

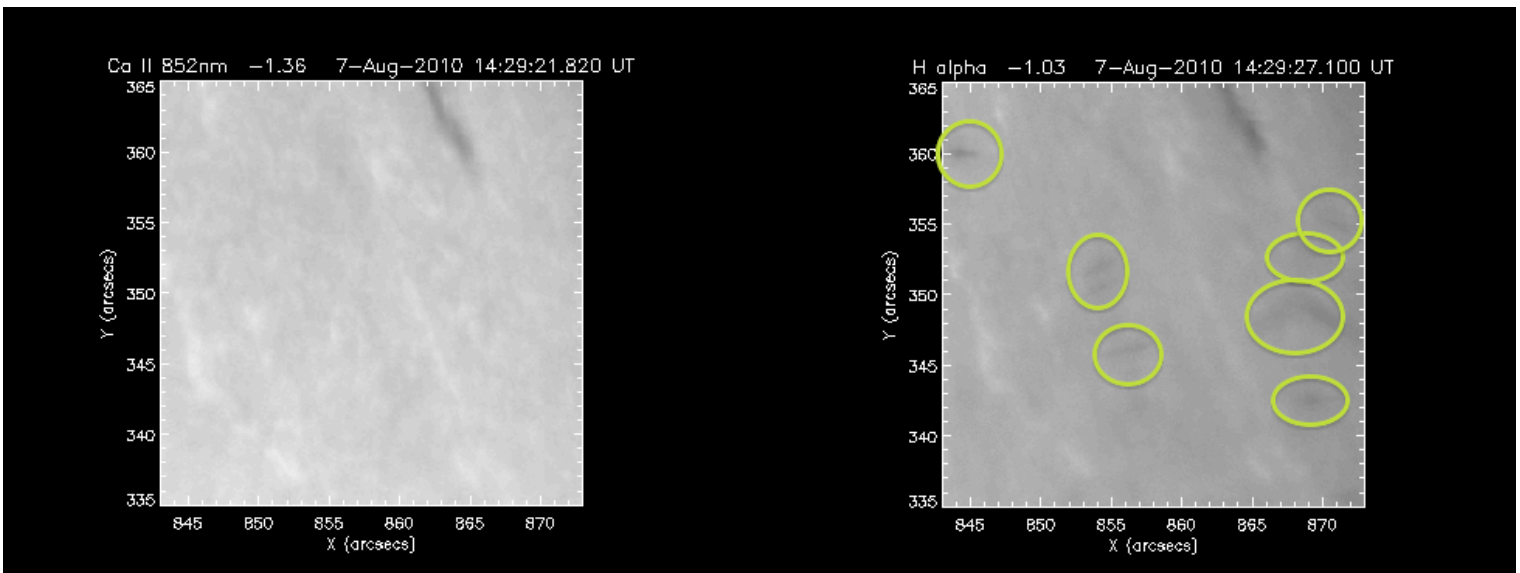
Investigating Doppler-Shifted Spicules in Ca II and H-Alpha

We observe a strong amount of spicules appearing in images taken at ± 0.11 nanometers shifted from the H-Alpha main line (656.28 nm). This translates to the spicules having velocities with magnitude of about 50 km/s. If we wanted to observe the same spicules in Ca II light, taking into account their velocity, we would have to look at wavelength shifts of about ± 0.143 nm from the main line of 854.2 nm.

