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Estimation of the astronomical Unit using the contact timings at the Transit of Venus

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The observation and measuring of Venus transits in front of the Sun have for long been the best opportunity to determine the distance between Earth and Sun. On June 8, 2004 astronomers all over the world encountered a rare opportunity of experimenting with the Venus transit which occurred after 122 years. Though the mean distance between the Earth and the Sun is being perfectly measured today from the radar measurements on the surface of the inner planets or from the Doppler tracking of solar system orbiters, this event gave us a remarkable opportunity to experiment the methods used in the astronomy history with our modern instruments. Moreover the measurements made in an event like this using the recently installed ACCIMT telescope and comparing them with other internationally reputed observatories gave us an opportunity to validate the accuracy and capability of the ACCIMT telescope.

On June 8th ,2004 from 11.13 a.m. onwards the transit of Venus was observed at two different locations Yala, Kirinda and Artur C Clarke Institute for Modern Technolgies(ACCIMT), Katubedda to obtain the contact timings at internal ingress and egress. At ACCIMT, Sri Lanka largest optical telescope was used to observe the Venus transit with a special optical solar filter fitted in front of the telescope. A 40 mm eyepiece with cross hairs with magnification equal to 135 was used to get the contact timings. The computer clocks synchronized with the international internet time servers were used to take the timings. We collaboratively observed the transit of Venus with the University of Duisburg-Essen in Germany and the Netherland's Breda observatory. ACCIMT is the only candidate who obtained the contact timings in the south Asia region with a good accuracy in this team. In this study we adopted two methods namely Halley's method and Delisle's method in calculating the solar parallax and the astronomy unit.

The time of the topocentric contacts t^i of the observer in the latitude ϕ and the longitude λ from the geocentric timings is given by the equation $t^i = t_{geo} + \tau^{(1)} + \tau^{(2)}$ where $i = 1 \ldots 4$ correspond to the four contacts and t_{geo} is for the geocentric timing. The location(latitudeϕ longitude λ $_{W}$ degrees) and observations carried out at 4 stations with timing at the 2nd contact inner ingress t_1(UT), $_3$rd contact egress t_2(UT) and the t_2-t_1 are Colombo-ACCIMT (6.783N, 79.9E) $5^h33^m58^s$,$11^h02^m57^s$,$5^h58^m59^s$; Netherland-Breda (51.567N, 4.80E) $5^h39^m49^s$, $11^h03^m42^s$, $5^h23^m53^s$; Germany1 (53.310N, 8.35E) $5^h39^m38^s$, $11^h03^m27^s$, 5^h2nd3^m49^s and Germany2 (48.376N, 10.90E) $5^h39^m54^s$, $11^h04^m00^s$, $5^h24^m06^s$, respectively. By grouping the above stations two by two, one parallax was estimated for each of the possible pair.

We were able to estimate the astronomical unit(AU) with good accuracy. Our value for the AU is $(1493289 \pm 3) \times 10^2$ km and it is very close to the internationally accepted value 149597870.61 km. The accuracy of the value heavily depends on the accuracy of the timings at the contacts. Because of the black drop effect considerable uncertainty of the timings can occur almost all the times. The random error for a timing caused by the black drop effect is taken as 10s. Had we found more stations with large separations to each other we would have estimated the AU to a greater accuracy. As the value obtained here for the AU is very close to the internationally accepted value it can be concluded that the contact timings obtained at ACCIMT are of the international standards.