Venus' Rotation Equations

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Constants

$f_R := 2791.826$	Free Rotation Constant
$i_M := 0.127036$	Maximum Influenced Rotation Constant (for planets and moons only)
$i_{St} := 1.0121647 \cdot 10^{-12}$	Start Influenced Rotation Distance Constant
$i_{Ma} := 5.6964797 \cdot 10^{-10}$	Maximum Influenced Rotation Distance Constant
$i_{Sp} := 1.0686849 \cdot 10^{-9}$	Stop Rotation Distance Constant

Facts	Venus	Sun
Mass (kg)	$m := 4.8685 \cdot 10^{24}$	$M := 1.9891 \cdot 10^{30}$
Density (g/cm^3)	$\rho := 5.243$	$\rho_S := 1.408$
Axis Tilt (deg)	$t := 177.36$	$t_S := 7.25$
Semi-major Axis (km)	$a := 108210000$	
Orbit Eccentricity (deg)	$e := 0.00677323$	
Orbit Inclination (degree), with respect to equator	$i := 3.86$	

$$\omega_F := f_R \div \sqrt[6]{m} \cdot \sqrt[2]{\rho}$$

$\omega_F = 0.49103496$ Venus' Free Rotation (per day)

Part 1

Venus' Influenced Rotation by the influence of the Sun

$$q := a \cdot (1 - e)$$

$q = 107477068.8$ Venus' Perihelion Distance (km)

$$Q := a \cdot (1 + e)$$

$Q = 108942931.2$ Venus' Aphelion Distance (km)

$$i_r := \left(\left| cos\left(\frac{i \cdot \pi}{180} \right) \right| + 1 \right) \div 2$$

$i_r = 0.99886576$ Venus' Influenced Rotation Reduction Factor by Orbit Inclination

$$\omega_{Mi} := \frac{\sqrt[6]{m \cdot i_r \div M} \div \sqrt[6]{\rho}}{i_M}$$

$\omega_{Mi} = 0.69318767$ Venus' Maximum Influenced Rotation by the Sun (p.d.)

$$S_t := \frac{\sqrt[6]{m \cdot i_r \div M}}{i_{St}}$$

$S_t = 114671746473.9$ Venus' Start Influenced Rotation Distance to the Sun (km)

$$M_a := \frac{\sqrt[6]{m \cdot i_r \div M}}{i_{Ma}}$$

$M_a = 203751615$ Venus' Maximum Influenced Rotation Distance to the Sun (km)

$$S_p := \frac{\sqrt[6]{m \cdot i_r \div M}}{i_{Sp}}$$

$S_p = 108607030.8$ Venus' Stop Rotation Distance to the Sun (km)

Calculating Venus' average distance to the Sun, if $(q < S_p < Q)$

$$x := if\left(q < S_p, if\left(S_p < Q, \frac{S_p - a}{e}, 0\right), 0\right)$$

$x = 58617648.78$ X value at Venus' orbit intersection with S_p Boundary (km)

$$b := a\sqrt{1 - e^2}$$

$b = 108207517.8$ Venus' Semi-minor Axis (km)

$$y := b\sqrt{a^2 - x^2} \div a$$

$y = 90956010.23$ Y value at the Venus' orbit intersection with S_p Boundary (km)

$$\theta := atan\left(\frac{-x}{y}\right) + \frac{\pi}{2}$$

$\theta = 0.99832445$ Half-angle of the Venus' orbit out of S_p Boundary (rad)

$$P_o := 2 \cdot a \cdot \int_0^{\pi} \sqrt{1 - e^2 \cdot sin(\theta)^2}\, d\theta$$

$P_o = 679895684.1$ Venus' Orbital Perimeter (km)

