**Transit of Venus 2004**  
Data Analyzes

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**Abstract:** Since April 2004, HRC astronomy department has established a scientific group for transit of Venus June 08, 2004. This group is included talented and active university and high school students. When HRC became a member of Essen university project, they started to work on the projects. They studied projects, used useful references, reviewed last project for Mercury transit 2003 and finally at June 08, 2004 they measured and calculated parameters which were supposed for this project. Some of the measured parameters were time and height of culmination, radius of Earth, radius of Venus orbit and Venus positions over the solar disk. Requiring common measurements in some projects, HRC has collaborated with other centers, organizations and groups from India, Germany, Mauritius and Spine. This report is the final measurements and calculations.

**Project.1:** Radius of Venus orbit

*Nasim Khosravi*

According to the project methods the R.A. and Dec. of Venus were measured during its retrograde motion. May 24, 2004 and June 12, 2004 were selected for this measurement. Results have been illustrated in following table.

<table>
<thead>
<tr>
<th>Date</th>
<th>R.A.</th>
<th>Dec.</th>
</tr>
</thead>
<tbody>
<tr>
<td>May 24, 2004</td>
<td>5h 39m 1.3s</td>
<td>26° 17' 34&quot;</td>
</tr>
<tr>
<td>June 12, 2004</td>
<td>4h 57m 0.8s</td>
<td>21° 31' 2&quot;</td>
</tr>
</tbody>
</table>

The recommended software of Essen (RadiusofOrbits.exe) was used and following value was obtained:

\[ r_{\text{Venus}} = 0.73 \text{ AU} \]

**Project.2:** Determining own geographical coordinates and projected distance of different observers.

*Akram Mir Ahmadi*

At this project we will determine and calculate height of culmination, Sun R.A. and Dec., distances of observers and angle of projection.  
Coordinated of observatory (K1 observatory, Isfahan, Iran) determined carefully By GPS:

**K1 longitude (λ):** 52h 47' E = 52.78 h
K1 latitude ($\varphi$): $32^\circ 51'\ N = 32.85^{\text{deg}}$

Time zone: $+3.5$

Altitude: 1200 $m$

Then according to the method explained in project, the height of culmination was obtained by the shortest shadow length.

**Length of Vertical Pole ($l$):** $64.3\ \text{Cm}$

**Shortest Shadow Length ($l_s$):** $13.1\ \text{Cm}$

$$h_{\text{culmination}} = 78.485^{\text{deg}}$$

So we can calculate R.A. and Dec. of the Sun and Dec. of K1 observatory, the culmination time was used form project 3:

- **Sun R.A.** ($\alpha_{\text{sun}}$) = $05^h06^m19^s = 05.105^h$
- **Sun Dec.** ($\delta_{\text{sun}}$) = $44^\circ\ 21'\ 54'' = 44.365^{\text{deg}}$
- **K1 Dec.** ($\delta_{k1}$) = $32^\circ\ 51' = 32.85^{\text{deg}}$

Other parameters will be determined after that other observers send us their results.

**Project.3:** Determining the radius of the Earth

*Mina Soltan Gheys*

In project 3 the radius of the Earth was determined by ourselves measurements and at least measurements of an observer in a place with same longitude or latitude. At the first, the culmination time, should be determined. The project text shows the solution of these problems. So according to the text, the shortest shadow length was measured.

- **Length of Vertical Pole ($l$):** $64.3\ \text{Cm}$
- **Shortest Shadow Length ($l_s$):** $13.1\ \text{Cm}$

The culmination time was calculated by averaging between two contact times of vertical pole shadow and circle drawn on the sheet.

- **First Contact Time ($T_1$):** 06:49:57 UT
- **Second Contact Time ($T_2$):** 10:03:42 UT
- **$T_{\text{culmination}}$:** 08:26:57 UT

By using $l$ and $l_s$, $Z$ was calculated:

$$Z = \frac{l_s}{l} = 0.2037$$

To determine the radius of the Earth we need other collaboration data.

For example for Jose Fernández-Arozena from Santa Cruz de la Palma, Spine:

- **$T_{\text{culmination}}$:** 13:12 = 13.2
- **$S$ (distance between us) =** 6570 $km$
- **Longitude =** $17^\text{h} 53'\ 53''\ W$
- **Latitude =** $28^\circ\ 45'\ 47''\ N$

So we can calculate the parameter, $\alpha$:

$$\alpha = 1.2438$$

Then the radius of the Earth must be:

$$R_E = 6288\ km$$

This difference between real radius of the Earth and our calculation is related to 4 degrees difference between two observation latitudes (K1 lat = $32^\circ\ 47'$, Jose lat = $28^\circ\ 45'\ 53''$).

**Project.4 :** Measuring the angular radius of the Sun
Zahra Eizady

The other parameter that we need to calculate the parallax, is angular radius of the Sun, $\rho_s$. This parameter is calculated by determining the speed of Sun movement. According to the project text, this parameter is calculated by measuring the time between 3rd and 4th contacts of Sun picture and circle drawn on the sheet ($t_1$ to $t_2$).

$$\Delta t = t_2 - t_1 = 02^m:44.84^s$$

By using declination of the Sun, $\delta_{\text{sun}}$, the angular speed, $\omega$, is calculated.

$$\omega = 7.272E^{-5}\text{ Rad/S}$$

Therefore, the angular radius of the Sun must be:

$$\rho_s = 20.61'$$

Project.5 : Exercises in photographing the Sun and exact position measurement on the Sun’s disk
Mansooreh Pezeshkzadeh

In order to determine the position angle of Venus with respect to the direction to east we photographed the Sun twice on each picture with fixed camera. Precondition of this procedure is that the size of the picture is large enough for more than one Sun. A Nikon camera and film Konica 100 were used for this project. By using suitable accessories on the telescope we could photograph two suns in each photo. We took photos on recommended times in project.

Then the photos were scanned by computer and processed by recommended software in Essen project (Bildauswertung.exe). The parameters $x'$ and $y'$ and position angle, $\Theta$, were obtained by this method.

<table>
<thead>
<tr>
<th>No.</th>
<th>UT</th>
<th>$x'$</th>
<th>$y'$</th>
<th>$\Theta$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>06:29:40</td>
<td>-.6096</td>
<td>-.5286</td>
<td>220.93°</td>
</tr>
<tr>
<td>2</td>
<td>06:43:00</td>
<td>-.5531</td>
<td>-.5558</td>
<td>225.14°</td>
</tr>
<tr>
<td>3</td>
<td>06:58:00</td>
<td>-.4965</td>
<td>-.5557</td>
<td>228.22°</td>
</tr>
<tr>
<td>4</td>
<td>08:28:00</td>
<td>-.1173</td>
<td>-.6571</td>
<td>-100.12°</td>
</tr>
<tr>
<td>5</td>
<td>09:13:30</td>
<td>.0792</td>
<td>-.6956</td>
<td>-83.51°</td>
</tr>
<tr>
<td>6</td>
<td>10:15:00</td>
<td>.3195</td>
<td>-.7531</td>
<td>-67.01°</td>
</tr>
<tr>
<td>7</td>
<td>10:28:00</td>
<td>.4031</td>
<td>-.7636</td>
<td>-62.13°</td>
</tr>
<tr>
<td>8</td>
<td>10:58:00</td>
<td>.5495</td>
<td>-.7907</td>
<td>-55.21°</td>
</tr>
</tbody>
</table>

Now by using another observers’ data we can calculate the parallax, completely.

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