OBSERVATIONS OF SOLAR PULSATIONS

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There have been several interesting developments during the last year with regard to global oscillations of the sun. However, because of the very full program of this Joint Discussion and the resulting tight schedule, only one point will be addressed here: the observational evidence for global oscillations of the sun with periods $\lesssim$ 1 hr and > 5 min.

The most decisive test currently available for identifying global oscillations is their examination for coherence of phase over an extended period of time. This test discriminates against both nonsolar phenomena, such as effects caused by observing through the earth's atmosphere, and solar phenomena which occur in the frequency range of interest but which are not global oscillations of the sun. The search for this coherence has been conducted using 2 sets of observations from SCLERA,[1] the 1973 observations of Hill and Stebbins (1975) and the 1978 observations described by Caudell et al. (1979). The results of these examinations strongly support the interpretation of the reported oscillations as solar in origin and as global in character.

The above observations consist of time chains of diameter measurements made at SCLERA. A list of references may be found in Hill and Stebbins (1975) and Hill (1978) which describe the telescope, the method for defining the solar diameter, the means of measuring the solar diameter, and the data reduction techniques used to produce the final Fourier transforms and associated power spectra of the diameter measurements.

The first test for coherency yielding statistically significant results was reported by Hill and Caudell (1979). They examined for phase coherency 6 peaks occurring in the averaged power spectra of the

NOTE

1. SCLERA is an acronym for the Santa Catalina Laboratory for Experimental Relativity by Astrometry jointly operated by the University of Arizona and Wesleyan University.

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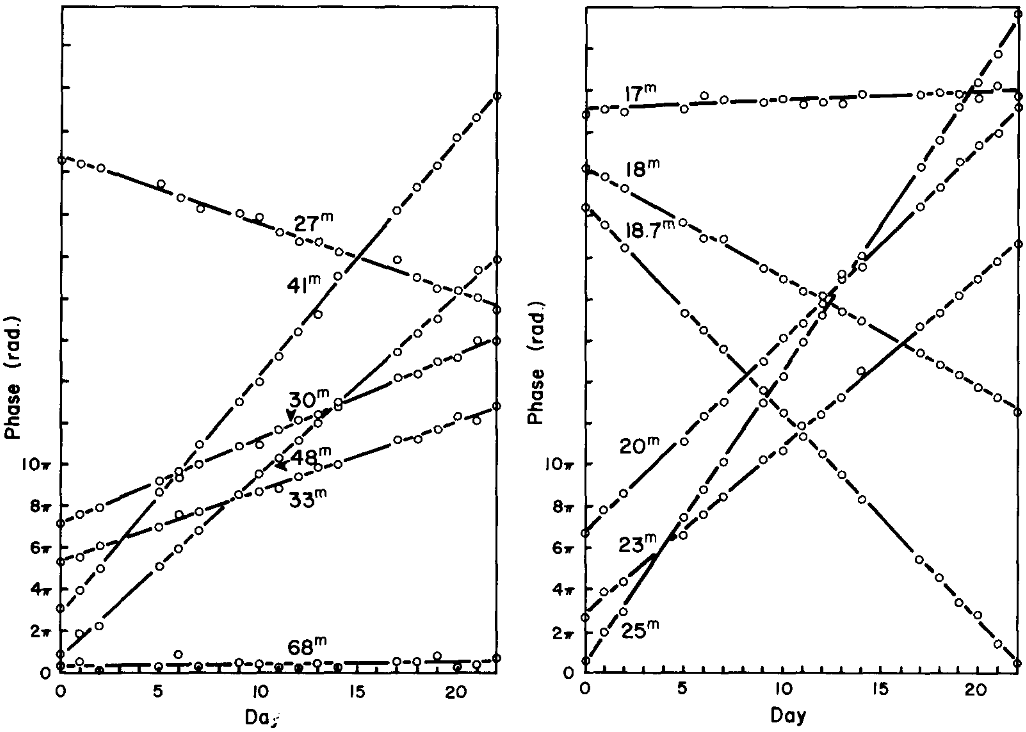
observations of Hill and Stebbins (1975). The statistical significance of the results of this examination has been analyzed by Caudell and Hill (1979) through the use of a Monte-Carlo numerical simulation. This analysis yielded a value of 3.8×10^{-5} for the probability that a random noise source would produce a root mean square deviation of the phases less than or equal to that observed. In the event that the observational results themselves originated from a random noise source, the corresponding probability was found to be 1.2×10^{-2}. This is very strong evidence for the existence of global oscillations in the 1973 observations by Hill and Stebbins (1975).



