BELLCOMM, INC.
955 L'ENFANT PLAZA NORTH, S.W. WASHINGTON, D.C. 20024

B69 04021

SUBJECT: Periodic Solutions of the Orbital Assembly Equations of Motion - Case 620

DATE: April 7, 1969

FROM: S. C. Chu

ABSTRACT

The existence of a unique solution to the linearized equations of motion of the Orbital Assembly is proved, and an algorithm for obtaining such a solution is presented. The existence of periodic solutions and a procedure for obtaining them are useful in deriving an attitude control law which is significantly more economical in thrustor ignitions and fuel consumption than currently planned. A periodic solution using a specific model for the aerodynamic torque is also computed.

(NASA-CR-106874) PERIODIC SOLUTIONS OF THE ORBITAL ASSEMBLY EQUATIONS OF MOTION (Bellcomm, Inc.) 21 p

N79-71885

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MEMORANDUM FOR FILE

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I. INTRODUCTION

The linearized equations of motion for the Orbital Assembly during missions AAP 1/2 and AAP 2/3A as derived by Fearnsides [1] are:

$$\ddot{\psi} = 2\alpha_z^2\psi\cos 2\omega_0 t - \alpha_z^2\sin 2\omega_0 t$$

$$\ddot{\theta} = \{\alpha_y^2[(1+\cos 2\omega_0 t)\theta - \phi\sin 2\omega_0 t] + \lambda_y^c\sin(\omega_0 t-\psi)$$

(*)

$$+ \lambda_y^p|\sin(\omega_0 t-\psi)|\sin(\omega_0 t-\psi)\}$$

$$\ddot{\phi} = \{\alpha_x^2[(1-\cos 2\omega_0 t)\phi - \theta\sin 2\omega_0 t] + \lambda_x^c\cos(\omega_0 t-\psi)$$

$$+ \sigma_r\lambda_x^p|\sin(\omega_0 t-\psi)|\cos(\omega_0 t-\psi)\} .$$

Although the unknown function ψ appears non-linearly in the second and third equations as part of the argument of both the sine and cosine functions, this system is still linear in the sense that the equation for ψ (the first one) is "uncoupled" from the second and third. The quantities ψ, θ, and ϕ are Euler angles, ω_0 is a frequency of disturbance, the α's and λ's are parameters depending on the moments of inertia; the reader is referred to the memorandum [1] for a precise definition of these quantities as well as their values. Suffice it to say here that the terms on the right-hand-side of the system (*) which depend linearly on ψ, θ, and ϕ, respectively, represent the gravity gradient torque, and the remaining terms on the right-hand-side (the "forcing term") represent the aerodynamic torque.

In [1], Fearnsides was able to find a particular solution to (*) which is periodic: ψ having period π/ω_0 and θ and ϕ having period $2\pi/\omega_0$. Two questions then naturally arise:

1. Are there other solutions to (*) which are periodic? and, more importantly,

2. Is there a systematic way to obtain these solutions? That is, if, for example, the model for the aerodynamic torque is changed, is there an algorithm which would enable us to obtain easily a new periodic solution?

It is the purpose of this memorandum to answer these questions. (The answer to the first is no, and to the second is yes.) The answer to these questions is important (particularly the second) because the existence of a periodic solution and an algorithm to obtain it will enable one to derive a control law which would require a significantly lower number of thruster firing than the currently planned law. (See [1].)

We prefer to treat the system (*) as a system of six <u>first</u> order differential equations of the form

$$\dot{x} = A(t)x + z(t) \quad , \tag{1}$$

where the n x n coefficient matrix A and the n vector z are continuous and periodic with period p, for $t \geq 0$. This reduction of (*) to the form of (1) will be carried out in Section III. In Section II a theorem is proved giving conditions for the existence of a unique periodic solution with a certain period, and, in the process, the desired algorithm for obtaining such a solution is derived. This algorithm is then applied to the Orbital Assembly in Section III. Using a specific model for the aerodynamic torque, we found the periodic solution desired.

II. THE THEORY

Before we state the existence and uniqueness theorem, some preliminary notions need be developed. We first consider the homogeneous system corresponding to (1):

$$\dot{x} = A(t)x \quad . \tag{2}$$

By a fundamental matrix $Y(t)$ we mean a matrix whose columns are linearly independent solution vectors of (2). Since n linearly independent solutions span the solution space, any solution of (2) can be expressed as a linear combination of these independent solutions. Hence we have

Property 1: If $\overline{Y}(t)$ is another fundamental matrix of (2), there exists a constant matrix C, such that

$$\overline{Y}(t) = Y(t)C \quad , \quad \det C \neq 0 \ .$$

We now define a "normalized" fundamental matrix $K(t,t_0)$, sometimes called the "transition matrix," as follows:

$K(t,t_0)$ is a fundamental matrix of (2), and

$$K(t_0,t_0) = I \quad .$$

One can, therefore, construct $K(t,t_0)$ by choosing, as column vectors, solution vectors $y^j(t)$ whose i^{th} component at $t = t_0$ satisfy the initial conditions

$$y_i^j(t_0) = \delta_{ij} \quad , \quad i,j = 0,1,\ldots,n \quad ,$$

where δ_{ij} is the Kronecker delta. Since initial value problems for equation (2) possess unique solutions, $K(t,t_0)$ is unique for any t_0.

Since any solution to (2) can be expressed as a linear combination of the column vectors in K, one obtains a representation formula for an arbitrary solution $y(t)$ to equation (2):

$$y(t) = K(t,t_0)x_0 \quad , \tag{3}$$

where x_0 is the value of y at $t=t_0$. Suppose now for a solution y, $y(t_1) = x_1$ for any fixed t_1, then applying (3), we have

$$y(t) = K(t,t_1)\ x_1 \quad .$$

But

$$x_1 = y(t_1) = K(t_1,t_0)\ x_0 \quad .$$

Hence,

$$y(t) = K(t,t_1)K(t_1,t_0)x_0 = K(t,t_0)x_0 \quad .$$

Since x_0 can be arbitrarily chosen, we have

<u>Property 2</u>: $K(t,t_0) = K(t,t_1)K(t_1,t_0)$ for all $0 \le t,\ t_0,\ t_1 < \infty$. In particular, we have

<u>Property 3</u>: $K(t_0,t_1)K(t_1,t_0) = I$ for all $0 \le t_0,\ t_1 < \infty$; i.e., $K(t_0,t_1) = K(t_1,t_0)^{-1}$.

If we now use the periodicity of A, we obtain some specific properties for K. Since K is a solution matrix, we have

$$\dot{K}(t+p,0) = A(t+p)K(t+p,0)$$

$$= A(t)K(t+p,0) \quad .$$

Therefore $K(t+p,0)$ is another solution matrix. But the columns of $K(t+p,0)$ are again independent; hence, $K(t+p,0)$ is another fundamental matrix of (2). By Property 1, there exists a constant matrix C, such that

$$K(t+p,0) = K(t,0)\ C$$

for all t. Therefore, $K(p,0) = K(0,0)\ C = C$, and we have

<u>Property 4</u>: If A is periodic with period p,

$$K(t+p,0) = K(t,0)K(p,0) \quad ,$$

for all $0 \leq t < \infty$.