$$s := a \cdot \int_0^{\theta} \sqrt{1 - e^2 \cdot sin(\theta)^2}\, d\theta$$

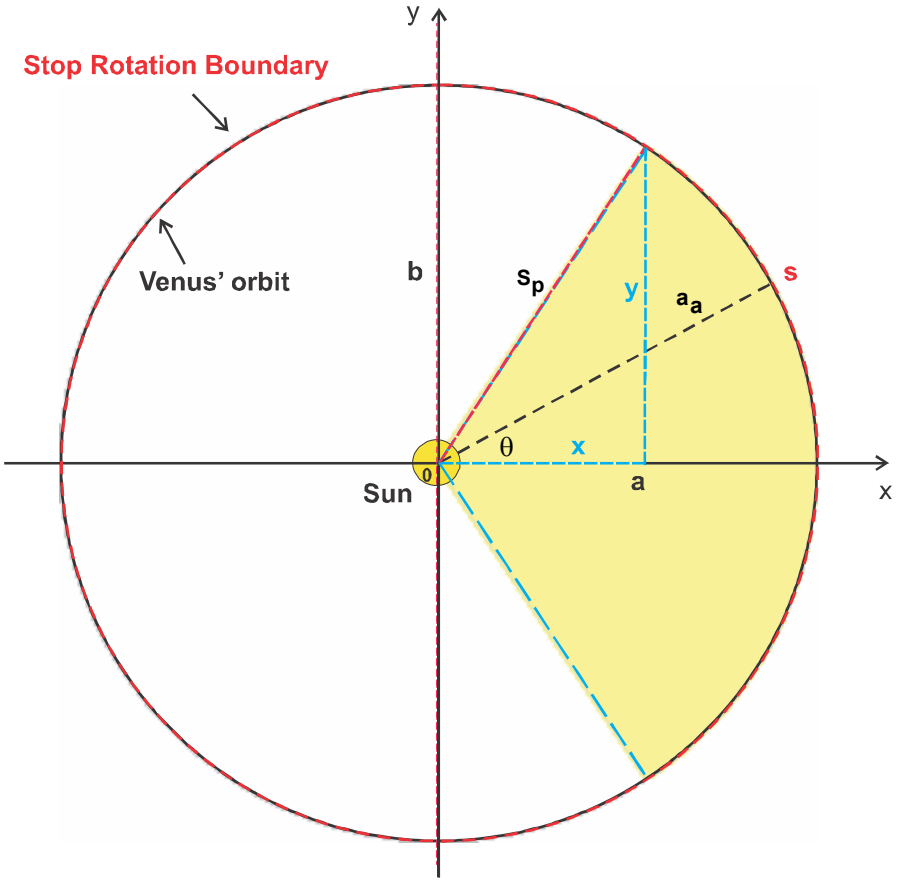
$s = 108028014.5$ Half of Venus' orbit out of S_p Boundary (km)

$$a_a := if\left[q < S_p, if\left[S_p < Q, a\frac{\int_{\pi - \frac{s}{a}}^{\pi} (1 - e \cdot cos(E)) \cdot \sqrt{1 - e^2 \cdot cos(E)^2}\, dE}{\int_{\pi - \frac{s}{a}}^{\pi} \sqrt{1 - e^2 \cdot cos(E)^2}\, dE}, 0\right], 0\right]$$

$a_a = 108827110.82$ Venus' average distance to the Sun outside S_p Boundary (km)

$$n := \frac{2 \cdot s}{P_o} \cdot \sqrt{\frac{a_a^{\,3}}{a^3}}$$

$n = 0.32050046$ Ratio of the Venus' orbit out of S_p Boundary to the whole orbit



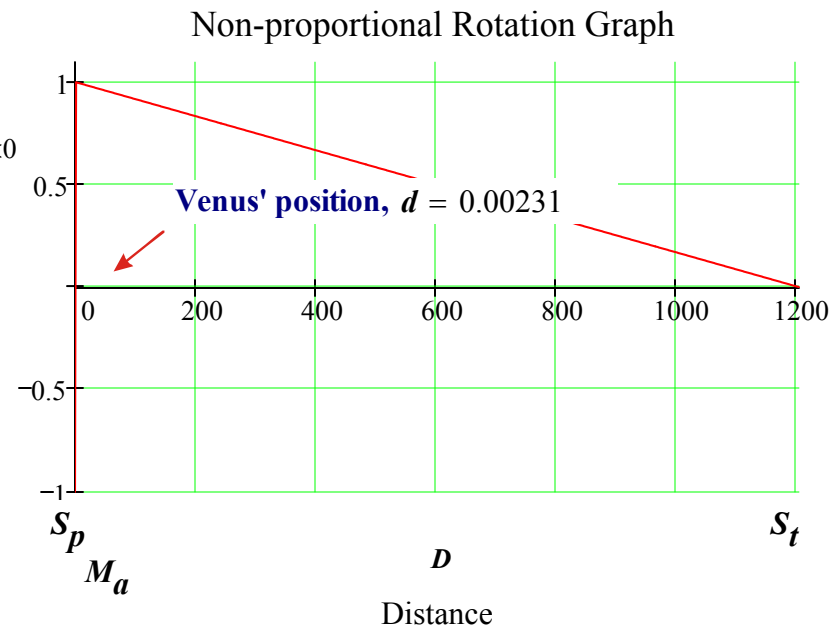
Venus' orbit overlapping the Stop Rotation's domain

$$d := \text{if}\left(q < S_p, \text{if}\left(S_p < Q, \frac{a_a - S_p}{M_a - S_p}, \frac{a - S_p}{M_a - S_p}\right), \frac{a - S_p}{M_a - S_p}\right)$$

$d = 0.00231311$ Venus' corresponding distance to the Sun relative to S_p on the X axis of the graph

