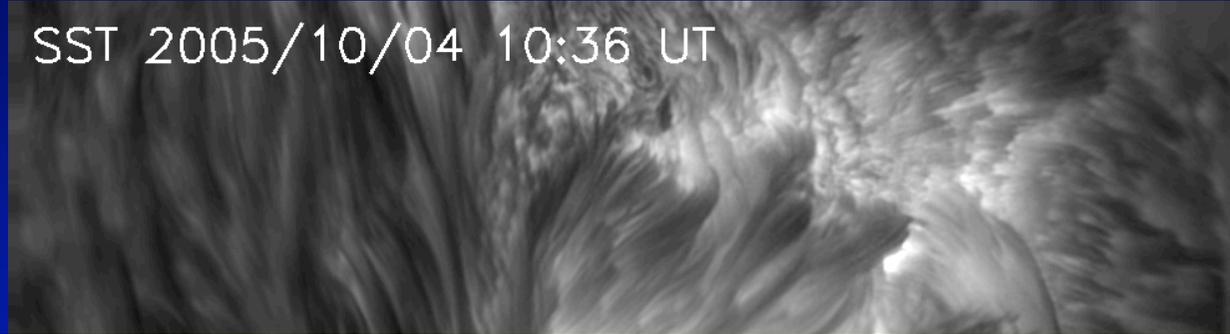


SST 2003 Aug 25, 16:11UT

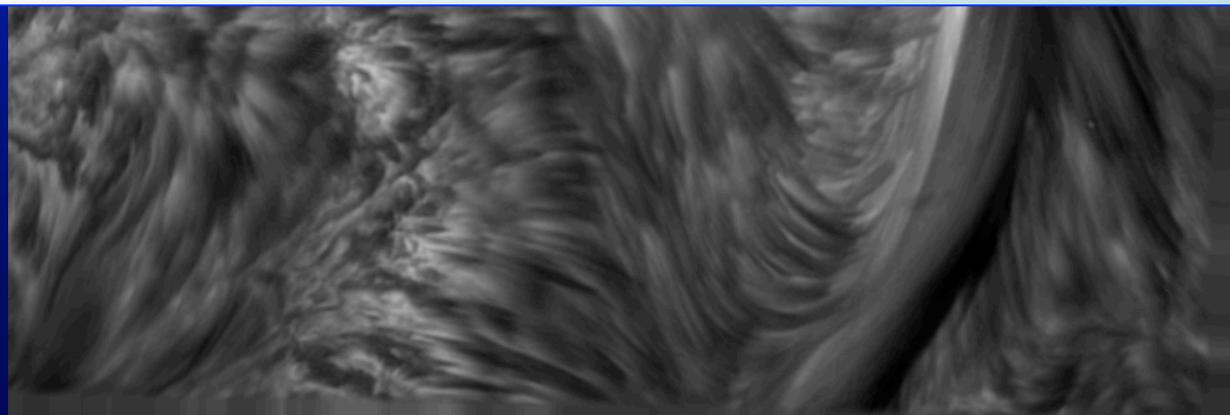
Active region filaments



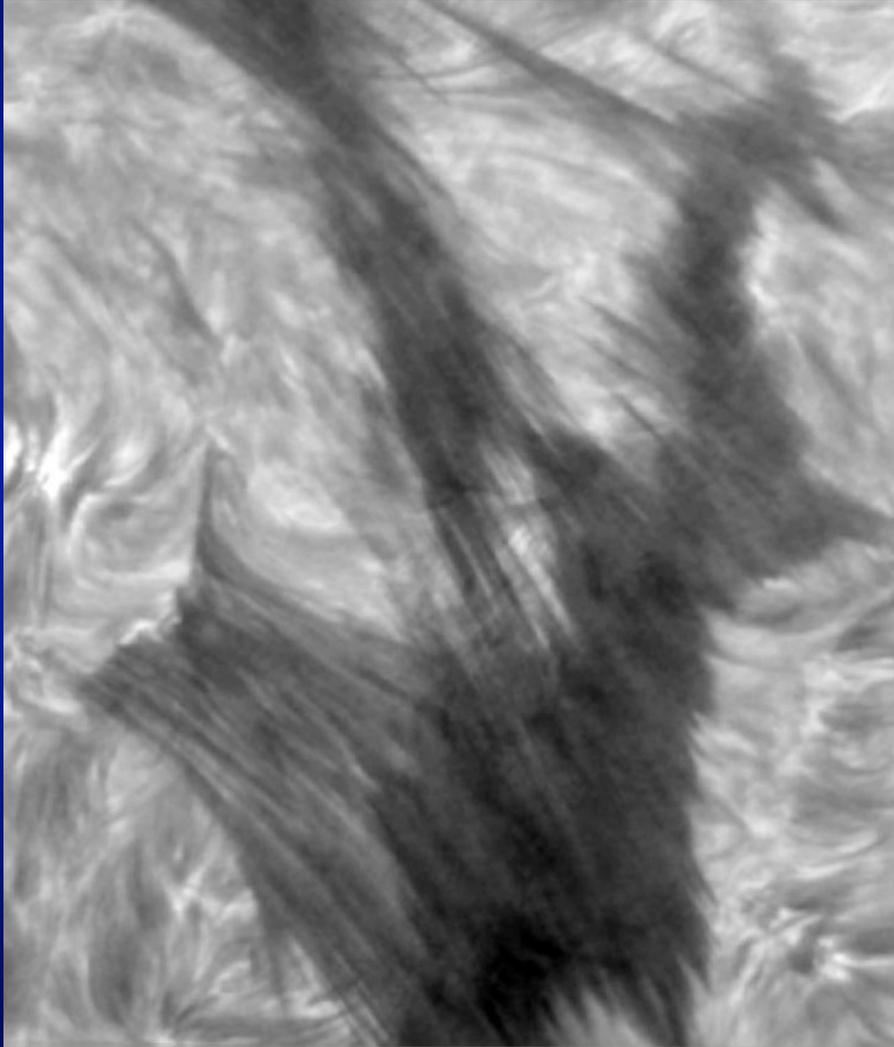
SST 2005/10/04 10:36 UT



**Threads are building blocks
of solar filaments**