If we now apply Properties 3 and 4, we have

$$\begin{aligned} K(0,t+p) &= [K(t+p,0)]^{-1} \\ &= [K(t,0)K(p,0)]^{-1} \\ &= K(p,0)^{-1}K(t,0)^{-1} \\ &= K(0,p)K(0,t) \quad . \end{aligned}$$

<u>Property 5</u>: If A is periodic with period p

$$K(0,t+p) = K(0,p)K(0,t) \quad ,$$

for all $0 \leq t < \infty$.

We can now apply Properties 2, 3, 4 and 5 to obtain

$$K(t+p,\tau+p) = K(t+p,0)K(0,\tau+p)$$

$$= K(t,0)K(p,0)K(0,p)K(0,\tau)$$

$$= K(t,\tau) \quad .$$

Property 6: If A is periodic with period p,

$$K(t+p,\tau+p) = K(t,\tau) \quad ,$$

for all t, $\tau \geq 0$.

We now return to the inhomogeneous system (1). Any solution x(t) of (1) can be represented by

$$x(t) = K(t,t_0)x_0 + \int_{t_0}^{t} K(t,\tau)z(\tau)d\tau \quad , \tag{4}$$

where x_0 is the value of x(t) at $t=t_0$. That x(t) given by (4) is a solution of (1) can be verified by direct computation. That (4) gives the only solution to equation (1) with the property $x(t_0) = x_0$ is due to the fact that initial value problems for equation (1) possess unique solutions.

We can now state the main result of this section.

Theorem: Given the system

$$\dot{x}(t) = A(t)x + z(t) \quad ,$$

assume A and z are continuous and periodic with period p for all $t \geq 0$. Assume also that $\det(K(p,0)-I) \neq 0$ (i.e., 1 is not an eigenvalue of $K(p,0)$.) Then

a. there exists a unique solution to the above equation which is periodic with period p. [That is, there exists a unique initial vector x_0 which gives rise to a periodic solution with periodic p.]; and

b. the corresponding homogeneous system possesses no periodic solutions of period p.

We remark here that p need not be the smallest period common to A and z, and that no mention was made of the possible existence of other periodic solutions with periods which are not integer multiples of p.

Proof: We first prove part (b). Suppose that $x(t)$ is a solution of (2) and is periodic with period p. Then by formula (3), and by the periodicity of x, we must have

$$x(p) = K(p,0)x_0 = x_0 \quad .$$

Hence 1 is an eigenvalue of $K(p,0)$, which is a contradiction.

Next, we prove the uniqueness part of (a). Suppose $x(t)$ is a periodic solution of (1) with period p. Let $x(0) = x_0$. Then by the representation formula (4) and by the periodicity of x, we must have

$$x(p) = x_0 = K(p,0)x_0 + \int_0^p K(p,\tau)z(\tau)d\tau \quad .$$

Or by multiplying through by $K(0,p)$, transposing, and noting that $K(p,\tau) = K(p,0)K(0,\tau)$, we obtain

$$(K(0,p)-I)x_0 = \int_0^p K(0,\tau)z(\tau)d\tau \quad . \tag{5}$$

Now, since 1 is not an eigenvalue of $K(p,0)$, it is not an eigenvalue of $K(0,p)$. Hence $K(0,p)-I$ is non-singular, and, thus, x_0 is uniquely determined by (5). Therefore, $x(t)$ is uniquely determined.

We now prove the existence of such a periodic solution. Since $K(0,p)-I$ is non-singular, define the vector x_0 by means of equation (5). Note that, for such an x_0, one has

$$x_0 = K(p,0)x_0 + \int_0^p K(p,\tau)z(\tau)d\tau \ .$$

Consider now the initial value problem

$$\dot{x} = Ax + z$$

$$x(0) = x_0$$

The solution, call it $\phi(t)$, to this problem can be represented by formula (4),

$$\phi(t) = K(t,0)x_0 + \int_0^t K(t,\tau)z(\tau)d\tau \ .$$

We need only show now that ϕ is periodic with period p.

$$\phi(t+p) = K(t+p,0)x_0 + \int_0^{t+p} K(t+p,\tau)z(\tau)d\tau$$

$$= K(t,0)K(p,0)x_0 + \int_0^{p} K(t+p,0)k(0,\tau)z(\tau)d\tau$$

$$+ \int_p^{t+p} K(t+p,\tau)z(\tau)d\tau$$

$$= K(t,0)\left[k(p,0)x_0 + \int_0^{p} K(p,0)K(0,\tau)z(\tau)d\tau\right]$$

$$+ \int_p^{t+p} K(t+p,\tau)z(\tau)d\tau \ .$$

Since $K(p,0)K(0,\tau) = k(p,\tau)$, the quantity in the brackets is just x_0. In the second integral if we make the change of variables $u = \tau - p$ and use the fact that $z(u+p) = z(u)$, then we have

$$\int_p^{t+p} K(t+p,\tau)z(\tau)d\tau = \int_0^{t} K(t+p,u+p)z(u)du$$

$$= \int_0^{t} K(t,u)z(u)du \quad ,$$

by Property 6. Hence

$$\phi(t+p) = K(t,0)x_0 + \int_0^{t} K(t,u)z(u)du = \phi(t) \quad .$$

The proof is now complete.

We remark here that much of the foregoing can be found in several books on differential equations and stability. We cite here only the book by Hahn [2], where the main theorem above is treated but not fully proved.

We now observe that the existence proof of the theorem actually provides an algorithm for finding a periodic solution. To recapitulate, the practical procedure for determining the periodic solutions of system (1), with A and z of period p, is as follows.

a. Solve the n initial value problems

$$\dot{y}^j = A(t)y^j \qquad j = 1, \ldots, n$$

$$y_i^j(0) = \delta_{ij} \qquad i = i, \ldots, n$$

b. Form the matrix K(t,0) by using the solution vectors y^j as columns.

c. Check the determinant of K(p,0)-I [at only the point t=p.] If $\det(K(p,0)-I) \neq 0$, then obtain the vector x_0 uniquely by the equation

$$x_0 = (K(0,p)-I)^{-1} \int_0^p K(0,\tau)z(\tau)d\tau \ .$$

d. Solve the initial value problem

$$\dot{\phi}(t) = A(t)\phi + z(t)$$

$$\phi(0) = x_0$$

This function ϕ is the periodic solution sought. All of this can be done on the digital computer. Observe that the condition $\det(K(p,0)-I) \neq 0$, and, therefore, the applicability of this algorithm, depends only on the coefficient matrix A and is independent of the "forcing term" z.

We remark here that the case where $K(p,0)-I$ is singular is also amenable to rigorous treatment, but it is much more complicated and will not yield the same kind of result as the theorem in this section. However, this theory is not needed for the solution of the specific problem to be solved in the next section.