Rotation

$$\begin{cases} -1 - \dfrac{0.04}{D - \left(\sqrt{0.29} - 0.5\right)} - \left(\sqrt{0.29} - 0.5\right) & \text{if } D < 0 \\ \dfrac{-0.04}{D + \left(\sqrt{0.29} - 0.5\right)} + \left(0.5 + \sqrt{0.29}\right) & \text{if } 0 \le D \le 1 \\ \dfrac{-D + 1}{\frac{S_t - M_a}{M_a - S_p}} + 1 & \text{if } 1 < D \end{cases}$$



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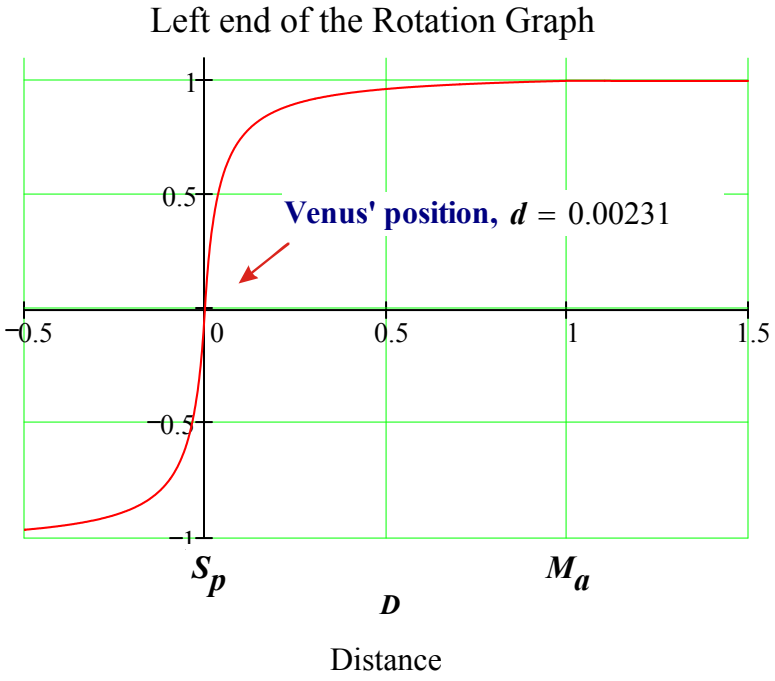

$$\omega(d) := \begin{cases} -1 - \dfrac{0.04}{d - \left(\sqrt{0.29} - 0.5\right)} - \left(\sqrt{0.29} - 0.5\right) & \text{if } d < 0 \\ \dfrac{-0.04}{d + \left(\sqrt{0.29} - 0.5\right)} + \left(0.5 + \sqrt{0.29}\right) & \text{if } 0 \le d \le 1 \\ \dfrac{-d + 1}{\frac{S_t - M_a}{M_a - S_p}} + 1 & \text{if } 1 < d \end{cases}$$

$\omega(d) = 0.05883488$ Venus' corresponding Influenced Rotation by the Sun on the Y axis of the graph

$$t_r := \text{if}\left(a < M_a, \text{if}\left(\omega_{Mi} > \omega_F, \frac{t \cdot \omega_F}{90}, \frac{t \cdot \omega_{Mi}}{90}\right), \text{if}\left(\omega(d) \cdot \omega_{Mi} > \omega_F, \frac{t \cdot \omega_F}{90}, \frac{t \cdot \omega(d) \cdot \omega_{Mi}}{90}\right)\right)$$

$t_r = 0.96766623$ Venus' Maximum and Free Rotational Speed Reduction by Axis Tilt

$$\omega i := \text{if}\left[a > M_a, \omega(d) \cdot \omega_{Mi} + \omega_F - t_r, \left[\omega(d) \cdot \left(\omega_{Mi} + \omega_F - t_r\right) \cdot \text{if}\left(q < S_p, \text{if}\left(Q > S_p, n, 0\right), 1\right)\right]\right]$$

$\omega i = 0.00408352$ **Venus' end result Rotation (p.d.)**

Part 2

Venus' Total Rotation

$$T := \text{if}\left(\omega i \le 0, 0, \text{if}\left(t \le 90, \frac{1}{\omega i}, \frac{-1}{\omega i}\right)\right)$$

$T = -244.88685$ **Venus' Sidereal Rotation Period (day)**
If (T = 0 , Venus' Synchronous Tropical Rotation)

Observation

$T_o := -243.02083$ **Venus' Sidereal Rotation Period) (day)**
If (T = 0 , Venus' Synchronous Tropical Rotation)

$$\%Diff := \frac{\left(T - T_o\right) \cdot 200}{T + T_o}$$

$\%Diff = 0.76490530$ Percentage deference between the calculation and the observation