Errata

Page 6

Last paragraph modified to the following:

Then
$$\begin{array}{ll} \beta' = \beta, \pi > \theta > 0 & \alpha' = \alpha, t_m > (t_2 - t_1) \\ \beta' = -\beta, 2\pi > \theta > \pi & \alpha' = 2\pi - \alpha, (t_2 - t_1) > t_m \end{array}$$

And now:

$$(t_2 - t_1) = \sqrt{\frac{a^3}{\mu}}((\alpha' - \sin\alpha') - (\beta' - \sin\beta'))$$

P22, figure updated

The figure for an example of extended duration transfer type is replaced by the following:

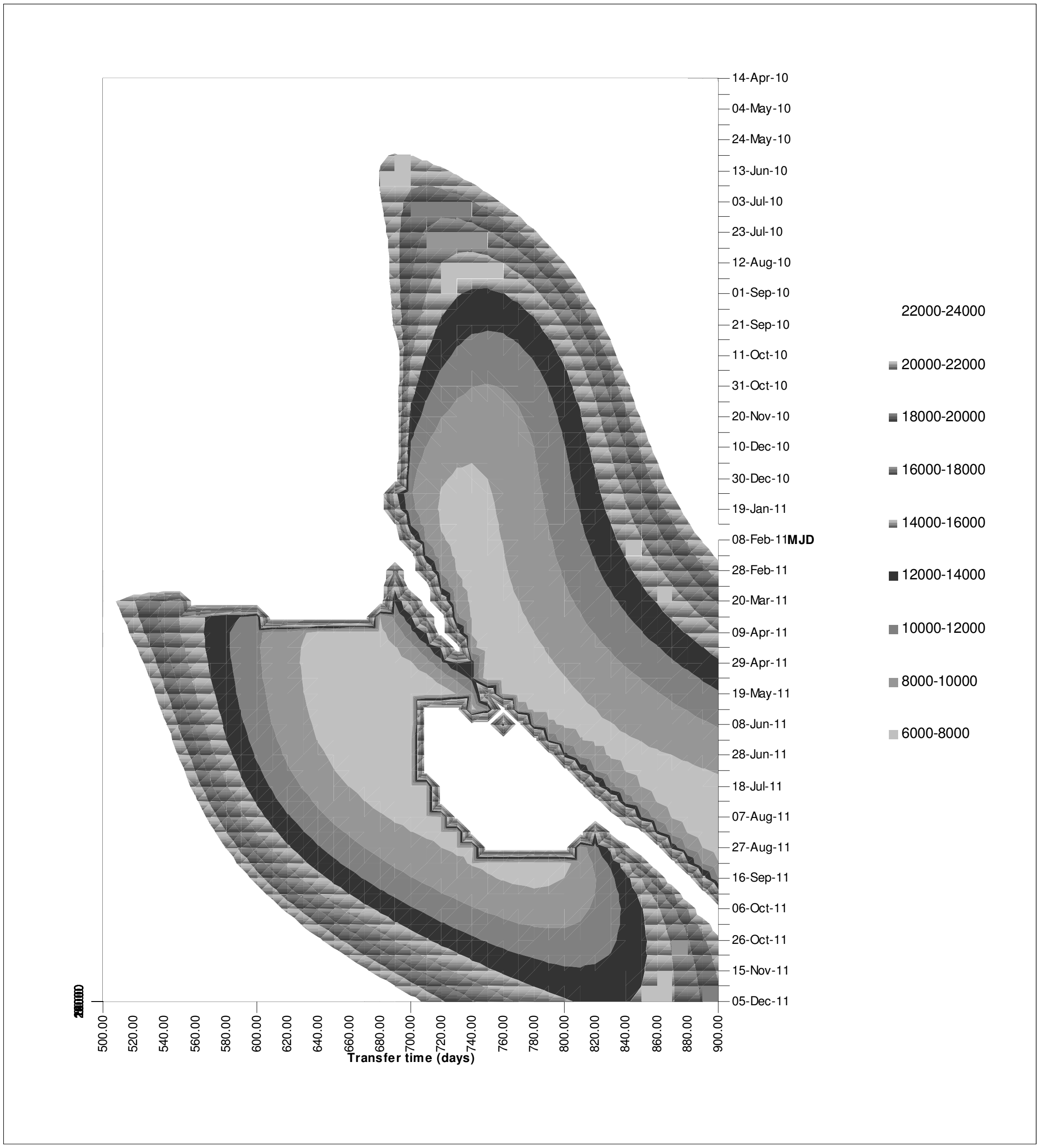

Figure 1.1.17 Extended duration transfers in terms of V_∞ contours, for Earth-Mars transfers starting in 2010

The transfers shown in this figure only include those with 1 to 2 heliocentric revolutions.

