one half, then this lifetime is found to be 8.6 minutes with an internal probable error of ± 0.2 minutes. This new value is approximately twice as long as the classical determination by Ten Bruggencate and Grottrian based on low-definition plates. It is in general agreement with the more recent approximate estimates by Macris, Röscher and Hugon, and Bray and Loughhead.

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Osculating Elements Derived from the Modified Hansen Theory for the Motion of an Artificial Satellite. A. BAILIE AND R. BRYANT, *NASA, Goddard Space Flight Center, Greenbelt, Maryland*.—The modified Hansen theory for the motion of an artificial satellite, as developed by Peter Musen, represents the gravitational perturbations. The development takes the form of several trigonometric series with numerical coefficients and specified arguments. The result of the modified Hansen theory is the position vector of the satellite which is obtained by evaluating these series.

In the present paper the velocity vector and the six classical osculating elements are shown to be obtainable also from the series in the general theory.

The ability to obtain osculating elements and/or velocity from the modified Hansen theory is considered a significant adjunct to that theory. Comparison with other general perturbations theories and with special perturbations techniques is now possible. Accurate transition from the general theory to numerical integration makes it possible to transfer to the latter method when additional disturbing forces, not included in the general theory, become of consequence.

An Investigation into the Seasonal Changes of Albedo as Derived from Earthshine Observations. GUSTAV A. BAKOS, *Smithsonian Astrophysical Observatory*.—Using A. Danjon's photometer, earthshine measurements were obtained at six of the Smithsonian Institution's Satellite Tracking stations. The double-image photometer is designed in such a way that the earth's albedo may be found through the ratios of the illuminations of the moon by the sun and by the earth. All of the measures are reduced to an adopted normal phase angle of 115° (or 245°), since the interest is in the fluctuations of the earthshine intensity relative to the atmospheric conditions and the percentage of land visible. Along this line, the land coverage was computed from photographs of a globe as seen from the moon; this was done for each observation. The weather data supplied by the IGY World Data Center enabled the amount of cloud cover over the corresponding area to be determined.

Before consideration of how the cloud cover and surface variations affected the earth's albedo, the observations were compared to the work of Danjon. The change in the magnitude difference (as seen from the moon) between the earth and sun would seem to indicate a more linear variation than that expressed by Danjon. This gives a basis for computation of a new phase function evaluation of the seasonal effect on the coefficients. The albedo was found then for each observation and studied with regards to station location, latitudinal and longitudinal variation of cloudiness, and of land and water surfaces.

As suggested by Dr. Fred L. Whipple, there should be a rapid change in the brightness of the moon as the solar reflection point passes from land to water. If such a region was clear at the time of observation, the increase in the brightness should be noticeable in the measurements. For a further use of the data obtained an analysis of this is underway.

Moonwatch Progress Report and Results Obtained. GUSTAV A. BAKOS AND LEON CAMPBELL, JR., *Smithsonian Astrophysical Observatory*.—The Smithsonian Observatory's satellite visual observing program (Moonwatch) continues to be an effective organization, producing a steady and ample flow of scientifically useful data. Affiliated in the program are 153 teams of volunteer observers in the U.S. and 19 other countries.

The optical instruments used by the stations vary greatly as to numbers and types. The significant variations relate to penetration power and extent of field view.

Timing equipment most widely used is a combination of radio receiver for reception of time signals and tape recorder. The use of stop watches is a satisfactory alternative.

In addition to the original mission of Moonwatch, namely, to obtain early acquisition data from which preliminary ephemerides could be derived and to make observations of the final decay of satellites, the program is engaged in a routine tracking project. It is obvious that the accuracy of Moonwatch observations does not match those of the Baker-Nunn cameras; however, some teams equipped with high-power telescopes are capable of producing observations closely approximating the field-reduced photographic observations. The mean error of Moonwatch observations, as derived from the residuals of 1959 Alpha 1 and 1959 Iota 1, is 0.6 second of time. The positional error is about 0.5° .

Planning calls for the acquisition of Moonwatch stations in the higher latitudes and other plans foresee

1. Procurement of additional deeper-penetration telescopes, (120 mm, $20\times$).