III. APPLICATION TO THE ORBITAL ASSEMBLY

We now return to the system (*). If we let $\sigma_r = 1$, and

$$\dot{\psi} = u, \qquad \dot{\theta} = v, \qquad \dot{\phi} = w,$$

then (*) can be changed to an equivalent system of six equations of the first order. But since the first equation of (*) is "uncoupled" from the rest, the system of six first order equations is also "uncoupled," yielding two systems of two and four equations respectively:

$$(6) \qquad \begin{bmatrix} \dot{u} \\ \dot{\psi} \end{bmatrix} = \begin{bmatrix} 0 & 2\alpha_z^2 \cos 2\omega_0 t \\ 1 & 0 \end{bmatrix} \begin{bmatrix} u \\ \psi \end{bmatrix} - \begin{bmatrix} \alpha_z^2 \sin 2\omega_0 t \\ 0 \end{bmatrix}$$

$$(7) \qquad \begin{bmatrix} \dot{v} \\ \dot{w} \\ \dot{\theta} \\ \dot{\phi} \end{bmatrix} = \begin{bmatrix} 0 & 0 & \alpha_y^2(1+\cos 2\omega_0 t) & -\alpha_y^2 \sin 2\omega_0 t \\ 0 & 0 & -\alpha_y^2 \sin 2\omega_0 t & \alpha_x^2(1-\cos 2\omega_0 t) \\ 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \end{bmatrix} \begin{bmatrix} v \\ w \\ \theta \\ \phi \end{bmatrix}$$

$$+ \begin{bmatrix} [\lambda_y^c + \lambda_y^p |\sin(\omega_0 t - \psi)|] \sin(\omega_0 t - \psi) \\ [\lambda_x^c + \lambda_x^p |\sin(\omega_0 t - \psi)|] \cos(\omega_0 t - \psi) \\ 0 \\ 0 \end{bmatrix}$$

We follow the procedure outlined at the end of the last section for both systems (6) and (7), using the numbers for the α's and λ's and ω_0 in [1]. By solving the two appropriate initial value problems for the homogeneous system corresponding to system (6), we constructed the (2 x 2) transition matrix $K_1(t,0)$. We then checked that $\det(K_1(\frac{\pi}{\omega_0},0)-I) \neq 0$. We then computed the unique initial vector which gives rise to a periodic solution $\psi(t)$ with period $\frac{\pi}{\omega_0}$, and computed such a ψ. The same procedure is then followed for system (7). We solved four initial value problems for the corresponding homogeneous system to construct the transition matrix $K_2(t,0)$. The (smallest) common period of the coefficient matrix and the forcing term, in this system, is $\frac{2\pi}{\omega_0}$. We verified that $\det(K(\frac{2\pi}{\omega_0},0)-I)$ is non-zero. Then by using the values of the solution $\psi(t)$ computed above in the forcing term of (7), we computed the unique initial vector which gives rise to the solutions $\theta(t)$ and $\phi(t)$, which are periodic with period $\frac{2\pi}{\omega_0}$, as well as the solutions themselves. A printout of the results, as well as a plot of ψ, θ, ϕ, is given at the end of the memorandum. They show very close agreement with the results of [1].

Now that an algorithm to compute periodic solutions of (*), has been obtained, different models of the aerodynamic torque can be easily simulated. Indeed, work is under way to study the effects of the diurnal bulge.

The excellent assistance in programming and computation by Mrs. Nancy Kirkendall is gratefully acknowledged.

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Attachment
References
Printout

REFERENCES

1. Fearnsides, J. J., "Attitude Control for AAP 1/2 and AAP 2/3A: A Progress Report," Memorandum for File, B69 03026, March 10, 1969, Case 620.

2. Hahn, W., Stability of Motion, Springer-Verlag, New York, 1967.

EULER ANGLES AND THEIR DERIVATIVES VS. TIME FOR 1 ORBIT OF THE AAP CLUSTER IN POP MODE

TIME	PSID	PSI	PHID	PHI	THED	THE
.00000000	.20239090-01	.28814860-05	.12174457-05	-.30391952+01	-.40297583-02	.30544607-01
.20000000+02	.20223583-01	.40468132-00	.40010187-04	-.30387854+01	-.40276079-02	-.50028678-01
.40000000+02	.20177050-01	.80873936-00	.80171013-04	-.30375858+01	-.40256565-02	-.13056103-00
.59999999+02	.20099469-01	.12115563+01	.12172643-03	-.30355692+01	-.40238474-02	-.21105587-00
.80000000+02	.19990804-01	.16125109+01	.16470192-03	-.30327073+01	-.40221205-02	-.29151547-00
.10000000+03	.19851004-01	.20109808+01	.20912166-03	-.30289716+01	-.40204109-02	-.37194081-00
.12000000+03	.19680009-01	.24063430+01	.25500837-03	-.30243327+01	-.40186510-02	-.45233156-00
.14000000+03	.19477749-01	.27979727+01	.30238295-03	-.30187614+01	-.40167686-02	-.53268602-00
.16000000+03	.19244148-01	.31852440+01	.35126434-03	-.30122274+01	-.40146886-02	-.61300097-00
.18000000+03	.18979128-01	.35675292+01	.40166923-03	-.30047006+01	-.40123316-02	-.69327170-00
.20000000+03	.18682615-01	.39441991+01	.45361187-03	-.29961504+01	-.40096155-02	-.77349182-00
.22000000+03	.18354534-01	.43146232+01	.50710378-03	-.29865459+01	-.40064546-02	-.85365333-00
.24000000+03	.17994828-01	.46781696+01	.56215363-03	-.29758559+01	-.40027599-02	-.93374644-00
.26000000+03	.17603450-01	.50342051+01	.61876692-03	-.29640493+01	-.39984394-02	-.10137595+01
.28000000+03	.17180377-01	.53820962+01	.67694580-03	-.29510948+01	-.39933982-02	-.10936792+01
.30000000+03	.16725611-01	.57212089+01	.73668890-03	-.29369611+01	-.39875387-02	-.11734900+01
.32000000+03	.16239187-01	.60509095+01	.79799105-03	-.29216169+01	-.39807605-02	-.12531746+01
.34000000+03	.15721179-01	.63705657+01	.86084310-03	-.29050311+01	-.39729607-02	-.13327136+01
.36000000+03	.15171707-01	.66795469+01	.92523170-03	-.28871729+01	-.39640344-02	-.14120855+01
.38000000+03	.14590941-01	.69772254+01	.99113908-03	-.28680117+01	-.39538743-02	-.14912667+01
.40000000+03	.13979114-01	.72629774+01	.10585429-02	-.28475174+01	-.39423712-02	-.15702315+01
.42000000+03	.13336520-01	.75361846+01	.11274161-02	-.28256603+01	-.39294144-02	-.16489518+01
.44000001+03	.12663528-01	.77962355+01	.11977263-02	-.28024112+01	-.39148916-02	-.17273976+01
.46000000+03	.11960585-01	.80425260+01	.12694362-02	-.27777419+01	-.38986894-02	-.18055363+01
.48000000+03	.11228222-01	.82744627+01	.13425030-02	-.27516248+01	-.38806932-02	-.18833332+01
.50000000+03	.10467065-01	.84914628+01	.14168781-02	-.27240331+01	-.38607883-02	-.19607513+01
.52000000+03	.96778340-02	.86929579+01	.14925075-02	-.26949413+01	-.38388590-02	-.20377512+01
.54000000+03	.88613541-02	.88783945+01	.15693308-02	-.26643249+01	-.38147899-02	-.21142913+01
.55999999+03	.80185580-02	.90472367+01	.16472817-02	-.26321606+01	-.37884660-02	-.21903277+01
.58000000+03	.71504916-02	.91989683+01	.17262874-02	-.25984266+01	-.37597731-02	-.22658142+01
.60000000+03	.62583179-02	.93330956+01	.18062686-02	-.25631026+01	-.37285978-02	-.23407020+01
.62000000+03	.53433202-02	.94491488+01	.18871396-02	-.25261700+01	-.36948286-02	-.24149407+01
.64000000+03	.44069052-02	.95466856+01	.19688078-02	-.24876118+01	-.36583558-02	-.24884772+01
.66000000+03	.34506049-02	.96252924+01	.20511736-02	-.24474131+01	-.36190727-02	-.25612562+01
.68000000+03	.24760772-02	.96845882+01	.21341306-02	-.24055609+01	-.35768750-02	-.26332206+01
.70000000+03	.14851072-02	.97242259+01	.22175654-02	-.23620447+01	-.35316627-02	-.27043111+01
.72000000+03	.47960535-03	.97438955+01	.23013576-02	-.23168559+01	-.34833397-02	-.27744664+01
.74000000+03	-.53839339-03	.97433269+01	.23853797-02	-.22699889+01	-.34318148-02	-.28436233+01
.76000000+03	-.15667327-02	.97222910+01	.24694975-02	-.22214402+01	-.33770023-02	-.29117171+01
.78000000+03	-.26031385-02	.96806040+01	.25535695-02	-.21712093+01	-.33188227-02	-.29786810+01
.80000000+03	-.36452238-02	.96181279+01	.26374479-02	-.21192987+01	-.32572035-02	-.30444470+01
.82000000+03	-.46904945-02	.95347740+01	.27209780-02	-.20657138+01	-.31920797-02	-.31089457+01
.84000000+03	-.57363568-02	.94305044+01	.28039993-02	-.20104630+01	-.31233946-02	-.31721064+01
.86000000+03	-.67801245-02	.93053340+01	.28863452-02	-.19535583+01	-.30511006-02	-.32338574+01
.88000000+03	-.78190291-02	.91593321+01	.29678431-02	-.18950149+01	-.29751598-02	-.32941262+01
.90000000+03	-.88502289-02	.89926243+01	.30483160-02	-.18348515+01	-.28955450-02	-.33528393+01
.92000000+03	-.98708210-02	.88053938+01	.31275820-02	-.17730903+01	-.28122400-02	-.34099233+01
.94000000+03	-.10877853-01	.85978820+01	.32054550-02	-.17097575+01	-.27252407-02	-.34653042+01
.96000000+03	-.11868334-01	.83703902+01	.32817461-02	-.16448827+01	-.26345554-02	-.35189083+01
.98000000+03	-.12839254-01	.81232794+01	.33562632-02	-.15784995+01	-.25402056-02	-.35706620+01
.10000000+04	-.13787591-01	.78569708+01	.34288131-02	-.15106453+01	-.24422269-02	-.36204923+01
.10200000+04	-.14710330-01	.75719465+01	.34992014-02	-.14413614+01	-.23406687-02	-.36683272+01
.10400000+04	-.15604478-01	.72687484+01	.35672338-02	-.13706930+01	-.22355949-02	-.37140956+01
.10600000+04	-.16467080-01	.69479778+01	.36327169-02	-.12986891+01	-.21270849-02	-.37577280+01
.10800000+04	-.17295234-01	.66102950+01	.36954600-02	-.12254026+01	-.20152327-02	-.37991566+01
.11000000+04	-.18086107-01	.62564171+01	.37552752-02	-.11508902+01	-.19001480-02	-.38383157+01
.11200000+04	-.18836954-01	.58871175+01	.38119791-02	-.10752123+01	-.17819555-02	-.38751418+01

