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Preliminary report

EQUATOR AND EQUINOX CORRECTIONS FROM THE SUN AND PLANET OBSERVATIONS MADE AT THE BELGRADE OBSERVATORY

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SUMMARY: Some particulars concerning the observations of the Sun and the planets Mercury, Venus and Mars, made at the Belgrade Observatory, as well as the accuracy estimates of the observations and the corrections to the equator and the equinox positions are presented.

The observations of the solar system bodies: the Sun, Mercury and Venus since 1975, and Mars since 1981, are aimed at the determination of data necessary for further improvement of the equator and equinox positions.

The results of our observations of the Sun and planets, that is their apparent right ascensions and declinations, along with the corresponding (O-C) values, have been regularly published in Bull. Astron. Belgrade. In the case of the Sun the mean error of observation is $\pm 0''.48$. The mean values of errors derived from the observations performed using the semi-transparent Sukharev filter (A) for reducing the intensity of the solar radiation, and another one (B) produced in the USA (used since 1984), are given in Table 1. The mean error pertaining to the planets are listed in Table 2, wherein:

σ_0 – rms error of a single observation;
n – the number of observations;
k – the average number of stars per observing tours.

Table 1. Mean values of errors in the solar observations

	right ascension			declination		
Filter	σ_o	n	k	σ_o	n	k
A	$\pm 0^s.045$	200	5	$\pm 0''.36$	339	8
B	± 0.028	445	5	± 0.31	448	5

Table 2. Mean errors of a single observation of planets

	right ascension			declination		
Planet	σ_o	n	k	σ_o	n	k
Mercury	$\pm 0^s.074$	211	4	$\pm 0''.36$	221	5
Venus	± 0.066	677	5	± 0.40	696	6
Mars	± 0.036	180	6	± 0.36	182	6

As is well known, there appears in the observations of the Sun and the planets a number of systematic errors peculiar to the nature of these observations. The "room-refraction" is among the strong sources of systematic errors. The determination and examination of these systematic errors rests upon the observations of bright stars conjointly with the solar system body concerned.

In the observations of the celestial bodies presenting a disc in the field of view one is confronted with a number of errors connectted with the setting upon the body's limb. This is particularly true of the settings on the solar limb.

The mean (O-C) values for Venus and their mean errors are set out in Table 3.

Table 3. Means of (O-C) values and their errors for Venus

	front limb			rear limb			both		
	$(O-C)_\alpha$	σ_o	n	$(O-C)_\alpha$	σ_o	n	$(O-C)_\alpha$	σ_o	n
CE	$+0^s.002$	$\pm0^s.050$	98	$-0^s.002$	$\pm0^s.050$	86	$-0^s.008$	$\pm0^s.027$	9
CW	-0.005	±0.055	139	$+0.010$	±0.050	194	$+0.004$	±0.049	55
	lower			upper			both		
	$(O-C)_\delta$	σ_o	n	$(O-C)_\delta$	σ_o	n	$(O-C)_\delta$	σ_o	n
CE	$+0''.08$	$\pm0''.48$	74	$+0''.01$	$\pm0''.46$	50	$-0''.06$	$\pm0''.40$	100
CW	$+0.06$	±0.30	102	$+0.00$	±0.39	61	$+0.00$	±0.40	213

From our observations of the Sun in the period 1975-1994 the following results are obtained:

$$\Delta A = +0^s.026 \pm 0^s.024 \quad , \quad \Delta\delta_o = -0''.04 \pm 0''.10 \quad \text{for period 1975-1979 ;}$$

$$\Delta A = -0^s.010 \pm 0^s.007 \quad , \quad \Delta\delta_o = +0''.05 \pm 0''.03 \quad \text{for period 1975-1981 ;}$$

$$\Delta A = -0^s.002 \pm 0^s.003 \quad , \quad \Delta\delta_o = +0''.03 \pm 0''.02 \quad \text{for period 1975-1984 ;}$$

$$\Delta A = +0^s.003 \pm 0^s.003 \quad , \quad \Delta\delta_o = +0''.03 \pm 0''.02 \quad \text{for period 1975-1994 .}$$

Our observations being on the whole evenly distributed throughout the period concerned, the formulae proposed by Newcomb (Nemiro, 1963) have been used for the calculation of the corrections to the Sun's orbital elements

$$\Delta\alpha = -\Delta A - \cos\alpha \operatorname{tg}\delta\Delta\varepsilon - 2cos\varepsilon \sec^2\delta \cos M e\Delta\pi$$
$$\Delta\delta = -\Delta\delta_0 + \sin\alpha\Delta\varepsilon + \sin\varepsilon\cos\alpha(1+2e\cos M)\Delta L_0 \qquad (1)$$

and the expressions

$$\Delta\lambda = x_1 + y_1\cos(l-L) + z_1\sin(l-L)$$
$$\Delta\beta = x_2 + y_2\cos(l-L) + z_2\sin(l-L) \qquad (2)$$

for calculating the corrections to the orbital elements of Mercury and Venus (McClenahan, 1952).

A good agreement has been obtained between the results indicated and the observational material for the period 1975-1994 for the values of the right ascension and declination corrections of the FK5 stars:

$$\Delta A = +0^s.013 \pm 0^s.003$$
$$\Delta\delta_0 = +0''.03 \pm 0''.02 .$$

The corrections to the equator and equinox positions obtained from the Mercury and Venus observations, following from the above equations, are given in Table 4.

Table 4. The equator and equinox corrections obtained from the Mercury and Venus observations

	unit $0^s.001$					unit $0''.01$				
Planet	x_1	σ_{x_1}	y_1 σ_{y_1}	z_1 σ_{z_1}	n	x_2	σ_{x_2}	y_2 σ_{y_2}	z_2 σ_{z_2}	n
Mercury	-10	±5	-14 ±6	$+19$ ±5	211	$+1$	±3	-4 ±3	$+4$ ±4	221
Venus	$+3$	±2	$+2$ ±2	$+4$ ±3	677	$+3$	±2	-2 ±2	-3 ±2	696

It is obvious from the above results that they are within the satisfactory limits, indicating that our measurements are comparable with modern observations of the Sun and the planets.

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ПОПРАВКЕ ЕКВАТОРА И ЕКВИНОКЦИЈА ИЗ ПОСМАТРАЊА СУНЦА И ПЛАНЕТА УРАЂЕНИХ НА БЕОГРАДСКОЈ ОПСЕРВАТОРИЈИ

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