P42, para 2 should read

The right ascension, RA, of the departure vector, measured with respect to the same inertial longitude reference as the orbit ascending node, is given in two parts by the following equations. First, the angle, α from the ascending node is given by

P43, para 2, sentence should read

'The direction of the asymptote, θ, is then 150 deg (assuming a perigee radius for the departure orbit of 6,578km)'

(ie not 159 deg)

p43, para 3, sentence should read

Both solutions for the argument of perigee are shown, for a given declination (assuming both solutions lie in the same plane)

Page 114

Top of page:

Where Thrust is the spacecraft thrust, *Azimuth* is the spacecraft thrust vector azimuth angle measured in the radius vector frame (azimuth is in the orbit plane, measured from the normal to the radius vector), and *Elevation* is the spacecraft thrust vector elevation angle measured out of the orbit plane

becomes

Where Thrust is the spacecraft thrust, *Azimuth* is the spacecraft thrust vector azimuth angle measured in the radius vector frame (azimuth is in the orbit plane, measured from the radius vector (x_T) towards (y_T)), and *Elevation* is the spacecraft thrust vector elevation angle measured out of the orbit plane

P182, Figure 4.3.13

Plot axes unit. Labelled AU, should be km

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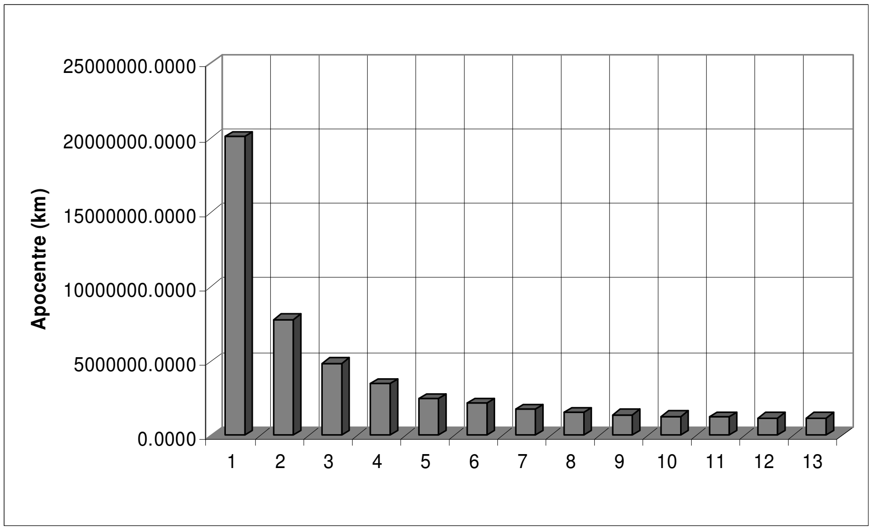
Equation 4.3.47 $a_{\max} = \dfrac{1}{\left(\dfrac{2}{r} - \dfrac{V_{\max}{}^{2}}{\mu}\right)}$

P199, Figure 4.3.27

The orbits used in this figure are not fully resonant (implying rendez-vous does not occur at exactly the same longitude). Exact resonance, where the moon completes exactly an integer number of revolutions between fly-bys (and so longitude of fly-by is constant) results in a modification to the figure.