EULER ANGLES AND THEIR DERIVATIVES VS. TIME FOR 1 ORBIT

OF THE AAP CLUSTER IN POP MODE (Cont.)

.11400000+04	-.19545130-01	.55032235+01	.38653940-02	-.99843299-00	-.16607952-02	-.39095741+01
.11600000+04	-.20208108-01	.51056137+01	.39153489-02	-.92061965-00	-.15368218-02	-.39415548+01
.11800000+04	-.20823492-01	.46952165+01	.39616806-02	-.84184320-00	-.14102048-02	-.39710293+01
.12000000+04	-.21389038-01	.42730063+01	.40042353-02	-.76217762-00	-.12811273-02	-.39979465+01
.12200000+04	-.21902660-01	.38400012+01	.40428691-02	-.68169992-00	-.11497860-02	-.40222593+01
.12400000+04	-.22362447-01	.33972588+01	.40774493-02	-.60048988-00	-.10163897-02	-.40439242+01
.12600000+04	-.22766675-01	.29458737+01	.41078562-02	-.51862978-00	-.88115893-03	-.40629026+01
.12800000+04	-.23113818-01	.24869724+01	.41339824-02	-.43620418-00	-.74432474-03	-.40791598+01
.13000000+04	-.23402557-01	.20217102+01	.41557355-02	-.35329965-00	-.60612730-03	-.40926665+01
.13200000+04	-.23631791-01	.15512667+01	.41730375-02	-.27000444-00	-.46681479-03	-.41033975+01
.13400000+04	-.23800641-01	.10768410+01	.41858260-02	-.18640822-00	-.32664199-03	-.41113333+01
.13600000+04	-.23908459-01	.59964776-00	.41940548-02	-.10260178+00	-.18586878-03	-.41164591+01
.13800000+04	-.23954828-01	.12091214+00	.41976939-02	-.18676623-01	-.44758627-04	-.41187657+01
.14000000+04	-.23939571-01	-.35813469-00	.41967304-02	.65275300-01	.96422940-04	-.41182490+01
.14200000+04	-.23862746-01	-.83626041-00	.41911678-02	.14916195-00	.23740998-03	-.41149101+01
.14400000+04	-.23724648-01	-.13122362+01	.41810265-02	.23289150-00	.37793770-03	-.41087557+01
.14600000+04	-.23525810-01	-.17848416+01	.41663435-02	.31637274-00	.51774407-03	-.40997975+01
.14800000+04	-.23266996-01	-.22528690+01	.41471721-02	.39951533-00	.65657134-03	-.40880525+01
.15000000+04	-.22949193-01	-.27151284+01	.41235814-02	.48223018-00	.79416754-03	-.40735429+01
.15200000+04	-.22573613-01	-.31704517+01	.40956559-02	.56442970-00	.93028792-03	-.40562958+01
.15400000+04	-.22141679-01	-.36176974+01	.40634943-02	.64602817-00	.10646963-02	-.40363428+01
.15600000+04	-.21655014-01	-.40557542+01	.40272091-02	.72694198-00	.11971662-02	-.40137208+01
.15800000+04	-.21115438-01	-.44835454+01	.39869260-02	.80708989-00	.13274823-02	-.39884706+01
.16000000+04	-.20524948-01	-.49000324+01	.39427821-02	.88639329-00	.14554409-02	-.39606373+01
.16200000+04	-.19885713-01	-.53042185+01	.38949256-02	.96477643-00	.15808515-02	-.39302700+01
.16400000+04	-.19200052-01	-.56951515+01	.38435142-02	.10421666+01	.17035368-02	-.38974214+01
.16600000+04	-.18470430-01	-.60719276+01	.37887143-02	.11184944+01	.18233338-02	-.38621479+01
.16800000+04	-.17699430-01	-.64336930+01	.37306993-02	.11936938+01	.19400942-02	-.38245084+01
.17000000+04	-.16889752-01	-.67796470+01	.36696494-02	.12677021+01	.20536846-02	-.37845653+01
.17200000+04	-.16044186-01	-.71090439+01	.36057492-02	.13404607+01	.21639868-02	-.37423830+01
.17400000+04	-.15165601-01	-.74211945+01	.35391877-02	.14119144+01	.22708978-02	-.36980284+01
.17600000+04	-.14256926-01	-.77154674+01	.34701563-02	.14820118+01	.23743298-02	-.36515703+01
.17800000+04	-.13321139-01	-.79912908+01	.33988482-02	.15507054+01	.24742099-02	-.36030789+01
.18000000+04	-.12361244-01	-.82481523+01	.33254571-02	.16179518+01	.25704801-02	-.35526259+01
.18200000+04	-.11380262-01	-.84855999+01	.32501768-02	.16837111+01	.26630968-02	-.35002841+01
.18400000+04	-.10381211-01	-.87032423+01	.31731991-02	.17479475+01	.27520301-02	-.34461267+01
.18600000+04	-.93670940-02	-.89007480+01	.30947144-02	.18106291+01	.28372636-02	-.33902276+01
.18800000+04	-.83408833-02	-.90778454+01	.30149098-02	.18717273+01	.29187939-02	-.33326609+01
.19000000+04	-.73055089-02	-.92343222+01	.29339688-02	.19312178+01	.29966298-02	-.32735004+01
.19200000+04	-.62638447-02	-.93700238+01	.28520707-02	.19890797+01	.30707911-02	-.32128201+01
.19400000+04	-.52186976-02	-.94848526+01	.27693903-02	.20452955+01	.31413091-02	-.31506931+01
.19600000+04	-.41727967-02	-.95787665+01	.26860968-02	.20998512+01	.32082248-02	-.30871918+01
.19800000+04	-.31287833-02	-.96517769+01	.26023538-02	.21527363+01	.32715888-02	-.30223878+01
.20000000+04	-.20892030-02	-.97039473+01	.25183190-02	.22039434+01	.33314602-02	-.29563516+01
.20200000+04	-.10564975-02	-.97353908+01	.24341434-02	.22534681+01	.33879060-02	-.28891522+01
.20400000+04	-.32998737-04	-.97462684+01	.23499719-02	.23013091+01	.34410005-02	-.28208577+01
.20600000+04	.97907704-03	-.97367869+01	.22659425-02	.23474679+01	.34908246-02	-.27515341+01
.20800000+04	.19776332-02	-.97071955+01	.21821862-02	.23919486+01	.35374644-02	-.26812460+01
.21000000+04	.29606961-02	-.96577848+01	.20988273-02	.24347579+01	.35810122-02	-.26100561+01
.21200000+04	.39264172-02	-.95888833+01	.20159832-02	.24759051+01	.36215638-02	-.25380255+01
.21400000+04	.48730744-02	-.95008552+01	.19337640-02	.25154015+01	.36592195-02	-.24652129+01
.21600000+04	.57990721-02	-.93940981+01	.18522734-02	.25532605+01	.36940826-02	-.23916753+01
.21800000+04	.67029406-02	-.92690398+01	.17716081-02	.25894979+01	.37262596-02	-.23174676+01
.22000000+04	.75833345-02	-.91261369+01	.16918578-02	.26241309+01	.37558590-02	-.22426421+01
.22200000+04	.84390305-02	-.89658711+01	.16131060-02	.26571788+01	.37829908-02	-.21672496+01
.22400000+04	.92689241-02	-.87887477+01	.15354294-02	.26886623+01	.38077670-02	-.20913383+01
.22600000+04	.10072026-01	-.85952927+01	.14588987-02	.27186035+01	.38303000-02	-.20149539+01
.22800000+04	.10847457-01	-.83860510+01	.13835781-02	.27470262+01	.38507029-02	-.19381404+01

