



FORTUNE EIGHT

Aerospace Industries, Inc.

International Technical Services

Original Lecture: 2002 April 20

MEMORANDUM

To: CMA Class
From: Chauncey Uphoff
Subject: Class Notes for Lecture #10

In Lecture #10, I began a discussion of the Main Problem of Artificial Satellite Theory as I implemented it in the late 1970s and early 1980s. I showed how I had used ingenious variables of Hill used by Izsak in his note in the AJ (1963) and mentioned John Breakwell's hint to me to read that note so I could understand the transformation from osculating to mean elements in these theories. I'm sure I mentioned somewhere in this lecture, or in the next, that Izsak's statement that "the mean elements bear the same relationship to the mean disturbing function that the osculating elements bear to the osculating disturbing function." (This quote is approximate but the concept is very important; it allows one to understand why there can be a "zero mean eccentricity.") I did not elucidate this concept because I knew there would be a final homework problem with that question in it. I wanted you to get it for yourselves. Refs. for Lecture #11 are included below.

I mentioned that the definition of mean elements is given in many ways and that I have never understood many of them. I gave the example of the 2-line element sets used by NORAD and the people who keep track of the satellites in Low-Earth orbit. Blair Thompson dug out the definitions of these mean elements and distributed them to the class. Jason posted them to the web-site, as they were already on the net. I also mentioned that I have my own way of reconciling the differences between the 2-line element sets and the Brouwer/Kozai mean elements; I simply "fudge" the value of the mean semi-major axis until I get the correct motion of the ascending node. I'm sure I mentioned, somewhere, that Brouwer's a'' is the same (to within terms of order J_2^2) as Kozai's a_{bar} (an a with a bar over it). I think NORAD uses Brouwer's a_0 instead of a'' . I gave the last "left-brain/right-brain" exercise and asked Jason to post it to "Bonus Handouts" on the website. It was called "I Before E." It contains 3 of my inputs to thinking with the right-brain and the left-

brain simultaneously. It contained a handy-dandy poem for remembering when to use “i” before “e,” and two puzzles that require one to use the right brain and the left brain in close conjunction. I later gave the answers to these puzzles in class. If you missed it, you missed it. I won’t give it here because I want the students to work it out for themselves if they can. This was not a “required” homework problem like the first puzzles I gave out; those were just to get the student thinking out of both sides of the brain and to see who was articulate and who was not. If you want to know the answers to the “I Before E” puzzles, send me an e-mail and I’ll give you the answers. Please don’t distribute these answers or you’ll cheat your own potential students.

I recall that I appeared in class wearing a sweatshirt with the inscription “When all else fails, manipulate the data.” This is funny only if you know me and know what a stickler I am for Integrity in scientific work. It’s hard enough not to manipulate the data (to get the answer you want) even if one is completely sincere. Many people (not in this class) thought it was funny and asked me if I worked for Enron. When I had time, I read them the riot act (figuratively) by launching into a diatribe about honesty in scientific work. I believe I discussed the work of Robert A. Milliken (and his student Harvey Fletcher), during the early part of the 20th century on the “‘Milliken’ Oil-Drop Experiment.” Harvey Fletcher was the Father of James Fletcher, the Administrator of NASA, when I was a young wolf. Dr. (James) Fletcher presented the NASA Exceptional Service Medal to Dr. Phil Roberts and me for our work on gravity assist at the Galilean satellites.

REFERENCES

1. Kozai, Y. 1959 *Astron. J.* **64**, p 367.
2. Izsak, I. 1963 *ibid.* **68**, p 559.
3. Brouwer, D. 1959 *ibid.*, **64**, p 378.
4. Hill, G.W. 1913, *ibid.* **27**, p 171.
5. Aksnes, K. 1972 *Astron.&Astrophys.*, **17**, p 70
6. Kozai, Y. 1962 *Astron. J.* **67**, p 446.

Best regards,

Chauncey Uphoff 2002 April 20