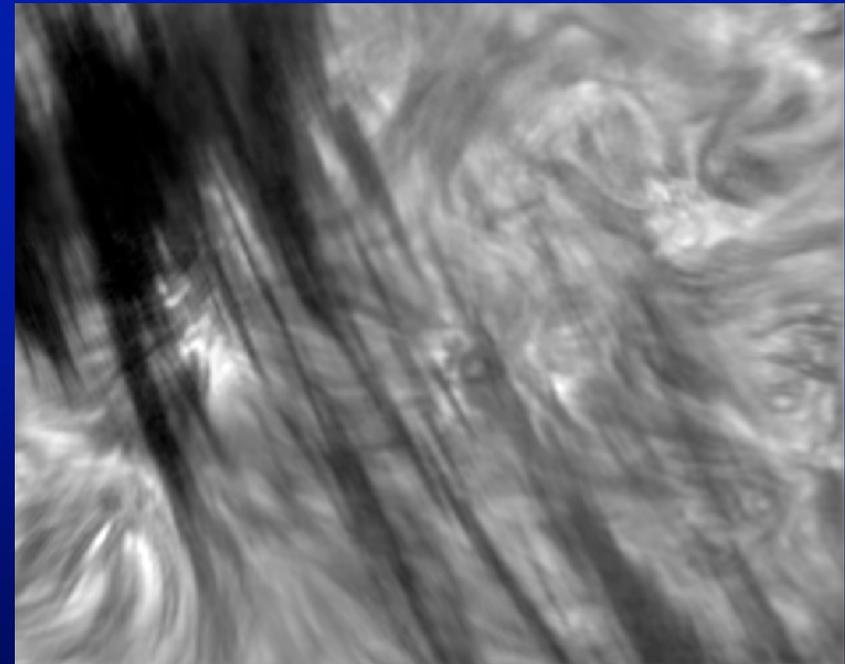


Property of filament thin threads

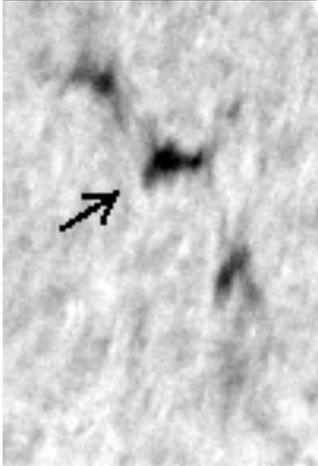
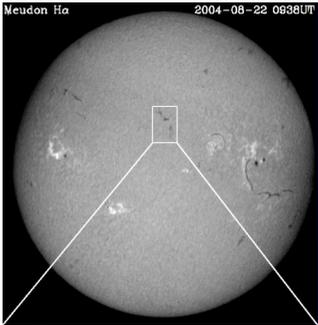


SST 2003 August 25

- Width $0.2'' \sim 0.3''$
- Apparent length $5'' \sim 20''$
- Filled with inhomogeneous plasma
- Field aligned

