I emphasize that the effect is not merely due to a *shift* or distortion of the image. It is an intrinsic velocity change, an acceleration, which makes a signal which goes through maxima and minima. The next slide, which brings this out in another way, represents not a Doppler *difference* such as we just looked, at, but what we call a Doppler *sum*; instead of taking two *similar* Doppler photographs, we take two which are intrinsically of *opposite Doppler polarity* and then cancel the positive one against the negative of the other—which is the same as *adding* the velocity at each point to the velocity at some time later. Zero time difference is again along one edge and we see that there is a very large signal, as we would certainly expect. However, the signal essentially *disappears* after a short time in the region near the center of the disc, and again builds up. We also see the larger cells out near the boundary of the sun which are long lived in a Doppler sum and don't ever disappear. The reduction of the signal near the center of the disc in a Doppler sum can only mean that the velocities have been reversed after a half period. We have many cases of this. It occurs very reliably, very reproducibly. We have changed the speed of traverse of the spectroheliograph and all the variables under our control, and it always shows up to one degree or another, depending upon the seeing. The average period, from 25 observations, is (296 ± 3) s. The standard deviation of a single observation is about 15 s. The next slide shows a simple Doppler field taken in the D line of sodium. It shows the stabilization of the motions at a high level by the magnetic fields around the sunspot group.

The next slide shows the kind of a Doppler record one gets in H_α by setting the slit rather far from the center of the line—about one ångstrom—which means that one is looking at a relatively low level in the H_α chromosphere. It can be described as consisting of large areas of essentially no Doppler velocity with « islands » of motion, little « funnels », through which the hydrogen gas is *streaming downward* into the sun. Out near the limb, of course, one sees both very dark areas and very light areas indicating horizontal motion which can be of either sign, but near the middle of the disk the predominant motion is downward through little tunnels. The tunnels shrink in size as one moves further out in the H_α line. One also sees a few little spurts here and there in which there is *upward* moving gas also.

Discussion:

— G. Elste:

Which line was used to show this asymmetry in the motion?

— R. B. Leighton:

Principally the 6103 of Ca—both for magnetic observations and the Doppler observations.

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— G. ELSTE:

Did you try to do the same with the Fe line?

— R. B. LEIGHTON:

Yes—same results. I should also mention that, knowing what the period is, we arrange to scan the image of the sun over a smaller area in $\frac{1}{4}$ of the period. We went $\frac{1}{4}$ of the oscillation period in one direction and then another $\frac{1}{4}$ of the period back again, and then $\frac{1}{4}$ of the period out again and so on. Then in taking the second photographic difference we have the same time difference over the entire photograph, and this can be made either an even or odd number of half periods. We found that these are alternatively very contrasty and very uncontrasty. We can follow this difference in contrast out about three periods. This suggests that the Q is somewhere around 2 to 4.

— MRS. BÖHM-VITENSE:

I think we can expect the main part of the line used to be formed at an optical depth for the continuum of about 0.05 or so.

— K. O. KIEPENHEUER:

In the picture there are black dots; have you thought of these dots being spicules?

— R. B. LEIGHTON:

I think there are not enough of them to be that.

— K. O. KIEPENHEUER:

They look exactly as they look in our filtergrams although I have, of course, not counted them.

— J. C. PECKER:

Did I hear you well—you did find a strong correlation between brightness and direction in the velocity?

— R. B. LEIGHTON:

Yes, at this level.

— J.-C. PECKER:

I want to draw the attention of the aerodynamicists to the fact that this is a very controversial point. In the continuum photosphere, many observers including the Michigan group, I think, found in some cases an anticorrelation. I would like to know what it means.

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— G. Elste:

The Michigan arguments don't refer to this deep level.

— J.-C. Pecker:

Yes, all the observations do not refer to the same level.

— E. Spiegel:

Does that mean a correlation was measured or is this just a qualitative judgment?

— R. B. Leighton:

At the present time it is qualitative, but clearly by measuring the contrast of the two pictures, which we plan to do, one can make it quantitative.

A. B. Severny: **The motions and magnetic fields in the undisturbed solar atmosphere (outside active regions).**

The regular records of line-of-sight velocities with the aid of the solar magnetograph have been available at the Crimean Observatory since 1957, and a set of papers was published in *Publ. Crim. Observ.* since then. The method consists in recording the rotation of a plane-parallel plate before the slits of the magnetograph. This plate keeps the image of the line rigidly on these slits by equalizing the photocurrents from both slits, (the principle of the image follower). *The records of line-of-sight velocities* are always obtained *simultataneously* with the records of *magnetic field* because the principal aim of this image follower is to compensate automatically Doppler shifts of the line and to eliminate their influence on the measurements of magnetic fields. (To calibrate magnetic field in velocities of solar rotation we must switch off this compensator.) We found that there is no practical need to use a magnetic insensitive line (*e.g.* 5123.7) to record radial velocities, because of symmetrical change in Zeeman pattern at the modulation $(0, \frac{1}{4}\lambda)$ and high frequency of ADP modulation (120 Hz^{-1}). But most records were made in a magnetic insensitive line, 5123.7 [1].

The main sources of error are 1) the turbulence in the *spectrograph* itself producing accidental errors, and corresponding to display of r.v. from ± 50 up to ± 100 m/s; 2) *the trembling of images* across the slit of the spectrograph producing at *bad seeing* accidental deviations up to 1 km/s. But this error is reduced (by repeating scans) to an amount which is less than the display owing to the turbulence in spectrograph.

A brief summary of our results relating to undisturbed disk is the following (the results were chiefly obtained by Stepanov and partly by Severny [2, 3]).

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