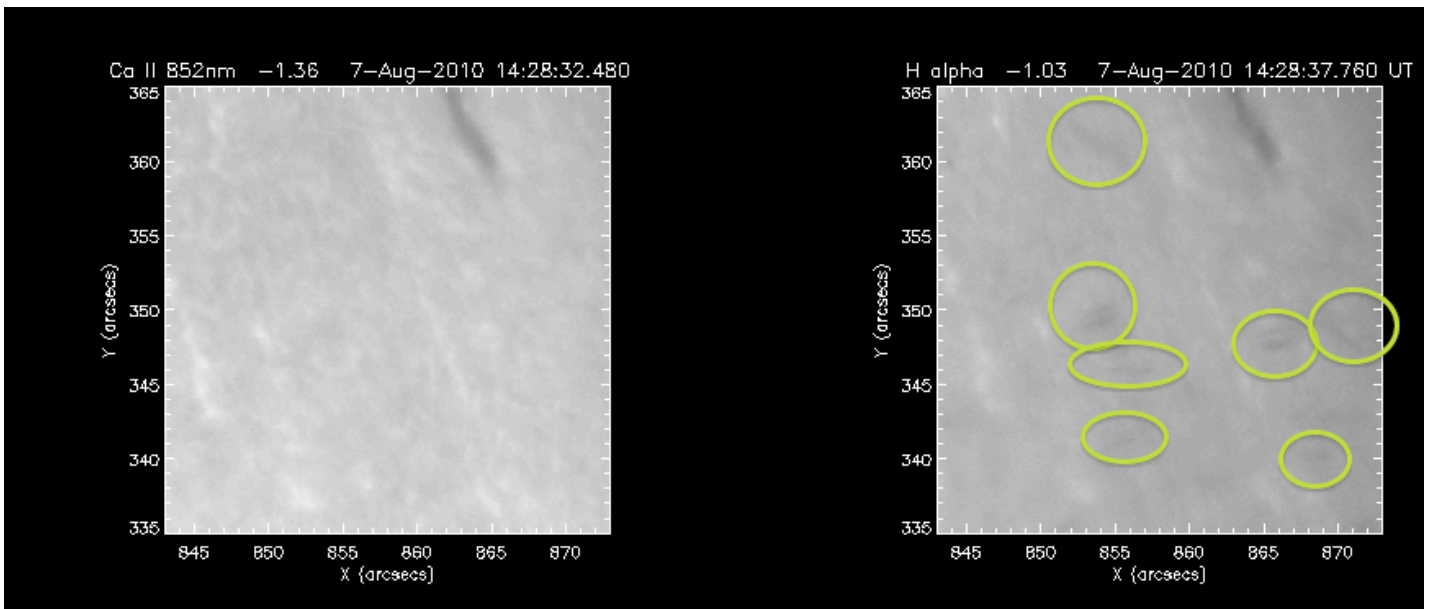
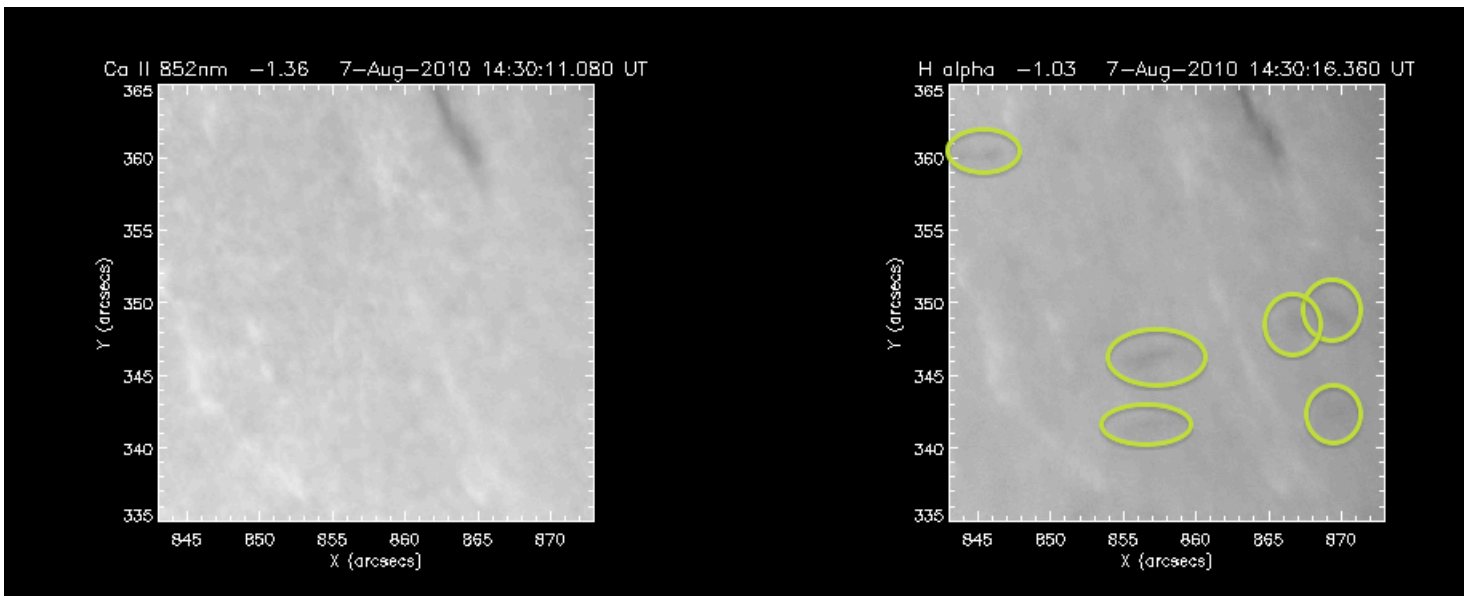
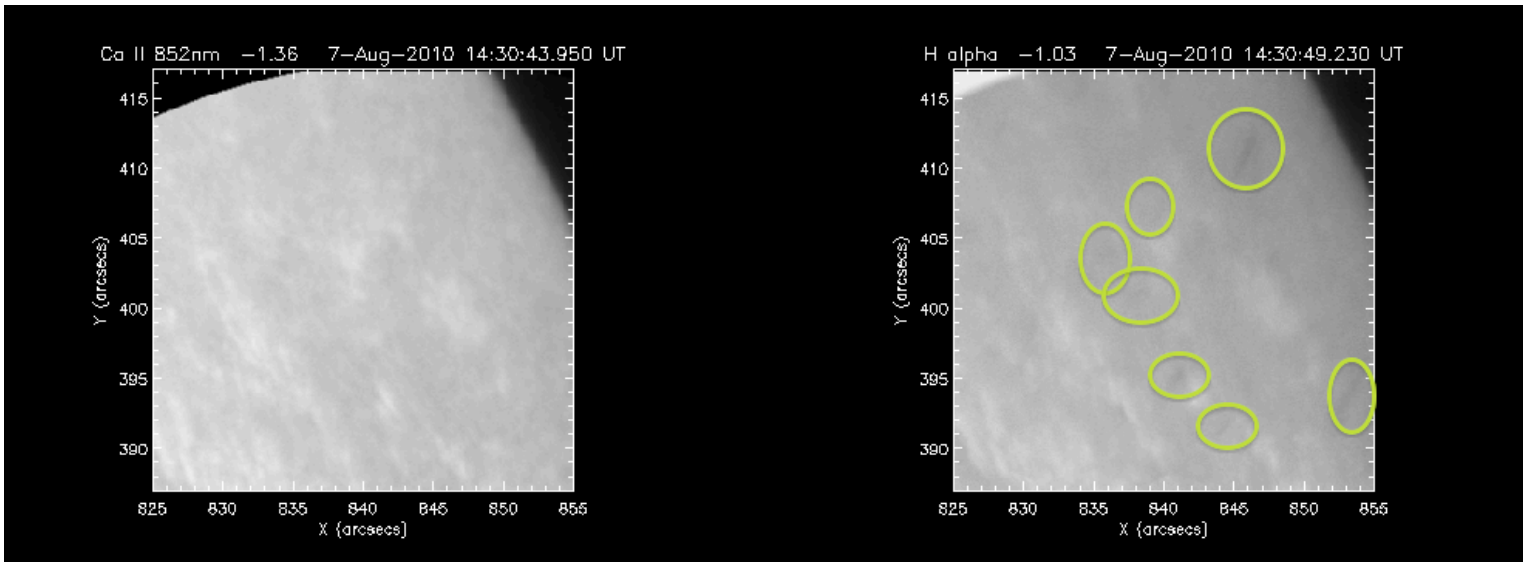
I wrote a program to compare H-Alpha images taken at -0.103 nanometers (in the blue wing) to Ca II images taken a -0.136 nm (also in the blue wing). In order to ensure that both sets of images would be very close in time and working within the constraints of the wavelength scan data we had, I had to select such wavelengths which vary from the desired 0.11 and 0.143 wavelengths. Fortunately, it works out that 0.103 nm for H-Alpha and 0.136 for Ca II both correspond to approximately the same velocity of 47 km/s!

