Observation of Baily's Beads During the Total Solar Eclipse of 1980 February 16

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Abstract

Precise timings of Baily's beads activity were made from stations in India near the limits of the path of totality. The technique and planned use are outlined.

Precise timings of the appearances and disappearances of Baily's beads as viewed from the limits of the path of totality during a solar eclipse can be used for the following long range programs through comparison to past and future observations :

1. A check on the accuracy of the solar ephemeris by determining the relative position of the Sun and the Moon, to within 0".03.

2. A check on the accuracy of eclipse predictions near the path edge.

3. A measurement of the solar radius, to detect systematic change over a period of years, or short-term variations correlated with the solar cycle.

4. Derivation of a calibration of visual observations to photographic methods.

5. Extension of accurate limb profile measurements beyond the polar regions of the Moon as refined by grazing occultation observations of stars.

In order to separate shifts in the entire path from changes in the width, it is necessary to have observers at both northern and southern limits. It is also desirable to have several stations at each limit, spread perpendicularly to the predicted line so as to better establish its true location. Finally, it is necessary to know the location of each station very accurately through the use of survey maps.

Final corrections to the predicted limits to account for limb corrections were calculated byD.W.Dunham and Mr. David Herald, of Canberra, Australia, and applied. Then observing sites were chosen and located and their coordinates scaled from 1:50,000 topographic maps loaned by Mr. C. Sittipatti Rao of Hyderabad.

Our group, supported by the U. S. National Science Foundation, set up two stations near the northern edge and one near the southern limit. The northern stations were near Shadnagar, 50 km southwest of Hyderabad, and the southern stations were near Gudipadu, 23 km west of Kurnool, or 225 km southwest of Hyderabad. Our northernmost observer was stationed 0.5 km inside the predicted limit, and our main station was about 1.5 km further south. Mr. and Mrs. Herald established a third independent station about 1.5 km still further south and east.

At our one main station at each limit, the solar image was projected into a white cardboard screen using a small telescope, and the bead activity near maximum eclipse was photographed with a super-8 movie camera. A tape recorder was used to record radio time signals and visual observations, and to coordinate with the movie. Mr. and Mrs. Herald did not use a movie camera. The northernmost observer was to time the duration of totality, if any, with a stopwatch.

All stations successfully obtained observations. Reduction is not complete as yet. The main stations reported totality lasting 29 seconds (north) and 33 seconds (south), compared to predictions of 32 and 45 seconds respectively. Bead activity occurred for about 15 minutes. The movie film did not record them at the faintest for several seconds before and after totality. The tape recordings have yielded 30-100 timings per station, with an accuracy of $\pm$ 0.3 seconds before comparison with the film. The northernmost observer saw the corona and a prolonged diamond ring, but not totality. Hence the limit seems to have been south of the predicted line by about 0.5 km, or else there was an unusually deep valley on the lunar limb near the north pole, which had not previously been detected for the limb correction charts.

The southern limit observing team, coordinated by D.W. Dunham, included J. Dunham, Debra Johnson

(George Washington Univ.), and Maurice Quidley (East Carolina Univ.). The northern limit observers, coordinated by A.D.Fiala, included James Luxton, Joan Linnell, Anthony Kennedy, and John Sparrow (all East Carolina Univ.).

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Preliminary Results. So far only the recorded verbal observations have been reduced. A single observation consists of an accurate time (to 0.1 sec), identification of the type of event (bead form, disappear, reappear, merge, contact), and the cusp. For each, the predicted lunar limb profile and relative solar limb are computed, the feature identified, and a residual formed. A least squares procedure applied to the collected reduced observations yields corrections to the Solar position and radius. We now have 101 of our own bead timings from this eclipse, and also 143 form the the Australian team, 43 from the 1976 eclipse, and 54 from the 1979 eclipse.

In a previous analysis comparing the eclipses of 1715, 1976, and 1979 by a common reduction procedure, there was evidence of a decrease of $0''.68 \pm 0''.4$ in the Solar diameter from 1715 to 1976, but no change from 1976 to 1979. We have now analyzed the observations from 1976, 1979, and 1980 by a newer technique, and we find also no significant change from 1976 to 1979, but a further decrease from 1979 to 1980. This decrease in diameter lies in the range $0''.20$ to to $0''.50$, mean error $0''.20$. The amount is affected by the range of the lunar limb included and by the observer.

We still have to analyze the photographic observations, and we plan to make a much more critical examination of the limb corrections and personal equations for the observations already reduced.

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