Review of "**An Introduction to the Mathematics and the Methods of Astrodynamics**"
by **Richard H. Battin**, *AIAA Education Series*, New York (U. S. A.), 1987 & 1999
BEST SELLER! Winner of the Summerfield Book Award
as it appears in <http://www.amazon.com> [Book Rating: ØØØØØ]

The following comments refer to the 1987 edition. Some of these comments were communicated to Dr. Battin, who, very kindly, acknowledged them.

The book by Richard H. Battin, Senior Lecturer in Aeronautics and Astronautics, Massachusetts Institute of Technology, USA, covers essential mathematical background needed to work with astrodynamical problems. Topics covered include hypergeometric functions, elliptic integrals, continued fractions, coördinate transformations as well as essentials of two-body-central-force motion.

The author's way of discussing these topics with historical introduction and personal narrative makes the book interesting to read. There are minimal typographical errors, probably, because the author, personally, typeset this book. However, there are a few omissions and oversights. For example, on page 172 captions are given for Fig. 4.15 and Fig. 4.16, whereas the actual figures are missing (*The author has rectified this omission in the* 1999 *edition*). In addition:

a) On page 7 it is stated:

$$\Delta \mathbf{r} = \frac{s_g}{v_g} \mathbf{v}_g ,$$

where $s_g = \int \mathbf{v}_g \, dt$. In this equation, a scalar on the left-hand side is equated to a vector on the right-hand side. The equation should be modified as:

$$s_g = \left| \int \mathbf{v}_g \, dt \right|$$

b) On pages 10-11 it is stated: "If you want to drive a vector to zero, it is sufficient to align the time rate of change of the vector with the vector itself." This is not true, in general, but only if time rate of change is negative.

c) On page 13 the author tries to show that constant in the equation:

$$\frac{\nabla \times \mathbf{v}_c}{\rho} = constant$$

vanishes by the following argument. "The demonstration concludes with an argument that the fluid is converging on the target point $\mathbf{r}_T$ so that the density in the vicinity $\mathbf{r}_T$ of is becoming infinite. *Hence, the constant is zero, implying that the curl is everywhere zero.*" There are 2 problems in this line of argument: *(i)* The statement "hence, the constant is zero" is true, only if the numerator is finite. $B = \infty$ implies $A/B = 0$, only if $A \neq \infty$. Otherwise, one has to apply l'Hospital rule; *(ii)* Even if the constant is supposed to be zero, this does not imply that the curl is everywhere zero. $A/B = 0$, where $B = \infty$ does not imply that $A = 0$. In fact, *A* could have any finite value.

d) On page 109 equation of motion in a frame of reference moving with acceleration $-\mathbf{a}_1$ is written as:

$$m_2(\mathbf{a}_2 - \mathbf{a}_1) = \frac{m_1 + m_2}{m_1} \times \frac{G m_1 m_2}{r^2} \left[-\frac{\mathbf{r}}{r} \right]$$

Since the frame is noninertial (accelerated), Newton's second law, $\mathbf{F} = m\mathbf{a}$, is not applicable in this frame.

e) On page 223 it is stated: "When we compare Eqns. (5.57) and (5.58), it is clear that we **must** have:

$$\sin E \cong \sqrt{\frac{6(E-\sin E)}{\sin E}}$$

……." This is *not the only choice* for sin*E*, which reduces (5.58) to (5.57) in the limit $E \to 0$. The word "must" is inappropriately used here.

I would recommend this book **very strongly** to any one involved in astrodynamical research.

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This review is, now, part of the manuscript: The Multi-Stage-Q System and the Inverse-Q System for Possible Application in Satellite-Launch Vehicle (SLV), Proc. IBCAST 2005, pp 31, 32 <http://www.ngds-ku.org/Papers/C66.pdf>

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