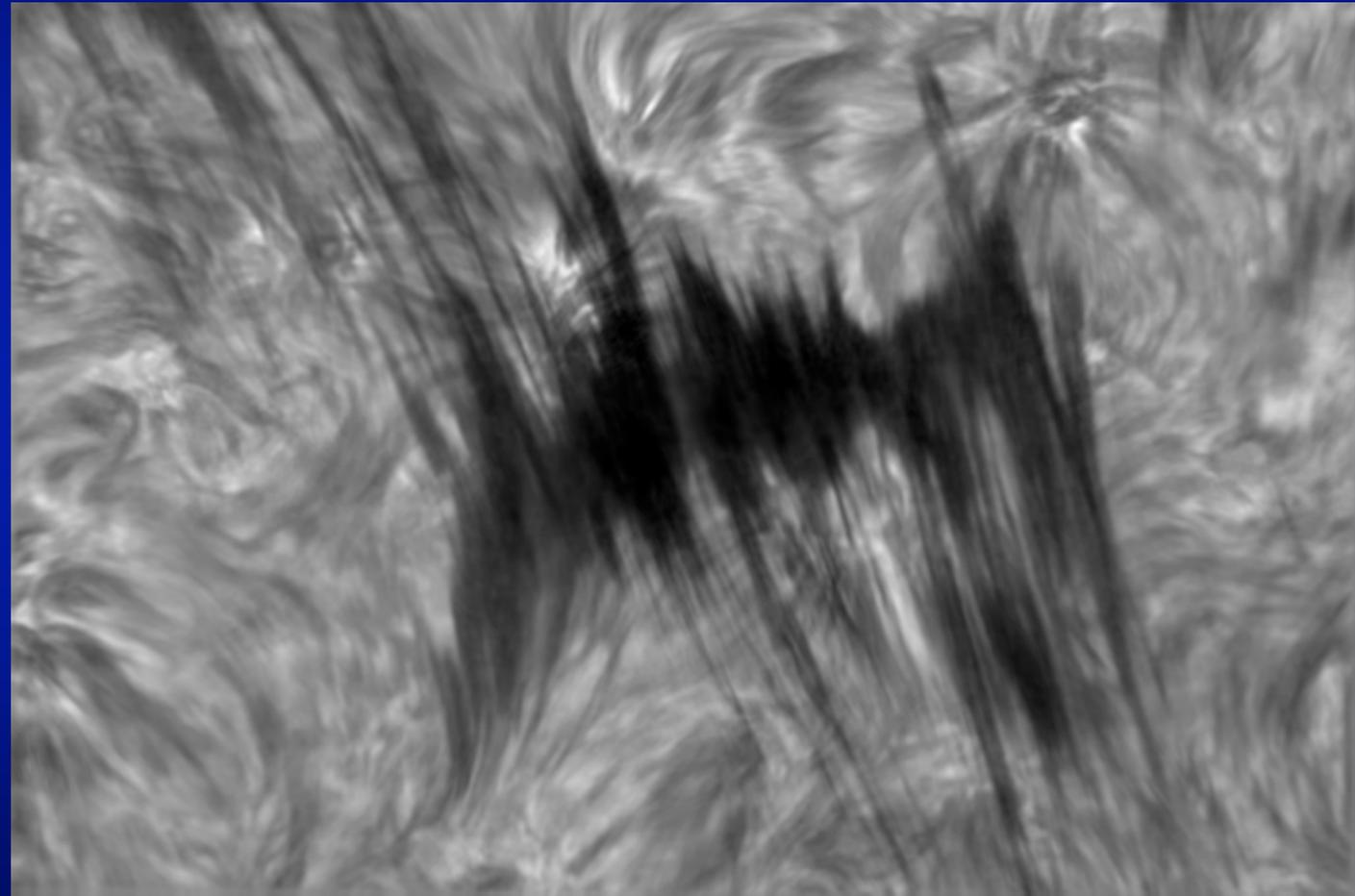


SST 2004 August 22



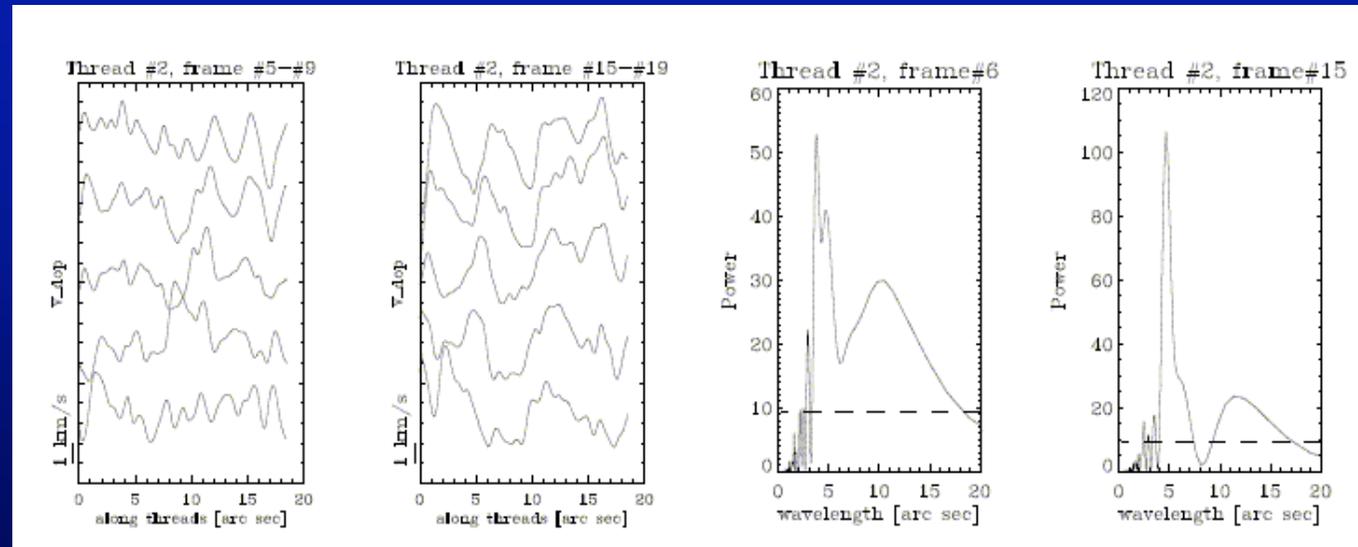
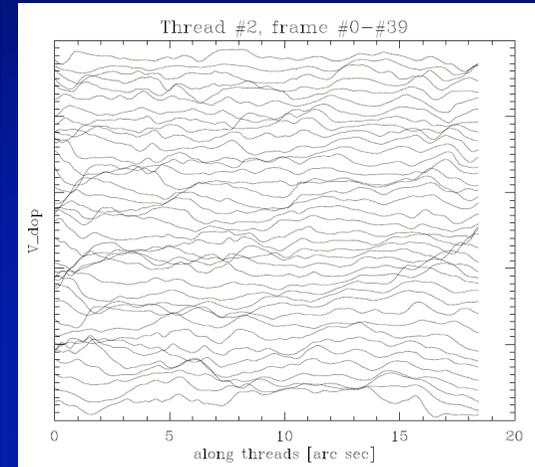
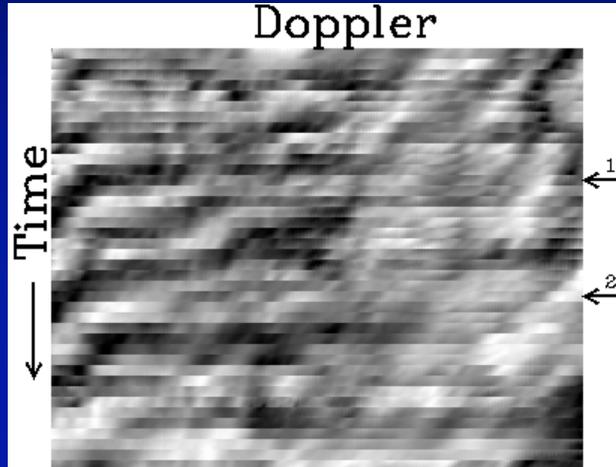
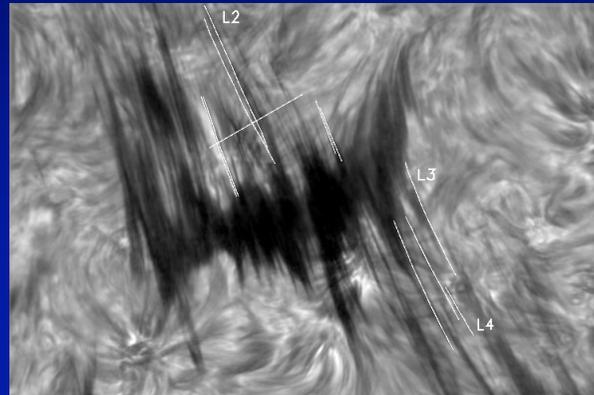
Mass flows along thin threads

