

COMMISSION 7: CELESTIAL MECHANICS (MÉCANIQUE CÉLÈSTE)

Report of Meetings, 19, 20, 22, 24 and 25 August 1970

PRESIDENT: W. J. Eckert.

VICE-PRESIDENT: G. N. Duboshin.

SECRETARY: P. J. Message.

Session (a): Business Meeting

The President referred to the Report on progress in the field in the previous three years, which was now presented in its final form, and not as a 'Draft Report', as formerly. He thanked those who had reviewed the various sections, and expressed satisfaction with the mechanized method which he had used to deal with the references. There had been no attempt to make the report exhaustive, but rather a cross-section of the types of work going on, and of the relation of Celestial Mechanics to other fields of study.

The Commission endorsed the President's strong support for the tradition that workers in Celestial Mechanics be autonomous, and work independently, without formal organization of projects by the Commission.

Dr A. Deprit raised the question of the difficulties in dissemination of numerical and computer information arising in large quantities, as in large scale numerical experiments, literal theories taken to a large number of terms, and raw observational data, where the publication of such material in the usual journals was not feasible. This appeared to be a matter of some widespread concern. Knowledge of the existence of such material is often only accidentally come by. A committee of the Commission, under the chairmanship of Dr M. S. Davis, was charged to discuss the question, and report to a later session.

Dr Déprit acted as interpreter in this and all later sessions.

Sessions (b), (c), and (d): *Colloquium on: 'Analytical Methods for Orbits of Artificial Celestial Bodies'*, organized by Professor G. N. Duboshin, with the assistance of Drs. E. P. Aksenov, B. Garfinkel, A. H. Cook, B. Morando, and D. G. King-Hele.

Session (b)

Chairman: Professor G. N. Duboshin.

Speakers: Yu. V. Batrakov, on 'Studies of the Motion of Artificial Earth Satellites at the Institute for Theoretical Astronomy at Leningrad'.

A. Deprit, 'On the Theory of an Artificial Satellite'.

P. Sconzo, on 'Time Series Solution in Explicit Form of the Asteroidal Three-Body Problem Using Generalized Lagrangian Functions f and g '.

R. R. Allan, on 'Resonance Effects for Close Earth Satellites'.

Session (c)

Chairman: Dr B. Garfinkel.

Speakers: V. Szebehely and P. Nacozy, 'On the Use of Chebeshov Polynomials in a General Perturbation Method of Earth-to-Moon trajectories'.

V. A. Brumberg, L. S. Evdokimova, and N. I. Kochina, on 'Analytical Methods for the Orbits of Artificial Lunar Satellites' (presented by Dr Abalakin).

K. Aksnes, on 'A Complete Second-Order Theory, Based on an Intermediate Orbit'.

I. Stelmacher, on 'Influence du champ magnétique sur le mouvement autour de son centre de gravité d'un satellite artificiel de la Terre' (presented by Dr J. Kovalevsky).

P. Bretagnon, on 'Expression analytique des termes en J_2 au carré dans la théorie des satellites artificiels' (presented by Dr B. Morando).

Session (d)

Chairman: Professor A. H. Cook.

Speakers: S. Herrick, on 'A Universal Singularity-Free Determination of an Orbit from Two Positions and Time-Interval'.

G. Hori, on 'A Second-Order Theory for an Artificial Satellite, Based on a Kepler Ellipse' (presented by Dr B. Garfinkel).

P. Sconzo, on 'Mechanized Algebraic Manipulation of a Second-Order Theory for Artificial Satellites'.

S. Ferraz-Mello, on 'Earth's Shadowing Effects in the Long-Periodic Perturbations of Satellites' Orbits'.

Sessions (e), (h), and (f): *Colloquium on 'The Impact of Precise Measurements of Distances on Celestial Mechanics'*, organized by Dr G. M. Clemence, with the assistance of Drs R. L. Duncombe, J. Kovalevsky, and J. D. Mulholland.

Session (e)

Chairman: Dr. Clemence.

Speakers: C. A. Lundquist, on 'Laser Ranging to Artificial Satellites'.

P. Bender, on 'Lunar Ranging'.

A. Orszag, on 'Laser Ranging to the Moon'.

S. J. Peale, on 'Evolution of the Earth-Moon System'.

J. Kovalevsky, on 'Lunar Theory'.

Session (h)

Chairman: Dr J. Kovalevsky.

Speakers: I. I. Shapiro, on 'Solar System Tests of General Relativity by Radar Ranging'.

J. G. Davies, on 'Radio Tracking at Jodrell Bank'.

W. H. Michael, on 'Gravity Fields from Radio Tracking Data'.

G. C. McVittie, on 'Questions of Interpretation in Relativistic Celestial Mechanics'.

Session (f)

Chairman: Dr R. L. Duncombe.