Figures 1 and 2. The preliminary phase solutions for twelve oscillations as a function of day number for eighteen days' data. A least-squares fit line has been drawn on each set of phases. The approximate periods of the oscillations (in minutes) are given next to each solution.

Using observations obtained in 1978, Caudell et al. (1979) have found phase coherency which is statistically more significant by many orders of magnitude than that mentioned above. The 1978 observations consist of 18 days of equatorial diameter measurements interspersed

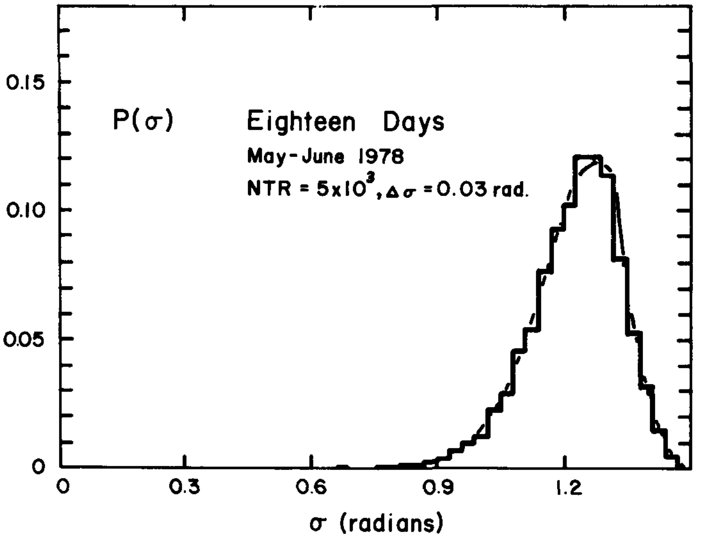


Figure 3. The histogram of the Monte Carlo generated probability density distribution of root mean square deviations, σ, for random phases. A smooth curve has been drawn on the plot for clarity.

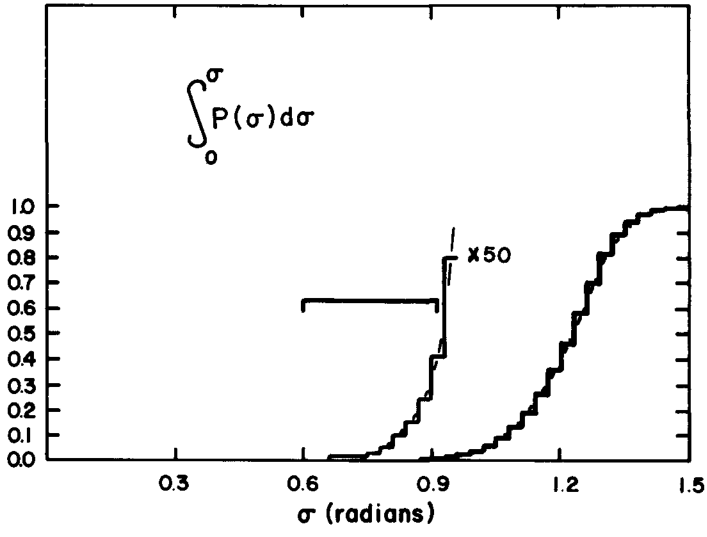


Figure 4. The integral of Figure 3 from zero to a particular σ as a function of this σ. The inset expands the range of observed σ's, designated by the horizontal bar, for clarity.

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between May 21 and June 12, 1978, a 23-day span. Twelve peaks in the power spectra, confined to a frequency range of 0.2 to 1.05 mHz, were analyzed for phase coherency. Preliminary results for the phase plots are shown in Figures 1 and 2.

The statistical significance of the results shown in Figures 1 and 2 has also been analyzed through the use of a Monte-Carlo numerical simulation. For a set of 18 days of random phases spaced over a 23-day period, Caudell et al. (1979) obtained by the Monte-Carlo technique the probability of finding a particular root mean square deviation which is shown in Figure 3. The probability that a random noise source will lead to a root mean square deviation less than or equal to any particular value σ is given by the integration of Figure 3 from 0 to σ. This probability is presented in Figure 4.

The range of the observed root mean square deviation is also indicated on Figure 4. It is apparent from this that, for most of the peaks in these observations, the probability is $\lesssim 10^{-3}$ that a random noise source would produce a root mean square deviation of the phases less than or equal to that observed (if the observations resulted from random noise, this value would have been 1/2). Additionally, in view of the high probability of independence of the 12 peaks, it is highly unlikely that they are the result of a random noise source. This evidence strongly suggests that the 12 peaks found in the 1978 observations of Caudell et al. do indeed represent global oscillations of the sun.

We thus have two sets of observations made in two separate years in which very strong evidence for the existence of global oscillations of the sun is found.

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