EULER ANGLES AND THEIR DERIVATIVES VS. TIME FOR 1 ORBIT

OF THE AAP CLUSTER IN POP MODE (Cont.)

.23000000+04	.11594445-01	-.81615839+01	.13095262-02	.27739552+01	.38690890-02	-.18609392+01
.23200000+04	.12312318-01	-.79224673+01	.12367954-02	.27994161+01	.38855714-02	-.17833896+01
.23400000+04	.13000496-01	-.76692893+01	.11654329-02	.28234360+01	.39002626-02	-.17055283+01
.23600000+04	.13658492-01	-.74026487+01	.10954800-02	.28460428+01	.39132743-02	-.16273903+01
.23800000+04	.14285898-01	-.71231535+01	.10269734-02	.28672649+01	.39247172-02	-.15490078+01
.24000000+04	.14882382-01	-.68314189+01	.95994417-03	.28871315+01	.39347009-02	-.14704113+01
.24200000+04	.15447682-01	-.65280660+01	.89441898-03	.29056726+01	.39433330-02	-.13916288+01
.24400000+04	.15981598-01	-.62137207+01	.83041982-03	.29229184+01	.39507195-02	-.13126863+01
.24600000+04	.16483984-01	-.58890123+01	.76796417-03	.29388996+01	.39569645-02	-.12336077+01
.24800000+04	.16954744-01	-.55545722+01	.70706546-03	.29536473+01	.39621699-02	-.11544147+01
.25000000+04	.17393824-01	-.52110337+01	.64773308-03	.29671927+01	.39664351-02	-.10751272+01
.25200000+04	.17801207-01	-.48590306+01	.58997267-03	.29795671+01	.39698572-02	-.99576291-00
.25400000+04	.18176902-01	-.44991967+01	.53378633-03	.29908021+01	.39725305-02	-.91633787-00
.25600000+04	.18520946-01	-.41321655+01	.47917283-03	.30009290+01	.39745466-02	-.83686609-00
.25800000+04	.18833393-01	-.37585696+01	.42612781-03	.30099794+01	.39759940-02	-.75735981-00
.26000000+04	.19114308-01	-.33790401+01	.37464400-03	.30179845+01	.39769581-02	-.67782956-00
.26200000+04	.19363765-01	-.29942069+01	.32471148-03	.30249754+01	.39775214-02	-.59828417-00
.26400000+04	.19581842-01	-.26046987+01	.27631786-03	.30309832+01	.39777627-02	-.51873086-00
.26600000+04	.19768617-01	-.22111420+01	.22944853-03	.30360383+01	.39777578-02	-.43917532-00
.26800000+04	.19924162-01	-.18141622+01	.18408688-03	.30401712+01	.39775787-02	-.35962172-00
.27000000+04	.20048544-01	-.14143832+01	.14021454-03	.30434117+01	.39772940-02	-.28007288-00
.27200000+04	.20141817-01	-.10124278+01	.97811603-04	.30457895+01	.39769687-02	-.20053024-00
.27400000+04	.20204025-01	-.60891766-00	.56856895-04	.30473337+01	.39766639-02	-.12099400+00
.27600000+04	.20235199-01	-.20447371-00	.17328204-04	.30480732+01	.39764372-02	-.41463163-01
.27800000+04	.20235354-01	.20028351-00	-.21313187-04	.30480362+01	.39763376-02	.38064366-01
.28000000+04	.20204491-01	.60473366-00	-.60705549-04	.30472148+01	.39763727-02	.11759141+00
.28200000+04	.20142593-01	.10082562+01	-.10169616-03	.30455901+01	.39764852-02	.19711974-00
.28400000+04	.20049631-01	.14102303+01	-.14407225-03	.30431386+01	.39766189-02	.27665076-00
.28600000+04	.19925561-01	.18100341+01	-.18791349-03	.30398212+01	.39767132-02	.35618419-00
.28800000+04	.19770328-01	.22070449+01	-.23323983-03	.30356123+01	.39767037-02	.43571858-00
.29000000+04	.19583866-01	.26006389+01	-.28006969-03	.30304817+01	.39765216-02	.51525117-00
.29200000+04	.19366102-01	.29901908+01	-.32841977-03	.30243994+01	.39760954-02	.59477781-00
.29400000+04	.19116959-01	.33750737+01	-.37830476-03	.30173347+01	.39753496-02	.67429285-00
.29600000+04	.18836360-01	.37546594+01	-.42973714-03	.30092569+01	.39742054-02	.75378913-00
.29800000+04	.18524230-01	.41283178+01	-.48272696-03	.30001349+01	.39725808-02	.83325785-00
.30000000+04	.18180501-01	.44954179+01	-.53728157-03	.29899374+01	.39703903-02	.91268858-00
.30200000+04	.17805123-01	.48553269+01	-.59340549-03	.29786332+01	.39675459-02	.99206910-00
.30400000+04	.17398058-01	.52074114+01	-.65110006-03	.29661907+01	.39639562-02	.10713854+01
.30600000+04	.16959295-01	.55510379+01	-.71036338-03	.29525787+01	.39595269-02	.11506217+01
.30800000+04	.16488852-01	.58855720+01	-.77118994-03	.29377658+01	.39541613-02	.12297603+01
.31000000+04	.15986784-01	.62103810+01	-.83357053-03	.29217208+01	.39477602-02	.13087813+01
.31200000+04	.15453183-01	.65248331+01	-.89749195-03	.29044127+01	.39402220-02	.13876631+01
.31400000+04	.14888197-01	.68282990+01	-.96293688-03	.28858110+01	.39314426-02	.14663819+01
.31600000+04	.14292024-01	.71201531+01	-.10298835-02	.28658853+01	.39213165-02	.15449118+01
.31800000+04	.13664927-01	.73997737+01	-.10983056-02	.28446058+01	.39097358-02	.16232248+01
.32000000+04	.13007236-01	.76665460+01	-.11681720-02	.28219435+01	.38965915-02	.17012908+01
.32200000+04	.12319359-01	.79198619+01	-.12394467-02	.27978696+01	.38817731-02	.17790773+01
.32400000+04	.11601782-01	.81591224+01	-.13120882-02	.27723565+01	.38651688-02	.18565498+01
.32600000+04	.10855083-01	.83837390+01	-.13860499-02	.27453773+01	.38466664-02	.19336714+01
.32800000+04	.10079934-01	.85931360+01	-.14612795-02	.27169061+01	.38261529-02	.20104030+01
.33000000+04	.92771064-02	.87867516+01	-.15377190-02	.26869181+01	.38035154-02	.20867033+01
.33200000+04	.84474774-02	.89640415+01	-.16153042-02	.26553898+01	.37786406-02	.21625287+01
.33400000+04	.75920360-02	.91244787+01	-.16939650-02	.26222988+01	.37514163-02	.22378332+01
.33600000+04	.67118848-02	.92675581+01	-.17736249-02	.25876245+01	.37217309-02	.23125689+01
.33800000+04	.58082463-02	.93927976+01	-.18542009-02	.25513477+01	.36894741-02	.23866853+01
.34000000+04	.48824646-02	.94997404+01	-.19356035-02	.25134511+01	.36545376-02	.24601299+01
.34200000+04	.39360080-02	.95879584+01	-.20177364-02	.24739187+01	.36168151-02	.25328482+01
.34400000+04	.29704710-02	.96570535+01	-.21004967-02	.24327374+01	.35762033-02	.26047833+01

EULER ANGLES AND THEIR DERIVATIVES VS. TIME FOR 1 ORBIT

OF THE AAP CLUSTER IN POP MODE (Cont.)

