ROTATIONAL SPLITTING OF SOLAR FIVE-MINUTE OSCILLATIONS OF LOW DEGREE*

(Invited Review, Abstract)

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Abstract. An analysis of 28 contiguous days of whole disk observations of the solar surface by means of optical resonant scattering in the K 769.9 nm line, taken at the Teide Observatory at Izana during July–August 1980, have thus far yielded two significant facts. Firstly when the results of an iterative sine-wave fitting procedure are considered in the period range 2–3 h, although the expected daily harmonics corresponding to 1/8, 1/10, 1/11, and 1/12 of a day are clearly seen the 1/9th contribution is significantly absent. It is suggested that this results from an interference between a signal of 160 min (1/9th of a day) with the daily harmonic. It is further pointed out that the observatories at which the 160 min oscillation has been seen, Crimea, Pic du Midi, and Stanford are all separated by integral numbers of 160 min, and thus the phase of the 160 min oscillation relative to the daily observation window is constant. However, the Teide Observatory is situated at a half integral number of 160 min periods relative to the others. Thus when constructive interference exist at the first three sites destructive interference will exist at the latter. It is thus concluded that the non-existence of a peak corresponding to the 1/9th harmonic of a day in the sine-wave fit data is strong indirect evidence for the existence of the 160 min signal.

An analysis of those same data in the 5 min region has revealed the now well established pattern of discrete frequencies and with the increased resolution obtainable from 28 contiguous days of data, clearly showed the existence of splitting by rotational effects. In all 33 discrete lines were considered in the frequency range 2.4–3.85 mHz, which could be divided up into 3 groups, each of 11 lines, corresponding to the $l = 0$, $l = 1$, and $l = 2$ modes. This definitive classification was possible as the lines are split into $(2l + 1)$ components yielding easily identifiable singlets, triplets and quintuplets. This first observation of the rotational splitting of solar oscillations gave the further information that the splitting of 0.75 ± 0.10 μHz indicated that the solar interior is rotating more rapidly than the observable surface (uniform rotation would yield a splitting of 0.4 μHz). A comparison of the widths of the individual peaks, with the

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intrinsic resolution of the data string ($\sim 1/T$ where T = length of the data string), showed that these were consistent with a high Q value oscillation, a fact which is further confirmed by the very existence of singlets triplets and quintuplets in the data.

The exact value of the speed of internal rotation of the Sun can only be deduced from these data by a model dependent calculation. The simplest of these would suggest that if the core were almost equal to the solar diameter then it is rotating twice as fast as the surface, whereas if the core were only 15% of the solar diameter, it would be rotating at 9 times the surface rate.

Reference

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