1.5 The Averaged Geopotential in Non-singular Orbital Elements. P. E. Nacozy, University of Texas at Austin and S. S. Dallas, Jet Propulsion Laboratory - The averaged geopotential is given entirely in terms of non-singular orbital elements. The development begins with Izsak (1964) and Allan's (1965) expansion of the geopotential. The short-periodic terms are removed and the long-periodic terms are transformed from the classical orbital elements to a set of non-singular variables.

Allan, R. 1965, Proc. Royal Soc. of London, A288, 60.
Izsak, I. 1964, J. Geo. Res., 69, 2621.

1.6 An Accelerated Elimination Technique for the Solution of Perturbed Hamiltonian Systems. R.A. HOWLAND, N.C.S.U. - A new technique is developed for the formal solution of non-degenerate or degenerate Hamiltonian systems under periodic perturbation through continually accelerated elimination of the periodic terms. Special features of the method are the ability to eliminate both short-period and long-period variables simultaneously and the attainment of [formal] "quadratic convergence" for non-degenerate systems and nearly quadratic convergence in degenerate cases. The technique utilizes Lie transforms and is based on an approach due to Kolmogorov and Arnol'd.

1.7 Third-Order Artificial Satellite Theory. H.KINOSHITA, Smithsonian Astrophysical Observatory, Camb., MA. -- Third-order periodic perturbations with fourth order secular perturbations (J_2, J_3, and J_4 only) are derived by Hori-Lie method, which does not depend on the choice of canonical elements. Since the eccentricity of satellites requiring a higher order theory is usually laser low, all quantities in the present theory are developed into power series of the eccentricity, but the solution is obtained in closed form with respect to the inclination. Delaunay variables are chosen as canonical elements, but the final relationships between osculating elements and mean elements are expressed in terms of L, ℓ+g, e sin g, e cos g, h and H, which are not singular at zero eccentricity and satisfy d'Alembert characteristic. All calculations were carried out by a computer algebra program (Smithsonian Package for Algebra and Symbolic Mathematics, SAO Special Report No. 291, 1969).

1.8 A New Method for Solving the Critical Argument Problem. WILLIAM H. JEFFERYS, Department of Astronomy, U. of Tex. - Traditional methods for isolating the critical argument in Hamiltonian mechanics involve the introduction of a special set of action variables which are both complicated in form and arbitrary in nature. The new variables are in general obscure in their interpretation. This paper introduces a new canonical system corresponding to the original one, but with one more degree of freedom, in which all the variables of the original Hamiltonian can be treated on the same footing. It appears to have significant advantages for machine calculations.

1.9 An Analysis of the Ancient Astronomical Observations With the Implications for Geophysics and Cosmology P.M. Muller JPL - The ancient eclipses and timed equinoxes (the remaining data have low sensitivity) are analyzed in regard of: $\dot{n}_t$ the tidal acceleration of the moon's longitude, $\dot{n}_a$ on Atomic Time, $\dot{n}_e$ from eclipses; $\dot{\Omega}$, $\ddot{\Omega}$ the rate and acc. of the lunar node (which corrections affect $\dot{n}_e$); units "cy^{-2}, "cy^{-1}; $\dot{\omega}$ ($\dot{\omega}_e/\omega_e$) the acc. of earth rotation; $\dot{\omega}_{ANT}$ the *apparent* non-tidal part of $\dot{\omega}$; $\dot{\omega}_{TNT}$ the true geophysical part of $\dot{\omega}_{ANT}$ *observationally* determined; and $\dot{G}/G$ the rate of the Gravitational Constant; units 10^{-11} yr^{-1}. Eclipses alone: $\dot{n}_e = -34.5 \pm 3$, $\dot{\omega}_{ANT} = +14 \pm 4$; with Martin & VanFlandern (1970) $\dot{\Omega} = +4.3$ $\dot{n}_e = -30.4 \pm 3$ in good agreement with Morrison & Ward (1975) $\dot{n}_t = -26 \pm 3$ from Transits of Mercury 1677 - 1973, and the implied $\dot{n}_t = -29.1 \pm 3.7$ from the *absolute* $\dot{\omega} = -23.8 \pm 2.3$ from ancient equinoxes. The so-called Spencer Jones anomaly (discrepancy between the ancient & modern $\dot{n}_t$) is therefore largely eliminated, and no evidence is found for a significant variation in the accelerations - contrary to R.R. Newton (1970, 1972 etc). Including the VanFlandern modern occultations (1955→) $\dot{n}_a = -36 \pm 9$ and the above yields the simultaneous solution from *all* data: $\dot{n}_t = -28.3 \pm 2.1$ (implying $\dot{\omega} = -23.3 \pm 1.3$); $\dot{\Omega} = +4.6 \pm 1$ ($+8.2 \pm 3.6$ without $\dot{\Omega} = 4.3 \pm 1$); $\dot{G}/G = -1.9 \pm 2.6$ (-4.6 ± 5.4 on Dirac's Cosmology); $\dot{\omega}_{TNT} = +6 \pm 3$ consistent with recent Geophysical theory (post-glacial uplift). Implied $\dot{G}/G = -5.7 \pm 0.7$ from the Sandage & Tammann Hubble Constant ($+55 \pm 7$ km/s/Mpc) with the $\dot{G}/G$ above indicates that the Hoyle-Narlikar class of cosmologies is marginal, while Dirac and Brans-Dicke are consistent within uncertainties, as is the value $\dot{G}/G = 0$. Thesis presented in candidacy for the PhD, University of Newcastle upon Tyne. Support: JPL (NAS7-100), Leverhulme & NATO Fellowships.

Invited

2.1 Determination of Solar-System Parameters by Very-Long-Baseline Interferometry. C. C. COUNSELMAN III, Mass. Inst. of Technology - Very-long-baseline interferometry (VLBI) enables the rotation of the earth and the apparent rotational and orbital motions of the moon and the planets to be determined accurately with respect to a coordinate frame anchored by extragalactic radio sources. Recent VLBI results in geodesy, selenodesy, and astrometry will be reviewed, including determinations of UT.1, polar motion, precession, and solid-earth tides; the moon's moment-of-inertia ratios and third-degree gravity harmonics; and relative and "absolute" source positions. Limitations of presently-used VLBI techniques, prospects for improvement, and planned applications of VLBI to solar-system problems will also be discussed.

2.2 Development of a VLBI reference co-ordinate system. R. A. Preston, M. A. Slade, J. G. Williams, J. L. Fanselow, A. W. Harris, J.P.L. - Observations of compact extragalactic radio sources by intercontinental Very Long Baseline Interferometry (VLBI) should allow the definition of an inertial coordinate system with an accuracy of $\sim 10^{-3}$ arcsecond. A survey effort is underway at JPL to identify compact radio sources for reference points. To date, 218 sources are known. Experiments are also underway to observe ALSEPs and planetary space probes differentially with respect to nearby natural sources. Such observations will allow the lunar and terrestrial planet ephermerides to be referenced to the inertial quasar reference frame, and will allow $\sim$100 times improvement in the accuracy of outer planet ephemerides. In support of these experiments, we have given particular attention to surveying the region near the