$V_{\text{flow}} \sim 10 - 20 \text{ km/s}$



SST 2004 August 22 FOV: 82 x 55 arc sec Duration: 86 min

Oscillations: Waves propagation along threads



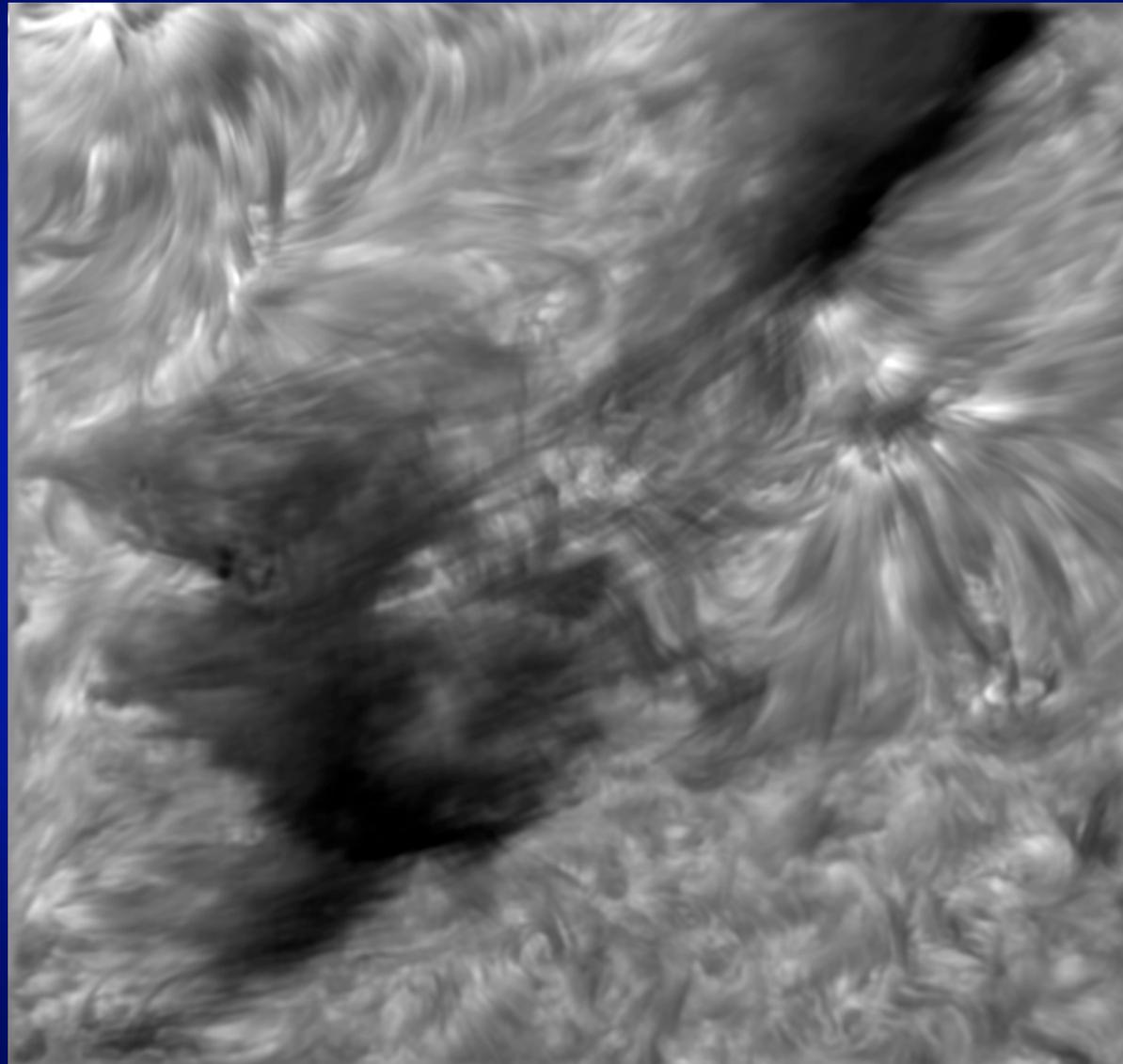
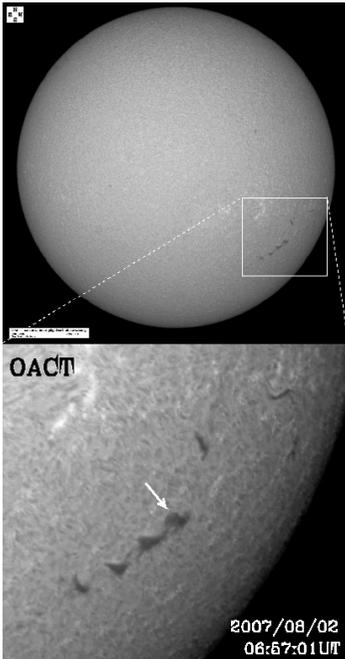
$$V_{ph1} = 8.8 \text{ km/s}$$

$$P_1 = 5.2 \text{ min}$$

$$V_{ph2} = 10.2 \text{ km/s}$$

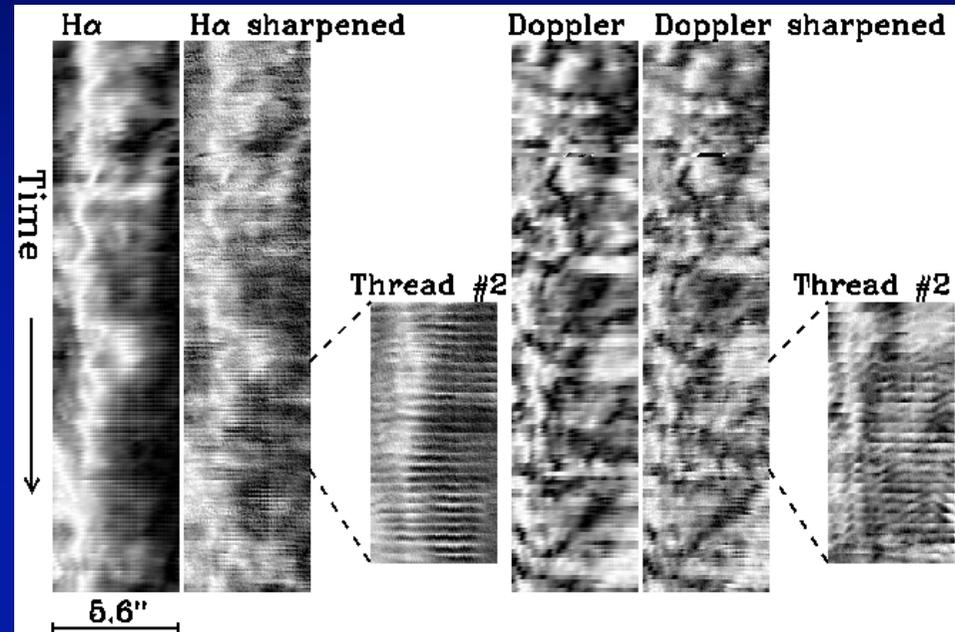
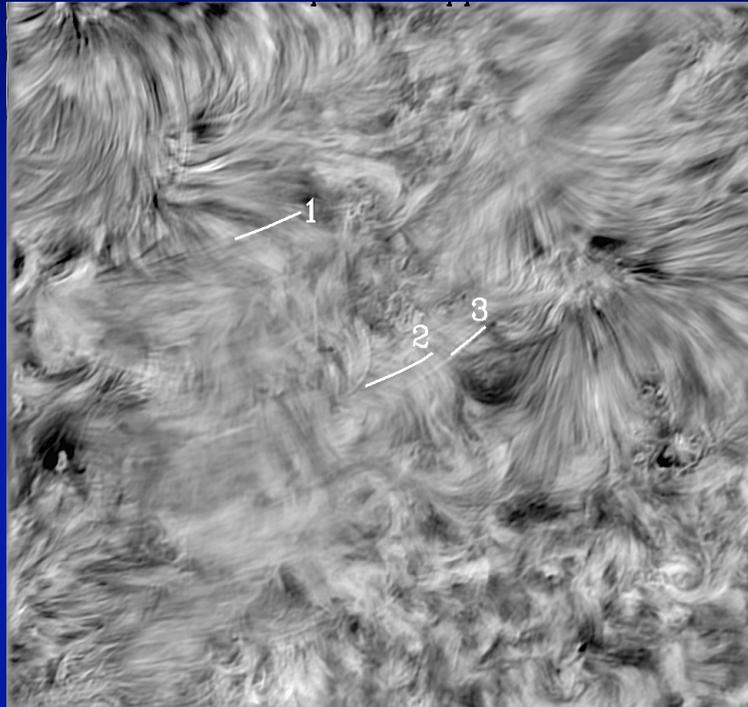
$$P_2 = 5.6 \text{ min}$$