Each set of H-Alpha and Ca II images were taken within 7 seconds of each other and were co-aligned. Even though the quality of these images isn't great (they were not reduced using either Speckle or MFBD), one can easily see that the super-fast phenomena observed in the H-Alpha images is not observed in the corresponding Ca II images.

Below are 4 examples out of 10 observed where there are spicules in a H-Alpha image (circled in green) but not in a Ca II image: (Ca II is to the left, H-Alpha is to the right)



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Theoretical models of the Sun of course predict that, if an object is moving at a certain speed, it should absorb all possible Doppler shifted wavelengths. With these models, there is no valid reason for why we are not seeing the same spicules in Ca II as we are seeing in H-Alpha.

In reality, there might be a plausible explanation for what we are seeing. The ability for an atom to absorb incoming photons relates to the conditions of the plasma it is in as well as the properties of the atom itself. Atoms with electrons at the H-Alpha transition versus atoms with electrons at the Ca II transition H-Alpha have a better ability to absorb their respective photons. There is in general a higher population of hydrogen atoms than there are calcium atoms as well and due to this and the general nature of the H-Alpha transition (as well as the fact that hydrogen atoms are lighter and perhaps much more sensitive to changes in thermal conditions), absorption of Balmer photons happens much more frequently than the absorption of Ca II transition photons. In short, plasma eligible for the Balmer transition is far more opaque to appropriate incoming photons than is plasma eligible for the Ca II transition.

The above explanation is not a sure thing, but is indeed one possibility in understanding what we are observing in the chromosphere with this data. This explanation is valid for consideration upon the fact that it should be expected that what we actually observe might deviate from theoretical assumptions that do not yet realize the vast complexity of the corona.