Speakers: C. Oosterwinter, on 'Numerical Integration and Analytical Theory'.

J. Chapront, 'Literal Planetary Theory'.

A. Deprit, on 'Literal Developments in Celestial Mechanics'.

W. J. Klepczynski, on 'Planetary Masses'.

D. A. O'Handley, on 'Ephemeris Improvement and the Topography of Mars'.

A short *Business Meeting* was held at the end of Session (e), at which the President's recommendations for the officers of the Commission for the following three years were approved.

The following list of Consultants of the Commission was approved:

D. G. King-Hele, J. Marchal, J. Moser, I. D. Zhongolovich, and E. A. Grebenikov.

Session (g): Business Meeting

The President referred to the working party on lunar laser ranging data being set up by COSPAR and Commission 17. The President of that Commission had invited representatives from Commis-

sions 4, 7, 17, 30, and 31 to join this working party. The Organizing Committee of Commission 7 asked Dr. Eckert to accept this invitation on behalf of the Commission.

The report of the committee on Program and Data Banks was presented by Dr Davis. The members of the committee were: M. S. Davis (chairman), Yu. V. Batrakov, J. Chapront, H. Debehogne, A. Deprit, and A. Ollongren. The report, which is given as the Appendix, was accepted in principle by the Commission. Dr Davis has accepted the Chairmanship of the Standing Working Group on Program and Data Banks, whose establishment was recommended by the committee, and membership of this Group has been accepted by Yu. V. Batrakov, H. Debehogne, A. Deprit, and A. Ollongren.

APPENDIX

REPORT OF COMMITTEE ON PROGRAM AND DATA BANKS OF COMMISSION 7

The committee recommends the establishment of a Standing Working Group of Commission 7 on 'Program and Data Banks', whose functions would be:

1. To collect and disseminate information on data and programs relating to celestial mechanics.
2. To recommend international standards for those interested in participating in this exchange of data and programs.
3. To serve as a clearing house for questions related to (1) and (2) whenever it is feasible and practicable to do so.

The committee distinguishes several kinds of data.

1. *Observational data.* This type of data is regarded as the chief concern of Working Group 1 and the several Commissions working with it to ensure the preservation of observations in the rawest form possible and with all relevant references. Commission 7 should be represented at all of the sessions of the IAU dealing with numerical data to be certain that its interests are represented.

2. *Numerical Data derived from Theories.* Examples of this class of data are (a) Clemence's theory of Mars, (b) the Improved Lunar Ephemeris, and (c) numerical experiments with periodic solutions in the restricted problem of three bodies. The purpose of having this kind of information in machine-readable form is, among other things, for comparison of theories, or extension of theories, or calculation of new numerical values by substitution of new numerical values as arguments.

3. *Analytical Data.* The lunar theories of Delaunay and Eckert in machine-readable form (for comparison with other theories, or for comparison with other derivations of the theory) is one example of analytical data.

The numerical data derived from theories (item 2 above) and analytical data (item 3) would be the proper concern of the subcommittee.

The committee also distinguishes two kinds of program for exchange.

1. *Numerical Programs.* This has been the most common use of computers. Examples would be programs for orbit determination and correction, calculation of Hansen perturbations, Schubart and Stumpff's n -body solar system numerical integrations.

2. *Analytical Programs.* Literal programs for symbol manipulation such as D. Barton's programs, Deprit and Rom's MAO, and the symbolic compiler at the Smithsonian Astrophysical Observatory.

The committee does not at this time recommend the establishment of a physical repository of data and programs in machine-readable form, but does recommend that the Standing Working Group be charged with the responsibility of collecting and disseminating information. In this capacity its function is that of a broker who establishes connections between requestors of programs and suppliers thereof.

To ensure the international character of this brokerage service, this function should be carried

out under the auspices of the IAU. The sub-committee should investigate what role supporting national committees can play in implementing its purposes. The advice and assistance of well-established groups which have dealt with similar problems, such as the U.S. Naval Observatory, the Royal Greenwich Observatory, and the Astronomisches Recheninstitut should be solicited.

The committee fully recognizes the serious difficulties involved in program exchange and therefore stresses that the principal goals can be realized by adequate documentation and the establishment of international standards. What is primarily intended here is the algorithmic presentation of theories so that any person or group can write programs *ab initio*, if necessary. It would be regarded as fortuitous, in general, if one institution were able to use another institution's programs intact.

It was stated that users of this service, following standard scientific practice, would be expected to acknowledge authorship of programs and data used.

Other suggestions made were:

1. Editors of astronomical journals should be alerted to the publication of information about material which would prove very useful in machine-readable form.
2. An inventory of computers in observatories, departments of Astronomy, Astronomical Institutes and Laboratories would prove very useful, in particular to visiting astronomers.
3. Guide lines should be set up for the mechanics and financing of interchanged material.

M. S. DAVIS (Chairman)