Individual threads in a filament barb

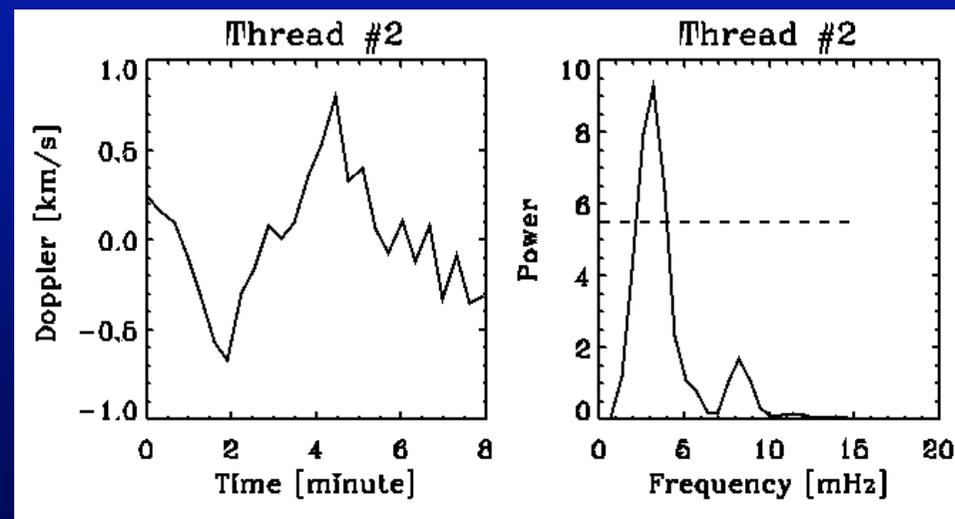


SST 2007-08-02 FOV: 64 x 60 arcsec

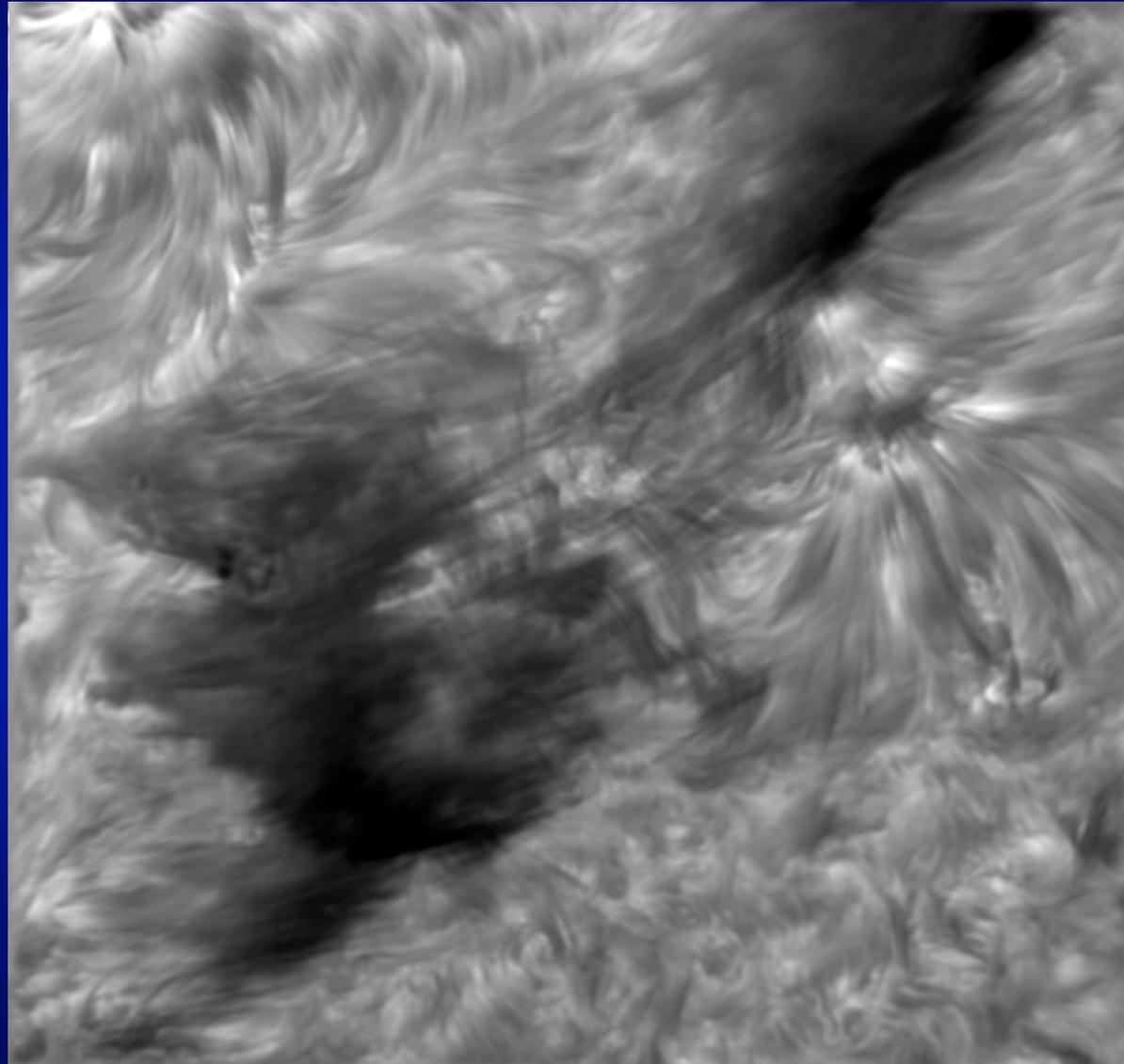
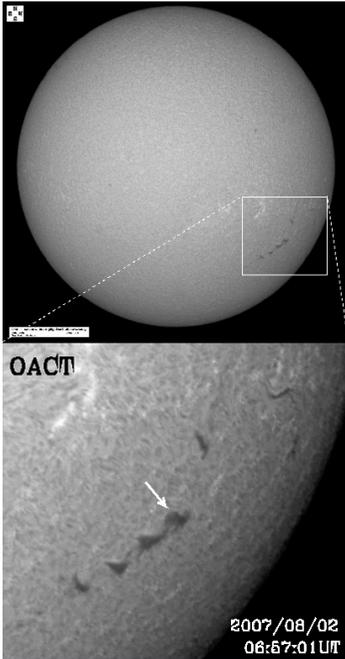
Oscillations in Dopplergrams



