ON SOME PROPERTIES OF THE VELOCITY FIELD IN A DEVELOPED ACTIVE REGION

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Thirty-eight series of photoelectric recordings of radial velocities in a developed active region have been studied. The recordings were made in the Fe I line λ 5250 Å from September 2–7, 1961, when the active region passed across the solar disk from E 30° to W 42°.

It is shown that the radial velocities averaged over many recordings for each day, i.e. 'quasi-stationary' velocities, differ from zero in the regions, where the magnetic-field strength is relatively high. Besides, the velocity can change the sign inside a region of a single polarity. There are found two types of 'quasi-stationary' motions for an active region as a whole: one type – with the predominantly horizontal motions, and the other type – with predominantly vertical motions (mainly downwards). Both types of motions are superposed by rapidly changing perturbations whose amplitude reaches (in some points) 1400 m/sec.

Predominantly horizontal motions are in the large spots and their vicinity. These are mainly the places where the stress of the longitudinal component of magnetic field is larger than that of the transversal component (it is also true for the surrounding regions). Predominantly downward motions occur in those parts of an active region where the transverse magnetic field predominates. These regions coincide with the places of the most rapid disintegration of an active region: disappearance of spots' penumbra and their magnetic fields.

In the regions with predominantly horizontal motions the descending flux of gas is practically totally compensated by ascending flux. On the contrary, the flux with predominantly downward motions is not compensated at all and may reach the value of 8×10^{40} atom/sec.

DISCUSSION

Maltby: How do you separate the horizontal and the vertical motion? Do you assume that the velocity pattern is constant as a function of time?

Gopasyuk: As the line of sight velocity changed sign during passage of a region from the East to the West limb, it was considered that the flow was predominantly horizontal. When the structure appears similar during the disk passage but the sign of the velocity changes, it is safe to assume that one is observing predominantly horizontal motion. When the velocity did not change sign, it was assumed that the motion was predominantly vertical.

Schröter: As far as I understood you get the result that motions in this spotgroup are often more

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or less perpendicular to the direction of the magnetic field. How did you get from your Doppler-shifts which give the line-of-sight component the spatial orientation of the motion vector?

Gopasyuk: The answer is the same as to the question by Maltby.

Sturrock: If gas is observed to be flowing downwards over a certain area, either gas must flow horizontally into this region, or gas must flow up in small regions of the area. In the latter case, the observed velocity profiles can be understood if the gas flowing downwards is hotter than the gas flowing upwards. Is this interpretation consistent with the observations?

Gopasyuk: In every case we observe that most of the gas moves downwards, so if the density of the upward- and downward-flowing gas streams are equal, there must be a net downward flow. This is one of the difficult problems in understanding the structure of active regions.

Bumba: If I understand correctly, large downward motions were found in places, where the disintegration of penumbra took place, this means in such a region where both polarities were fairly far apart each from the other. But in such place relatively weak transversal component of the field is normally observed in the photosphere. The transversal components are stronger only if the distance of both polarities is very small. Therefore I do not understand why you speak about motions going mainly perpendicular to the lines of force of the field.

Gopasyuk: At the location of the downward motion, the transverse component of the field was strong (1500–2000 gauss), and this was greater than the longitudinal field at this point. During the expansion of the region over several days, the magnetic fields weakened and the downward flow continued.

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