.34600000+04	.19875743-02	.97066613+01	-.21837743-02	.23898955+01	.35326020-02	.26758764+01
.34800000+04	.98916531-03	.97364529+01	-.22674524-02	.23453838+01	.34859151-02	.27460667+01
.35000000+04	-.22783703-04	.97461376+01	-.23514073-02	.22991955+01	.34360509-02	.28152917+01
.35200000+04	-.10461773-02	.97354656+01	-.24355081-02	.22513265+01	.33829227-02	.28834870+01
.35400000+04	-.20788004-02	.97042294+01	-.25196175-02	.22017752+01	.33264498-02	.29505864+01
.35600000+04	-.31183222-02	.96522677+01	-.26035912-02	.21505428+01	.32665579-02	.30165222+01
.35800000+04	-.41623021-02	.95794671+01	-.26872785-02	.20976335+01	.32031798-02	.30812254+01
.36000000+04	-.52081955-02	.94857632+01	-.27705223-02	.20430546+01	.31362562-02	.31446256+01
.36200000+04	-.62533621-02	.93711443+01	-.28531595-02	.19868167+01	.30657365-02	.32066516+01
.36400000+04	-.72950736-02	.92356521+01	-.29350213-02	.19289334+01	.29915794-02	.32672309+01
.36600000+04	-.83305238-02	.90793834+01	-.30159337-02	.18694222+01	.29137538-02	.33262903+01
.36800000+04	-.93568394-02	.89024923+01	-.30957179-02	.18083036+01	.28322391-02	.33837564+01
.37000000+04	-.10371091-01	.87051906+01	-.31741907-02	.17456022+01	.27470264-02	.34395552+01
.37200000+04	-.11370307-01	.84877491+01	-.32511657-02	.16813460+01	.26581191-02	.34936128+01
.37400000+04	-.12351484-01	.82504988+01	-.33264530-02	.16155669+01	.25655331-02	.35458554+01
.37600000+04	-.13311603-01	.79938303+01	-.33998613-02	.15483004+01	.24692979-02	.35962097+01
.37800000+04	-.14247646-01	.77181953+01	-.34711976-02	.14795862+01	.23694568-02	.36446033+01
.38000000+04	-.15156606-01	.74241053+01	-.35402685-02	.14094677+01	.22660675-02	.36909644+01
.38200000+04	-.16035507-01	.71121316+01	-.36068813-02	.13379919+01	.21592022-02	.37352227+01
.38400000+04	-.16881417-01	.67829051+01	-.36708453-02	.12652101+01	.20489484-02	.37773098+01
.38600000+04	-.17691468-01	.64371142+01	-.37319719-02	.11911770+01	.19354085-02	.38171587+01
.38800000+04	-.18462868-01	.60755041+01	-.37900770-02	.11159514+01	.18187003-02	.38547049+01
.39000000+04	-.19192918-01	.56988752+01	-.38449812-02	.10395953+01	.16989565-02	.38898864+01
.39200000+04	-.19879030-01	.53080804+01	-.38965113-02	.96217464-00	.15763248-02	.39226440+01
.39400000+04	-.20518743-01	.49040234+01	-.39445014-02	.88375849-00	.14509677-02	.39529213+01
.39600000+04	-.21109731-01	.44876555+01	-.39887942-02	.80441923-00	.13230617-02	.39806657+01
.39800000+04	-.21649828-01	.40599734+01	-.40292422-02	.72423235-00	.11927968-02	.40058280+01
.40000000+04	-.22137032-01	.36220150+01	-.40657087-02	.64327610-00	.10603757-02	.40283631+01
.40200000+04	-.22569524-01	.31748568+01	-.40980684-02	.56163139-00	.92601328-03	.40482301+01
.40400000+04	-.22945675-01	.27196096+01	-.41262092-02	.47938149-00	.78993510-03	.40653922+01