- Period ~ 5 min
- V_{Dop} : $-2 \sim 2$ km/s



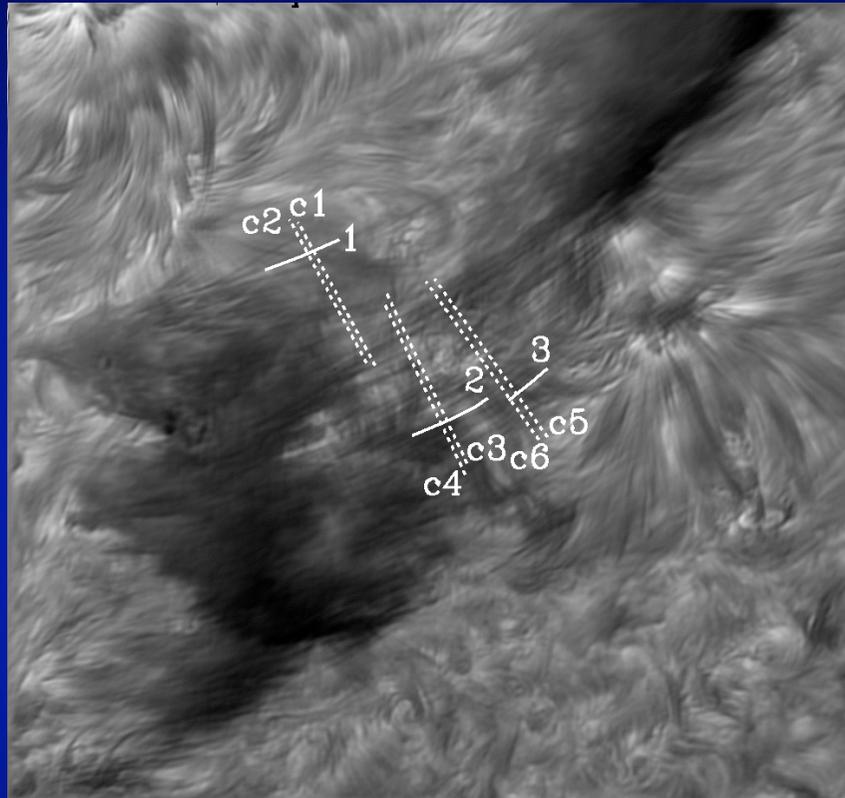
Motions of the threads



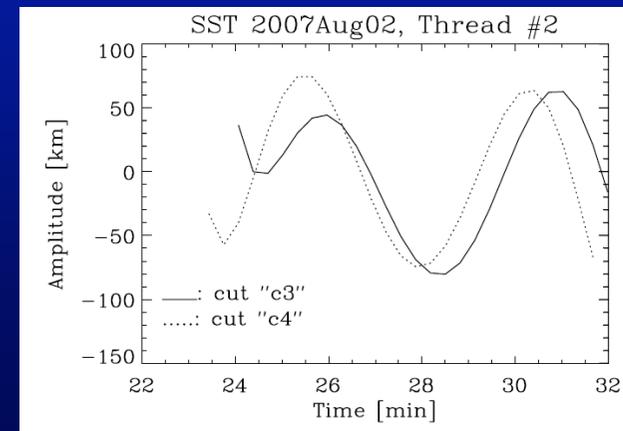
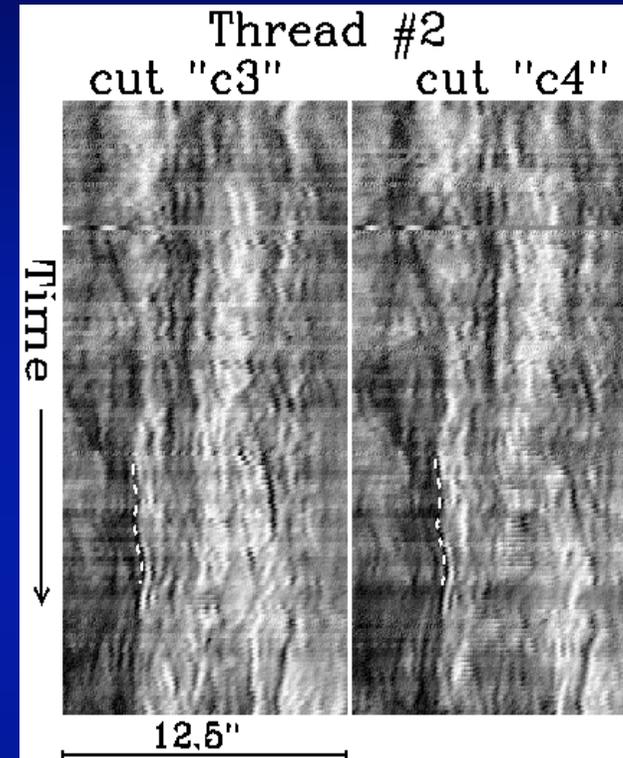
SST 2007-08-02

Duration: 40 min

Swaying of individual threads

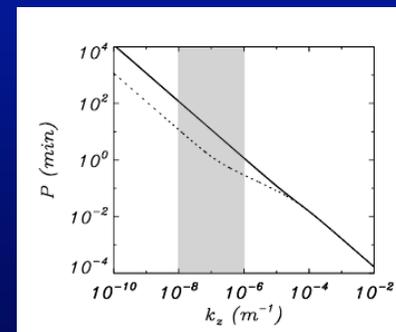
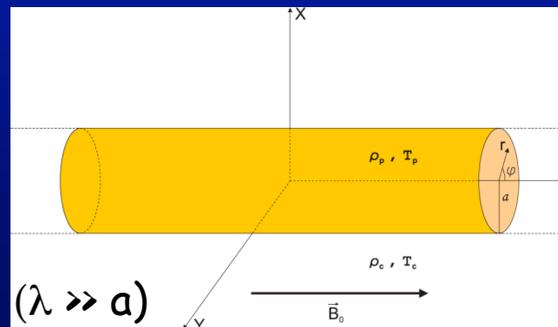


- Period = 4 min
- $V_{ph} = 34 \text{ km/s}$
- $V_{swaying} \sim 1.5 \text{ km/s}$



Remarks on thread oscillations

- The period ($\sim 5\text{min}$) and the velocity amplitude measured in the Doppler oscillations and the swaying threads are in agreement.
- There is no preferred orientation of the plane of motion of oscillating filament threads.
- Current observations are in agreement with the fast kink mode wave along a thin magnetic flux tube.

