Mass Motions in Off-limb Spicules

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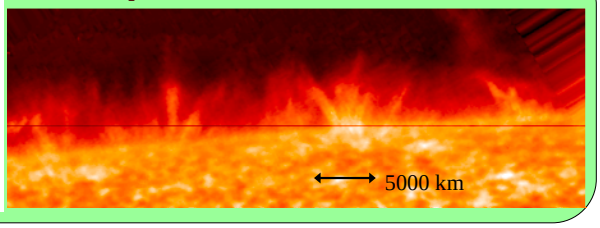
ABSTRACT

Recently, a second type of spicules was discovered at the solar limb with the Solar Optical Telescope (SOT) onboard Hinode. These previously unrecognized type II spicules are thin chromospheric jets that are shorter lived (10-60 s) and that show much higher apparent upward velocities (of order 50-100 km/s) than the classical spicules. Here, we report on observations of these type II spicules using spectra in the Ca II H line taken at the Swedish Solar Telescope on La Palma. We found Dopplershifts often reaching 50 km/s in limb spectra, sometimes reaching more than 100 km/s. These large Dopplershifts in the limb spectra are consistent with the large apparent velocities seen in type II spicules with Hinode being actual mass motions.

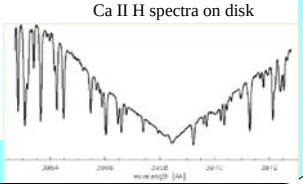
Off-limb spicules observed with Hinode/SOT Ca II H



OBSERVATION

Instrument : The TRI-Port Polarimetric Echelle-Littrow (TRIPPEL) spectrograph at the Swedish Solar Telescope
Target : North East limb of the sun with excellent seeing condition. Quiet region.
Period: 8 October 2009, 13:13-13:40 UT (27 min)
Observation : Ca II H (3968.4Å) spectrograph covering 3962.71Å-3972.82Å
0.9 s cadence, 0.068”/pixel in spatial, 0.49pm/pixel in wavelength
*The line center of Ca II H spectra is an indicator of mass motions in the solar chromosphere

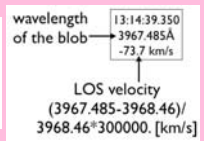
Ca II H spectra on disk



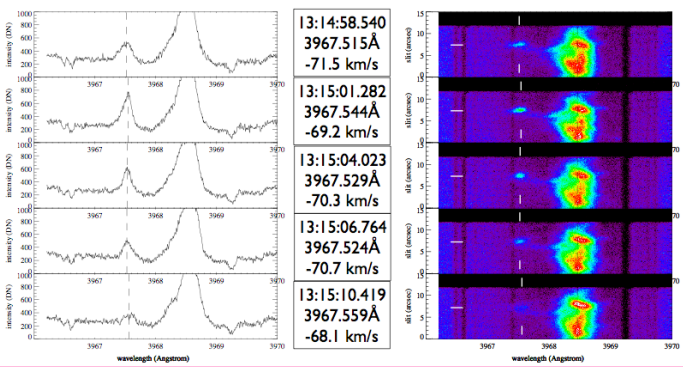
Swedish 1-m Solar Telescope on La Palma, Spain

RESULTS

We detect prominent detaching emission components in the off-limb spectra, which means the LOS components of (type II??) spicules.
Here we show 2 cases out of 12 samples.

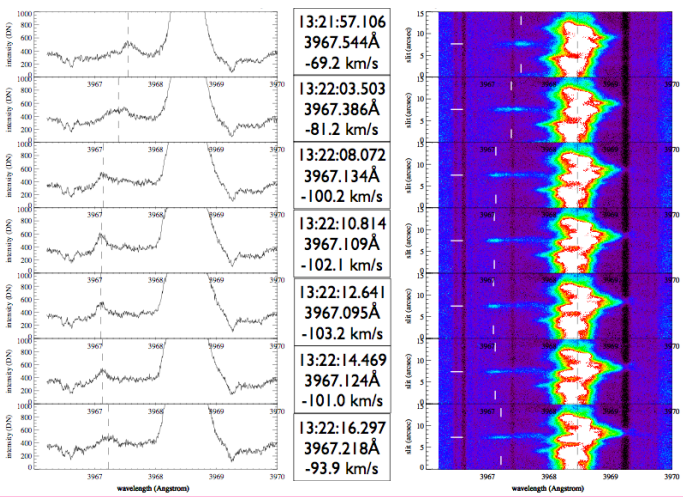


Case 1 6.0”=4300 km away from the limb



Right: spectra shown in pseudo color

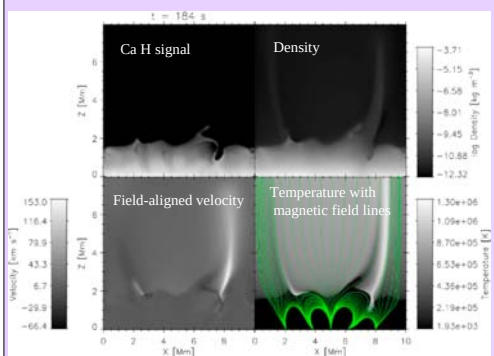
Case 2 5.5”=4000km away from the limb



DISCUSSION

We detect 12 extreme LOS velocity components in the Ca II H off-limb spectra. The maximum LOS velocities are 40-100 km/s, and the distance from the limb where we find these rapid components are 2500-7200 km.
(c.f., The maximum length of quiet limb spicules is 6500-9500 km.)
Considering that what we detect is LOS components of limb spicules, which are extending almost vertical to the local surface, the actual amplitude of the gas motion probably reaches >100km/s. This is the first study to report such high Dopplershifts in spicules.

Type I spicules are shock-driven, relatively slow (10-50 km/s) thin structures. Type II spicules are reconnection-driven, very fast (apparent motion speed 50-100 km/s) structures. These two types are considered to have the similar triggering mechanism, that is, pressure gradient or magnetic reconnection, but its acceleration mechanism is different. For type II spicules, higher the driving point is, faster the mass motion within spicules will be. *The large Dopplershifts we found is consistent with the observed apparent motion of type II spicules.*



(Figure 13 in Heggland et al. 2009)

← A 3D MHD simulation of reconnection event in the solar chromosphere and transition region. The lower boundary is drived using the LOS velocity observations with Hinode/SOT across a network element. The reconnection happens in the transition region. A strong and very fast hot jet is produced by the reconnection.

Acknowledgement
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References

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