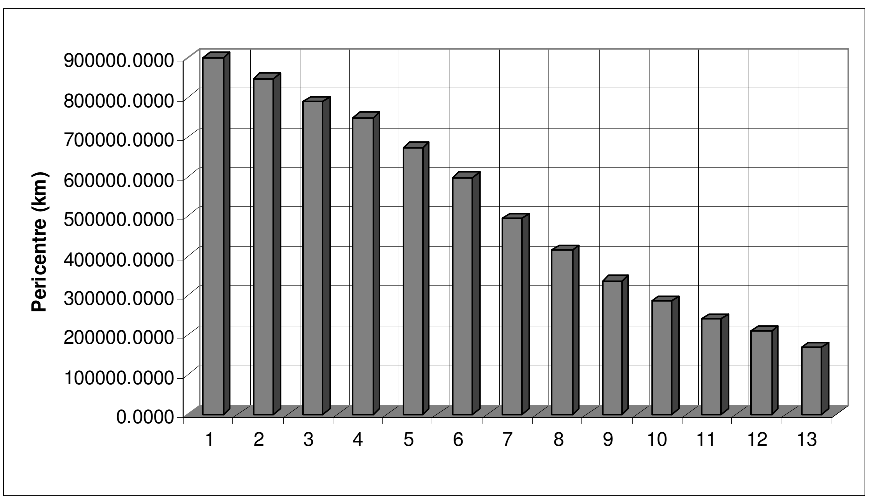


Figure 4.3.27 Apocentre and pericentre evolution for Ganymede GA sequence in the Jovian system. The initial orbit apocentre = 20 million km, pericentre = 900000km.

P200, Table 4.3.3

The orbits used in this table are not fully resonant (implying rendez-vous does not occur at exactly the same longitude). Exact resonance, where the moon completes exactly an integer number of revolutions between fly-bys (and so longitude of fly-by is constant) results in a modification to the table:

Target revs	Orbit Revs	Time
31	1	221.70
8	1	57.2
4	1	28.6
3	1	21.5
2	1	14.3
3	2	21.5
11	10	78.7
9	10	64.4
3	4	21.5
2	3	14.3
3	5	21.5
5	9	35.8
1	2	7.2
5	11	35.9

Table 4.3.3 Example of a resonant gravity assist sequence at Ganymede

P217, last para, sentence should read

'When approaching at 5.6 km/sec then after the gravity assist the spacecraft may still possess an excess hyperbolic speed of typically 4km/sec'

(ie not 2km/sec)

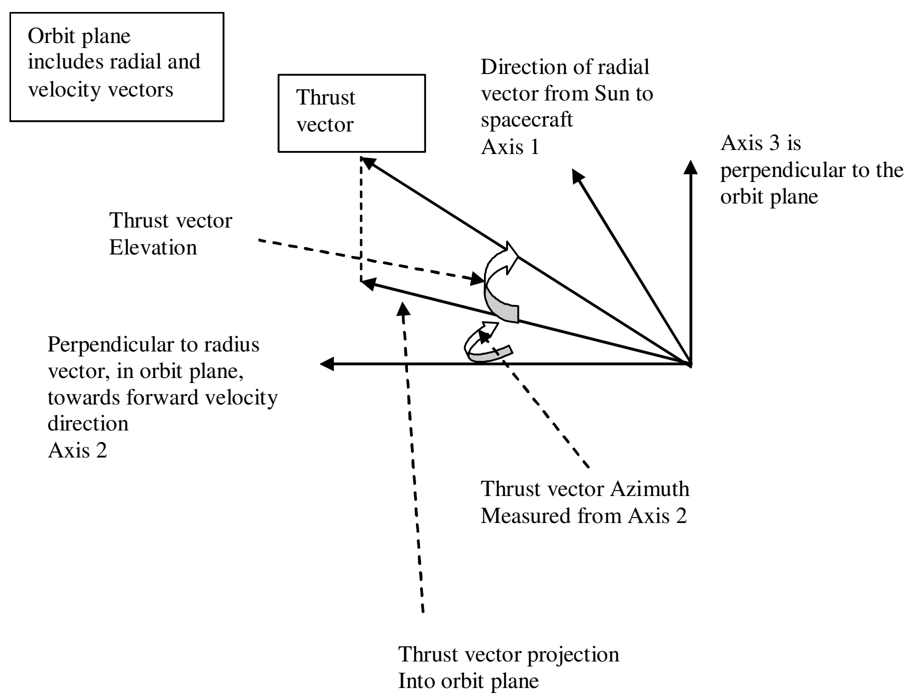
Page 230

At start of first full paragraph:

These expressions may be re-arranged into a more convenient format and using the assumption of a steerable thrust vector, with magnitude T, angle α from the normal to the radius vector in the orbit plane and angle β out of the orbit plane (azimuth and elevation angles as described in Section 3.3.1)

Should read

These expressions may be re-arranged into a more convenient format and using the assumption of a steerable thrust vector, with magnitude T, angle α from the normal to the radius vector in the orbit plane (axis 2 in the following illustration) and angle β out of the orbit plane (azimuth and elevation angles as described in the following illustration)



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From top

The strategy is to devise steering laws that can instantaneously maximise the rate of change of a given orbital element. Such a steering law can then be applied in a particular phase of a transfer. This analysis will consider the full perturbation equations.