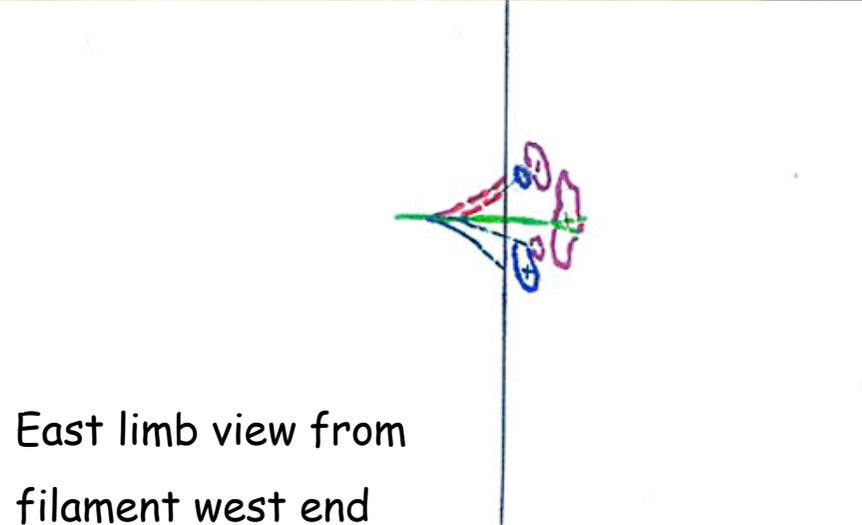
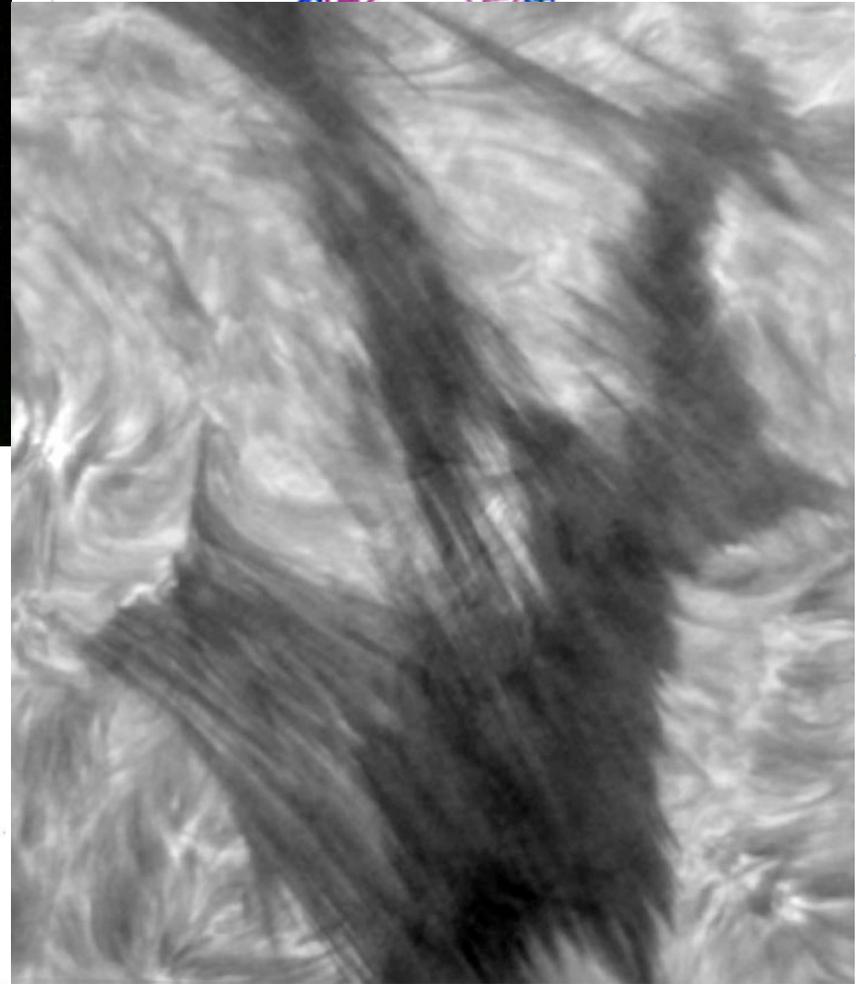
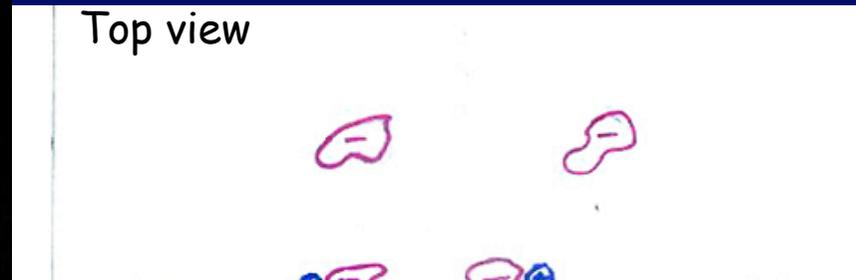
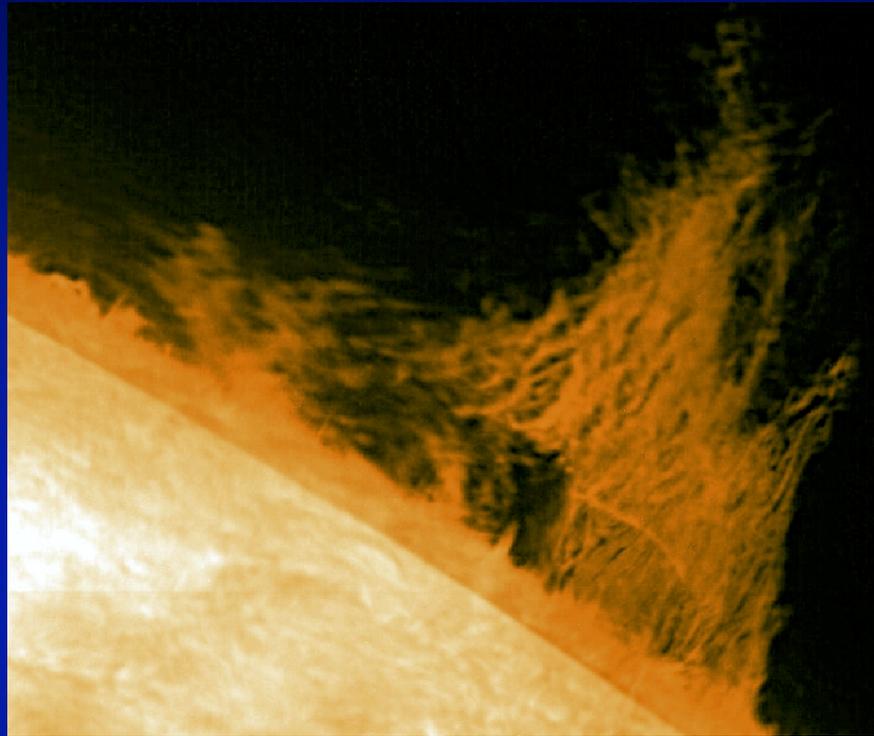