.40600000+04	-.23264063-01	.22574148+01	-.41500328-02	.39661180-00	.65237658-03	.40798175+01
.40800000+04	-.23523474-01	.17894401+01	-.41694549-02	.31340952-00	.51358166-03	.40914790+01
.41000000+04	-.23722918-01	.13168755+01	-.41844069-02	.22986341-00	.37380144-03	.41003542+01
.41200000+04	-.23861627-01	.84092817-00	-.41948360-02	.14606339-00	.23329283-03	.41064262+01
.41400000+04	-.23939069-01	.36281867-00	-.42007054-02	.62100348-01	.92316972-04	.41096827+01
.41600000+04	-.23954944-01	-.11622431+00	-.42019950-02	-.21934304-01	-.48862260-04	.41101173+01
.41800000+04	-.23909192-01	-.59496843-00	-.41987015-02	-.10594891+00	-.18997986-03	.41077287+01
.42000000+04	-.23801989-01	-.10721825+01	-.41908382-02	-.18985191-00	-.33077127-03	.41025204+01
.42200000+04	-.23633748-01	-.15466412+01	-.41784354-02	-.27355219-00	-.47097401-03	.40945017+01
.42400000+04	-.23405115-01	-.20171300+01	-.41615393-02	-.35695938-00	-.61032918-03	.40836871+01
.42600000+04	-.23116967-01	-.24824493+01	-.41402128-02	-.43998424-00	-.74858306-03	.40700960+01
.42800000+04	-.22770404-01	-.29414194+01	-.41145337-02	-.52253889-00	-.88548854-03	.40537529+01
.43000000+04	-.22366741-01	-.33928850+01	-.40845951-02	-.60453720-00	-.10208065-02	.40346871+01
.43200000+04	-.21907503-01	-.38357188+01	-.40505040-02	-.68589502-00	-.11543070-02	.40129328+01
.43400000+04	-.21394411-01	-.42688262+01	-.40123806-02	-.76653048-00	-.12857708-02	.39885285+01
.43600000+04	-.20829377-01	-.46911491+01	-.39703576-02	-.84636426-00	-.14149900-02	.39615170+01
.43800000+04	-.20214479-01	-.51016691+01	-.39245789-02	-.92531976-00	-.15417693-02	.39319452+01
.44000000+04	-.19551968-01	-.54994110+01	-.38751984-02	-.10033234+01	-.16659267-02	.38998637+01
.44200000+04	-.18844233-01	-.58834465+01	-.38223793-02	-.10803048+01	-.17872940-02	.38653268+01
.44400000+04	-.18093801-01	-.62528958+01	-.37662926-02	-.11561968+01	-.19057179-02	.38283917+01
.44600000+04	-.17303315-01	-.66069315+01	-.37071159-02	-.12309359+01	-.20210595-02	.37891187+01
.44800000+04	-.16475520-01	-.69447798+01	-.36450326-02	-.13044620+01	-.21331957-02	.37475707+01
.45000000+04	-.15613249-01	-.72657226+01	-.35802303-02	-.13767190+01	-.22420180-02	.37038130+01
.45200000+04	-.14719402-01	-.75690994+01	-.35128997-02	-.14476544+01	-.23474337-02	.36579128+01
.45400000+04	-.13796934-01	-.78543080+01	-.34432341-02	-.15172195+01	-.24493652-02	.36099388+01
.45600000+04	-.12848839-01	-.81208058+01	-.33714272-02	-.15853695+01	-.25477498-02	.35599618+01
.45800000+04	-.11878130-01	-.83681107+01	-.32976733-02	-.16520635+01	-.26425395-02	.35080529+01
.46000000+04	-.10887828-01	-.85958004+01	-.32221654-02	-.17172647+01	-.27337004-02	.34542844+01

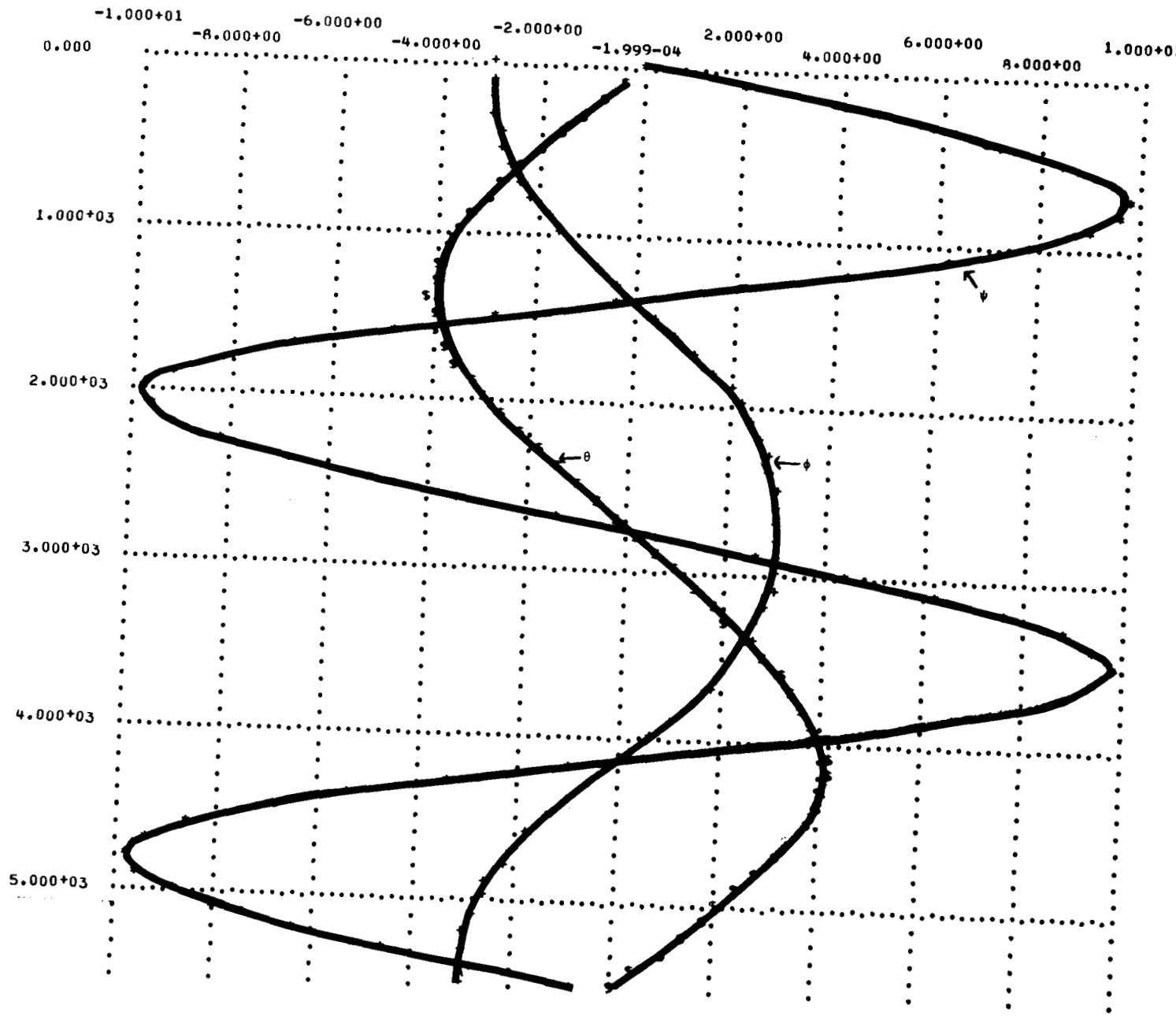
EULER ANGLES AND THEIR DERIVATIVES VS. TIME FOR 1 ORBIT

OF THE AAP CLUSTER IN POP MODE (Cont.)