Maximum rate of change of orbital energy
In this case, the objective is to provide a steering law that will maximise the rate at which the spacecraft's orbital energy changes.

Is updated to:

Maximising the rate of change of orbital elements
The strategy is to devise steering laws that can instantaneously maximise the rate of change of a given orbital element. Such a steering law can then be applied in a particular phase of a transfer. This analysis will consider the full perturbation equations.

It should be noted that although such steering laws find the maximum rate of change of an element at any instant, they are not the solutions to the formal optimisation problem that aims to maximise the overall change in an element over a fixed time interval. This later problem is a classical one in the theory of optimal control and is not presented in this book. The use of steering laws that provide an instantaneous maximum rate of change provides a quick way to obtain an efficient solution. This solution is generally a good approximation to the solution of the full optimisation problem for low acceleration cases.

Maximum rate of change of orbital energy
In this case, the objective is to provide a steering law that will maximise the rate at which the spacecraft's orbital energy changes.

P236, section 4.5.1

In the remainder of this section (4.5.1) describing maximum rate of change of orbital elements the terms 'optimum rate of change', optimum thrust direction' and 'optimum steering angle' are used. In this context 'optimum' is referring to the maximised instantaneous rate of change of a target orbit element. This is not referring to the solution to the formal optimisation problem that aims to maximise the overall change in the element over a fixed time interval (as commented in the above paragraphs).

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List items (1 to 7) : Add item 8:

(8) Initial departure may be either inwards or outwards.

Page 277

The following figure is updated

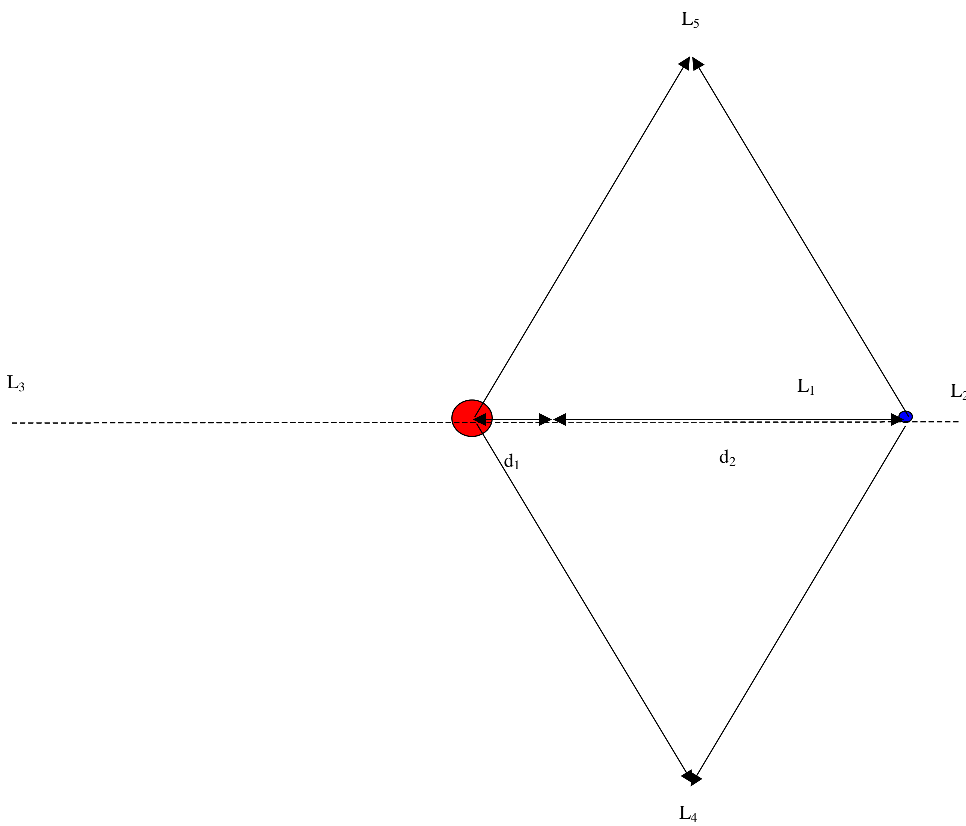


Figure 4.8-4 Locations of the Lagrange libration points

To:

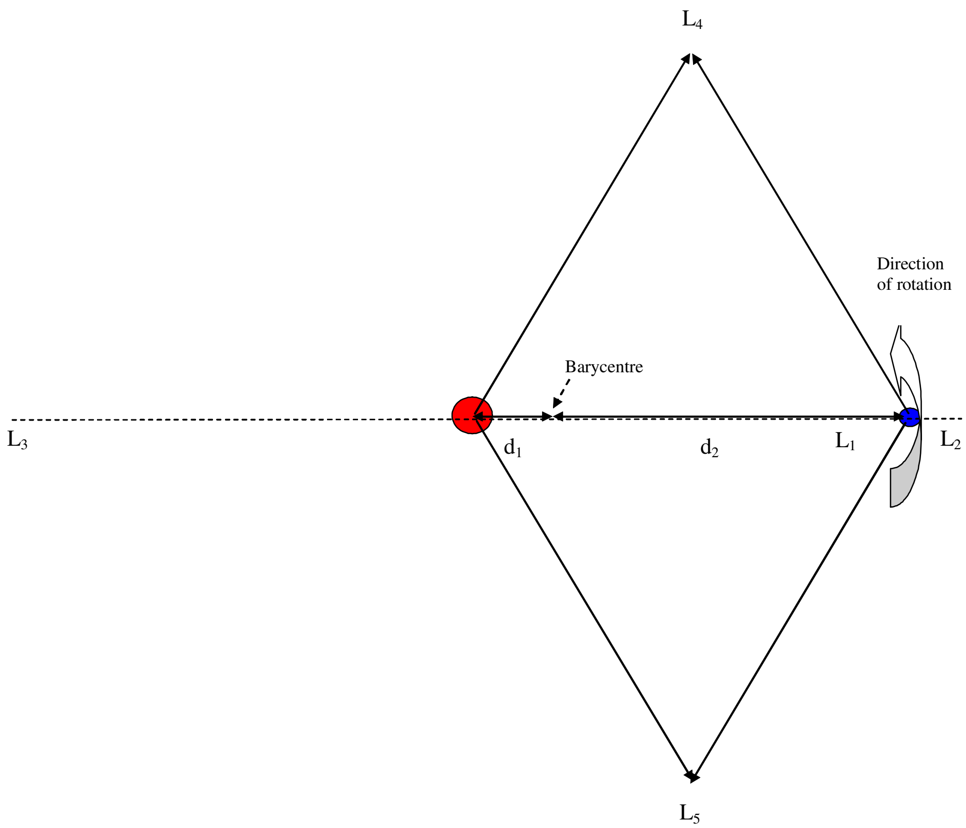


Figure 4.8-4 Locations of the Lagrange libration points

Figure shows the two bodies and the five Lagrange points

P301 para 6 end, Jacobi constant units

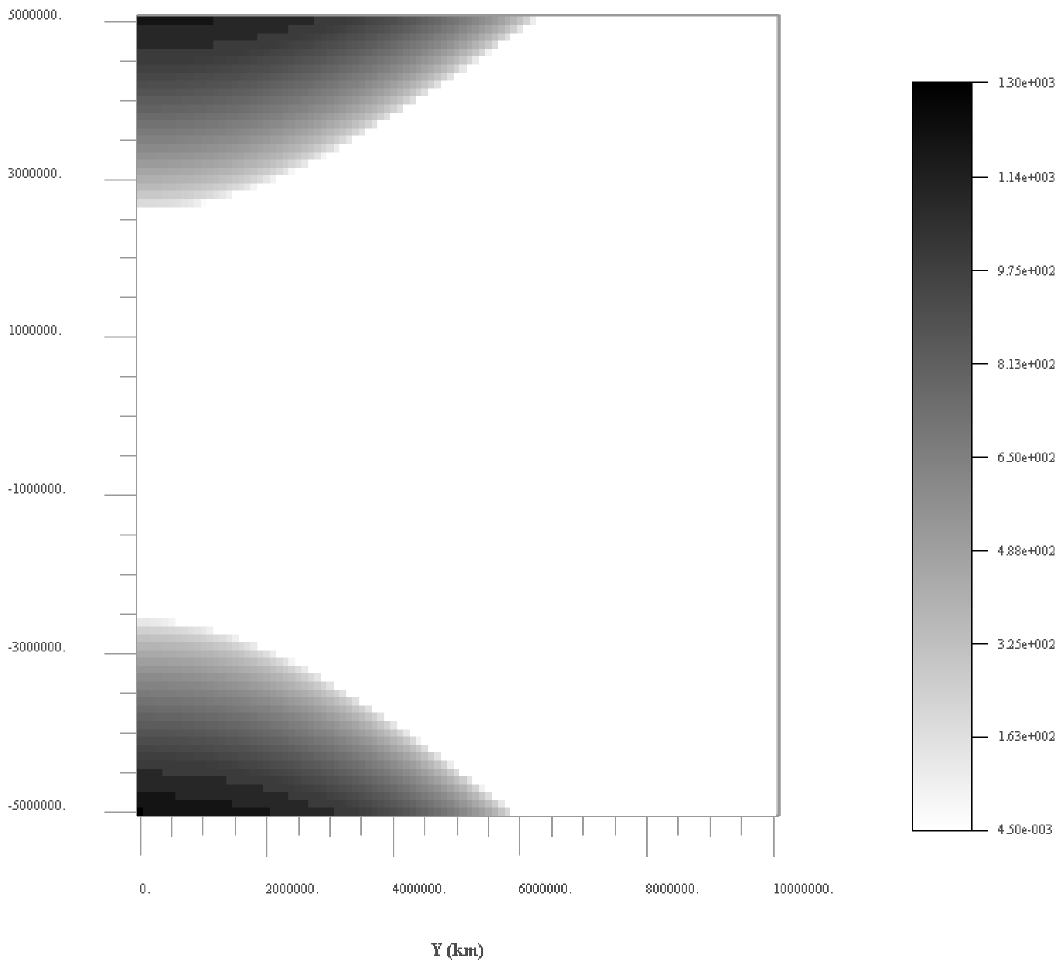
The value of Jacobi constant (per unit spacecraft mass) used is 2640500000 (m/s)^2.

P302 para 2 end, Jacobi constant units

The value of Jacobi constant (per unit spacecraft mass) used is 2639000000(m/s)^2.

P303-304 (last para p303)

Energy plot converted to excess hyperbolic speed. A plot for excess hyperbolic speed is not included. This is given in the next figure



Variation in excess hyperbolic speed (using rotating frame radial velocity vector direction assumption and reference Jacobi constant value) with X and Y displacement.

In this figure a real excess hyperbolic speed achieved between 2 and 3 million km from Earth on the Earth-Sun axis.

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Tables 5.1.6 and 5.1.8 are updated as follows:

Table 5.1.6 ΔV implications for a double VGA transfer to Mercury with a Venus 1:1 resonant orbit and V_∞ at Venus of 11.5 km/sec