From Observations:

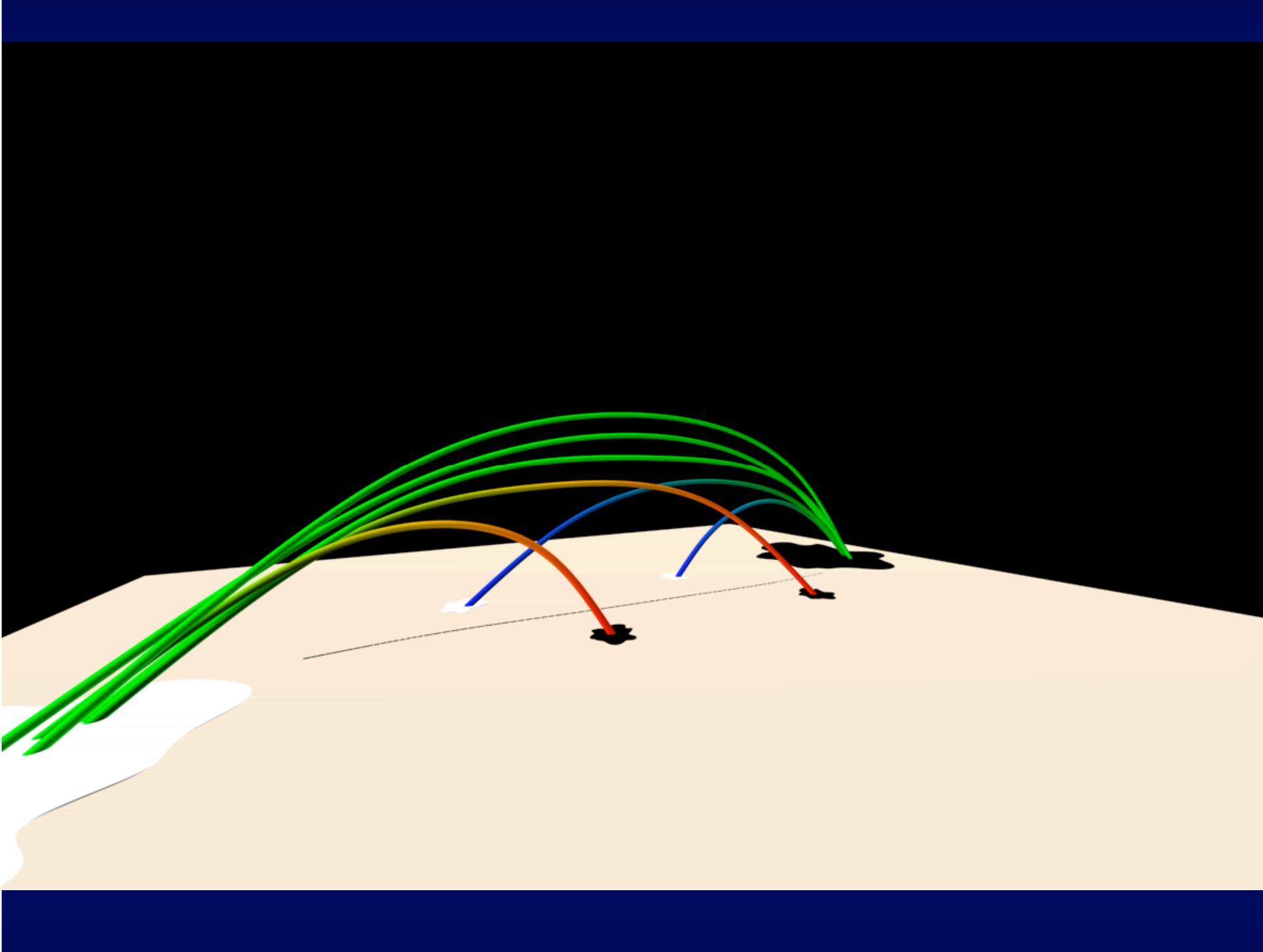
—————> An Empirical Model

- Threads are the fundamental elements of solar filaments
- Filament spines seem to be narrow ribbon-like structures with horizontal, parallel threads stacked vertically
- All threads of barbs, or the magnetic field lines they outline, emerge from and remain continuous with the spine
- Quiescent filaments are tall with many barbs whereas active region filaments are low with few barbs but their fundamental structures are similar

An empirical filament thread model



East limb view from
filament west end



Concluding remarks

- Solar prominences/filaments consist of numerous thin threads, which are field-aligned and are the fundamental structures of all filaments
- The field-aligned magnetic nature of thin threads is inferred from high resolution studies of:
 - observed flows (counterstreaming)
 - filament oscillations
- The conceptual magnetic model of a filament presented herein is consistent with the highest spatial and temporal resolution observations to date

Acknowledgments

- Oddbjørn Engvold
- Roberto Soler
- Sara F. Martin
- Olga Panasenco
- Luc H.M. Roupper van der Voort
- Øystein Langangen
- Michiel van Noort

I also acknowledge the Norwegian Research Council grant FRINAT171012.