SOLAR RADIUS MEASUREMENTS

T. L. Duvall, Jr. and H. P. Jones

NASA/GSFC, Laboratory for Astronomy
and Solar Physics
Solar Physics, Southwest Solar Station
Tucson, Arizona

ABSTRACT

Preliminary results of solar radius measurements made during 1979-1980 are discussed. Variability in the radius measurements of 0.4π is found, of unknown origin.

INTRODUCTION

An observational program to search for variability of the solar radius was begun in December 1979 at Kitt Peak. This program was initiated because of the claims of a secular decrease in the solar radius of ~ 1π/century (ref. 1). A search of the literature, however, also reveals claims of variability on time scales such as a 0.1π solar cycle variation (ref. 2). The first ten months of observations are discussed in this preliminary report. Unexplained variability at the level of 0.4π is found. At this stage of the investigation, all possible sources for this variability are being considered—instrumental, atmospheric, and solar.

OBSERVATIONS

The technique used to measure the solar radius is the classical one of obtaining the time interval between passage of opposite solar limbs across a detector pointed at a fixed place in the sky. The known rotation rate of the earth and declination of the sun are then used to derive an angular diameter. In the present application of this technique a linear array of 512 detectors is used. Each detector subtends an angle of 1π x 1π. The detector array, aligned at a 15° angle with respect to the solar drift direction, is used to measure 512 chord lengths in the neighborhood of the diameter of the circular solar disk. A diameter is derived from the chord lengths by a least-squares fit. The telescope used is the Vacuum Solar Telescope of the Kitt Peak National Observatory. The detector array and associated electronics is part of the 512 channel magnetograph normally used with this telescope.

An observation consists of recording the signals from the detector array with a time constant of 0.3 s for the time it takes the sun to drift across the entire array (~ 2 1/2 minutes). Four such observations were made on each of 18 days between 4 December 1979 and 30 September 1980. For each day's observations radius values are computed. The mean value of each set of 4 and also a statistical uncertainty are derived. The statistical uncertainties are consistent with an uncertainty for each of the daily mean values of 0.2π. The 18 daily mean values are found to vary by more than this estimated uncertainty and have a standard deviation of 0.4π. The source of this excess variability is not known at this time.

As a preliminary search for secular variability, the 18 daily mean values were fitted to a linear trend. The result is an apparent decrease in solar radius of 0.2 ± 0.2 π/year. Because the size of the uncertainty, this result is not statistically significant.

REFERENCES

1. Eddy, J. A.; and Boornazian, A. A.: Secular Decrease in the Solar Diameter, 1863-1953. Bull. Am. Astron. Soc. 11, 1979, p. 437.

2. Meyermann, B.: Zur Pulsation der Sonne, Astron. Nachr. 279, 1950, p. 45.