ΔV Earth departure (m/s)	ΔV Mercury approach (m/s)	Total ΔV (m/s)
1981.	2819.	4800.

Table 5.1.8 2D patch conic analysis of transfer orbits after the second gravity assist from a Venus 3:4 resonance and V_∞ at Venus of 8.2 km/sec

Resonant orbit	V_∞ at Venus (m/s)	h flyby (km)	Transfer orbit Apo (AU)	Transfer orbit Peri (AU)
V- 3:4	6219.	300	0.729	0.387
V- 3:4	8168.	300	0.724	0.303

Page 440

The velocity vector components calculated in the intermediate reference frame are

Equation 1-38

$$V_x' = V\cos(\omega+\theta+\frac{\pi}{2}-\Gamma)$$

$$V_y' = V\sin(\omega+\theta+\frac{\pi}{2}-\Gamma)\sin i$$

$$V_z' = V\sin(\omega+\theta+\frac{\pi}{2}-\Gamma)\cos i$$

Becomes

The velocity vector components calculated in the intermediate reference frame are

Equation 1-38

$$V_x' = V\cos(\omega+\theta+\frac{\pi}{2}-\Gamma)$$

$$V_y' = V\sin(\omega+\theta+\frac{\pi}{2}-\Gamma)\cos i$$

$$V_z' = V\sin(\omega+\theta+\frac{\pi}{2}-\Gamma)\sin i$$

Many thanks to those who kindly sent in comments and errata for the book.