SOLAR ROTATION, 1966–68

*(Research Note)**

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A modest program of measuring the rotation of the sun by means of the Doppler compensator of the solar magnetograph began in 1966. The observations continue and are taken twice a year around the time when the position angle P of the sun's rotational pole is zero and B_0, the meridinal tilt of the pole, is a minimum. Data obtained at these times are particularly simple to reduce to angular velocity. The aim is to measure solar rotation as a function of latitude, height in the sun's atmosphere, and, eventually, over the solar cycle. Height discrimination is obtained by comparing the chromospheric line Hα with the photospheric lines Fe 5250 and Fe 5233.

The observations are taken by causing the 800-mm image to move across the 4-mm square (10″) magnetograph aperture at a constant speed and along a chord of constant latitude. Recorded on synchronous strip charts are the relative Doppler shift and line brightness. The Doppler signal is derived from the tilt of a servo-controlled parallel glass plate that serves to keep the line centered on the double exit slit. The brightness signal corresponds to the mean light in the line wings and is developed by the same phototubes that operate the servo. Details on the system and dimensions of the slit settings are given elsewhere (LIVINGSTON, 1968).

On the Doppler trace a straight-line fit is made giving most weight to the central portion and neglecting the extreme ends where distortions due to the limb effect, aperture effect (i.e. limb darkening over the entrance slit), and residual servo zero-offset occur. From the slope of this linearized Doppler trace, and knowing the image diameter from the brightness trace, and the deflection sensitivity of the tilting plate, the angular speed of rotation follows.

The present photoelectric technique, which is of course closely akin to the classical spectrographic method, differs from the latter in two ways. First, points across the *entire disk* contribute to a measurement, while in the previous photographic studies spectra taken just inside the limb have been used. Second, the Doppler compensator senses the position of the *line wings*, while the micrometer-wire measurements of photographic spectra favor the line core.

Results for three years are given in Figure 1. The sizeable scatter for a given date and line is solar in origin (i.e. real and reproducible) and not an observational error. These data suggest the following:

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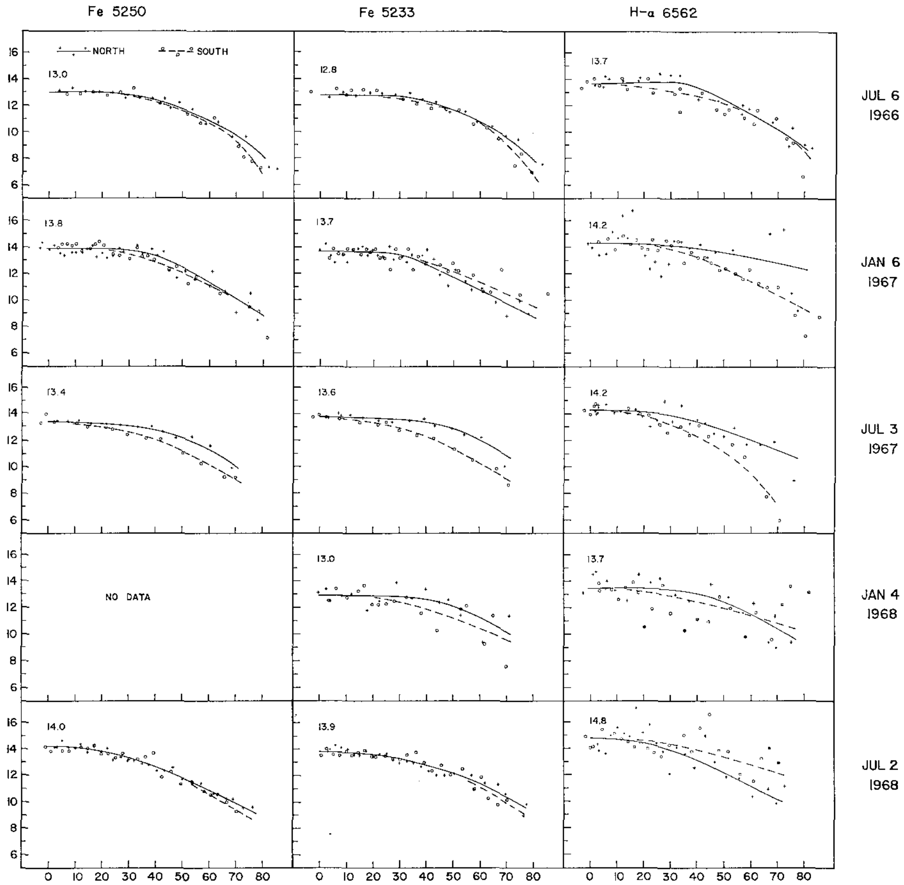

Fig. 1. Solar rotation in degrees per day, sidereal, as a function of solar latitude for different Fraunhofer lines. Equatorial rate is also given. The scatter in the data appears to be caused by large scale motions on the solar surface and is not an observational error.

(1) The discovery of ADAMS (1911) that the sun rotates about 0°.5 per day faster in Hα than the metallic lines is confirmed.

(2) Frequently the sun shows little or no differential rotation through the sunspot zone (0 to 30° lat.).

(3) For the first half of 1967 the Southern hemisphere lagged the Northern in Hα.

The observational fact that the sun rotates faster in Hα than in the photospheric finds a theoretical interpretation in the recent work of DE GASTON and ASHBY (1968). These authors propose that the driving force for differential rotation is found *externally* through a momentum exchange from the corona.

Acknowledgements

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References

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