.46200000+04	-.98809469-02	-.88035133+01	-.31450949-02	-.17809397+01	-.28212126-02	.33987292+01
.46400000+04	-.88604751-02	-.89909478+01	-.30666506-02	-.18430593+01	-.29050694-02	.33414603+01
.46600000+04	-.78293663-02	-.91578614+01	-.29870178-02	-.19035978+01	-.29852763-02	.32825508+01
.46800000+04	-.67905237-02	-.93040707+01	-.29063778-02	-.19625333+01	-.30618511-02	.32220735+01
.47000000+04	-.57467897-02	-.94294497+01	-.28249072-02	-.20198473+01	-.31348228-02	.31601008+01
.47200000+04	-.47009338-02	-.95339280+01	-.27427778-02	-.20755251+01	-.32042310-02	.30967043+01
.47400000+04	-.36556429-02	-.96174907+01	-.26601553-02	-.21295551+01	-.32701247-02	.30319550+01
.47600000+04	-.26135120-02	-.96801747+01	-.25771996-02	-.21819291+01	-.33325626-02	.29659224+01
.47800000+04	-.15770360-02	-.97220687+01	-.24940643-02	-.22326419+01	-.33916111-02	.28986751+01
.48000000+04	-.54860312-03	-.97433096+01	-.24108964-02	-.22816914+01	-.34473448-02	.28302801+01
.48200000+04	.46951149-03	-.97440814+01	-.23278361-02	-.23290785+01	-.34998444-02	.27608029+01
.48400000+04	.14751502-02	-.97246122+01	-.22450166-02	-.23748065+01	-.35491977-02	.26903073+01
.48600000+04	.24662771-02	-.96851722+01	-.21625642-02	-.24188816+01	-.35954973-02	.26188554+01
.48800000+04	.34409800-02	-.96260708+01	-.20805980-02	-.24613123+01	-.36388411-02	.25465072+01
.49000000+04	.43974730-02	-.95476544+01	-.19992302-02	-.25021094+01	-.36793309-02	.24733207+01
.49200000+04	.53340966-02	-.94503041+01	-.19185654-02	-.25412861+01	-.37170723-02	.23993523+01
.49400000+04	.62493176-02	-.93344331+01	-.18387019-02	-.25788573+01	-.37521740-02	.23246555+01
.49600000+04	.71417282-02	-.92004835+01	-.17597304-02	-.26148400+01	-.37847470-02	.22492822+01
.49800000+04	.80100437-02	-.90489246+01	-.16817353-02	-.26492531+01	-.38149045-02	.21732818+01
.50000000+04	.88531001-02	-.88802501+01	-.16047938-02	-.26821165+01	-.38427614-02	.20967013+01
.50200000+04	.96698503-02	-.86949759+01	-.15289770-02	-.27134523+01	-.38684335-02	.20195859+01
.50400000+04	.10459360-01	-.84936376+01	-.14543491-02	-.27432834+01	-.38920370-02	.19419778+01
.50600000+04	.11220804-01	-.82767885+01	-.13809684-02	-.27716345+01	-.39136890-02	.18639174+01
.50799999+04	.11953460-01	-.80449972+01	-.13088871-02	-.27985308+01	-.39335061-02	.17854425+01
.51000000+04	.12656703-01	-.77988461+01	-.12381512-02	-.28239989+01	-.39516046-02	.17065887+01
.51199999+04	.13330000-01	-.75389288+01	-.11688014-02	-.28480661+01	-.39681002-02	.16273891+01
.51400000+04	.13972902-01	-.72658487+01	-.11008727-02	-.28707604+01	-.39831074-02	.15478746+01
.51600000+04	.14585041-01	-.69802178+01	-.10343948-02	-.28921106+01	-.39967396-02	.14680739+01
.51800000+04	.15166120-01	-.66826542+01	-.96939237-03	-.29121459+01	-.40091085-02	.13880134+01
.52000000+04	.15715910-01	-.63737816+01	-.90588512-03	-.29308962+01	-.40203241-02	.13077173+01
.52200000+04	.16234235-01	-.60542275+01	-.84388815-03	-.29483914+01	-.40304943-02	.12272075+01
.52400000+04	.16720979-01	-.57246226+01	-.78341204-03	-.29646619+01	-.40397249-02	.11465038+01
.52600000+04	.17176065-01	-.53855993+01	-.72446311-03	-.29797380+01	-.40481194-02	.10656241+01
.52800000+04	.17599458-01	-.50377913+01	-.66704369-03	-.29936505+01	-.40557783-02	.98458394-00
.52999999+04	.17991155-01	-.46818323+01	-.61115219-03	-.30064299+01	-.40627999-02	.90339718-00
.53200000+04	.18351181-01	-.43183563+01	-.55678348-03	-.30181067+01	-.40692791-02	.82207557-00
.53399999+04	.18679579-01	-.39479960+01	-.50392900-03	-.30287113+01	-.40753081-02	.74062902-00
.53600000+04	.18976412-01	-.35713836+01	-.45257702-03	-.30382739+01	-.40809756-02	.65906566-00
.53800000+04	.19241749-01	-.31891495+01	-.40271287-03	-.30468243+01	-.40863671-02	.57739184-00
.54000000+04	.19475666-01	-.28019230+01	-.35431913-03	-.30543922+01	-.40915647-02	.49561228-00
.54200000+04	.19678243-01	-.24103317+01	-.30737594-03	-.30610067+01	-.40966468-02	.41373003-00
.54400000+04	.19849554-01	-.20150018+01	-.26186115-03	-.30666967+01	-.41016883-02	.33174668-00
.54600000+04	.19989669-01	-.16165576+01	-.21775060-03	-.30714905+01	-.41067599-02	.24966231-00
.54800000+04	.20098648-01	-.12156226+01	-.17501838-03	-.30754159+01	-.41119290-02	.16747564-00
.55000000+04	.20176543-01	-.81281890-00	-.13363706-03	-.30785003+01	-.41172586-02	.85184081-01
.55200000+04	.20223390-01	-.40876786-00	-.93577921-04	-.30807701+01	-.41228077-02	.27838349-02
.55400000+04	.20239212-01	-.40901394-02	-.54811276-04	-.30822519+01	-.41286315-02	-.79730053-01
.55402021+04	.20239214-01	.11859762-05	-.54425940-04	-.30822629+01	-.41286919-02	-.80564654-01

THE TOTAL NUMBER OF INTEGRATION STEPS IS 285
RDDG = .57295779+02

EULER ANGLES FOR AAP CLUSTER IN POP MODE (Degrees)



BELLCOMM, INC.

Subject: Periodic Solutions of the Orbital Assembly Equations of Motion - Case 620

From: S. C. Chu

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