Summary of: 1961-Explanatory Supplement to the Astr-Office.pdf

Key Points

1. The research paper provides a comprehensive explanation of the content, derivation, and use of The Astronomical Ephemeris and The American Ephemeris and Nautical Almanac, offering a thorough understanding of the tabulations, auxiliary tables, and reference data included in the Ephemeris. It outlines the historical accounts of changes in the editions of The Nautical Almanac and The American Ephemeris and Nautical Almanac from 1901 to 1959 and the methods and procedures employed in their preparation.

2. It discusses various astronomical calculations and notations used in the computation of positions of celestial bodies, including the use of symbols and notations throughout the Supplement and detailed explanations for the correction procedures involving precession, nutation, aberration, parallax, proper motion, and orbital motion.

3. The paper explores the adoption of Ephemeris Time (E.T.) as the fundamental unit of time, the redefinition of the second based on the tropical year for 1900, and the committee's work to coordinate physicists on atomic standards and astronomers on the astronomical standard of ephemeris time. Additionally, the paper discusses the precision required in navigation and surveying, emphasizing the necessity for self-consistency in the system and the potential impact of inconsistencies on data interpretation.

Synopsis

The paper "Explanatory Supplement Prepared Jointly by the Nautical Almanac Offices of the United Kingdom and the United States" provides a comprehensive explanation of the content, derivation, and use of The Astronomical Ephemeris and The American Ephemeris and Nautical Almanac. The purpose of the paper is to offer users a thorough understanding of the tabulations, auxiliary tables, and reference data included in the Ephemeris. The Explanatory Supplement has been jointly prepared by the Nautical Almanac Office, United States Naval Observatory, and H.M. Nautical Almanac Office, Royal Greenwich Observatory, and offers detailed explanations and derivations for the calculated quantities. It also includes the ephemerides of the Sun, Moon, and planets, elements for computing geocentric coordinates, corrections for short-period nutation, and a list of international atomic time, among other astronomical constants. The paper briefly discusses the history of international cooperation, the scope and purpose of the Ephemeris, and the configurations of the Sun, Moon, and planets. Additionally, it provides information on the transformations from mean to apparent places of stars, as well as the Julian and Gregorian calendars and the Formulae for plane and spherical triangles. The paper also includes historical accounts of the changes in the editions of The Nautical Almanac and The American Ephemeris and Nautical Almanac from 1901 to 1959. Moreover, it outlines the methods and procedures employed in the preparation of the Nautical Almanac, Air Almanac, Improved Lunar Ephemeris, and Sight Reduction Tables for Marine Navigation. Special attention is also given to the development and collaboration of the United States and British ephemerides, and the international conferences on fundamental constants of astronomy. This paper serves as an invaluable reference for astronomers and navigators, providing detailed explanations and derivations essential for the precise and accurate use of the Ephemeris.

The given article discusses various astronomical calculations and notations used in the computation of positions of celestial bodies. It includes information on the compilation and correction of ephemerides for minor planets, comets, and satellites. The paper details the use of symbols and notations throughout the Supplement, including specific reference systems for equatorial or ecliptic coordinates. It provides formulae and methods for the conversion of coordinates from one reference system to another, and the calculation of astronomical phenomena for specific dates. The discrepancy between the apparent and mean positions of celestial objects due to factors such as precession, nutation, and aberration is also discussed. The article concludes by addressing the impact of the Earth's motion on the annual aberration, as well as the approximations and corrections used in astronomical calculations.

The research paper discusses different measures of time used in astronomy, specifically Ephemeris time, Sidereal time, and Universal time. It explains that Ephemeris time is a uniform measure of time dependent on the laws of dynamics and is used as the independent variable in the gravitational theories of the Sun, Moon, and planets. The paper also discusses how Ephemeris time is determined by comparing observed positions of celestial bodies with their ephemerides. It also explains the Julian Day Number and Julian Date as well as the concept of Greenwich Sidereal Date and Greenwich Sidereal Day Number.

The paper also covers Sidereal time, which is the hour angle of the (vernal) equinox or the first point of Aries, and its role in measuring the diurnal rotation of the Earth. The definitions of apparent and mean sidereal time are explained, as well as the use of Greenwich Sidereal Date and Greenwich Sidereal Day Number for consecutively numbering sidereal days.

Furthermore, the paper discusses Universal time, which is used as the basis for all civil time-keeping and conforms to the mean diurnal motion of the Sun. It provides the definition of Universal time as 12 hours plus the Greenwich hour angle of a point on the equator with a specific right ascension. The paper also notes that Universal time is used for practical timekeeping and is closely related to the mean solar time.

The paper provides a comprehensive overview of the concepts and measures of time used in astronomy, highlighting their definitions, applications, and relationships.

The paper discusses the measurement and definition of time, focusing in particular on the concepts of universal time, mean solar time, and ephemeris time. It discusses the historical background of time measurement, including the use of mean solar time and its revisions over time. The significance of variations in the rate of Earth's rotation and their impact on time measurement is also explored. The paper addresses the distinction between apparent solar time, mean solar time, and mean sidereal time, and their relationship to ephemeris time. It emphasizes the need for precise timekeeping for astronomical and navigational purposes, and the practical methods for determining and reducing time are detailed. The influence of variations in the rate of Earth's rotation on the length of the mean solar day and the determination of mean solar time by astronomical observations is also discussed. Additionally, the paper addresses the historical evolution of timekeeping methods, the role of the International Astronomical Union in standardizing time measurement, and the efforts to establish a uniform fundamental standard of time. The concept of ephemeris time, its significance, and the developments in its determination are also addressed, highlighting its association with the gravitational theory of the motion of the Moon and the variations in Earth's rotation. The introduction of crystal-controlled clocks and the detection of periodic seasonal variations in the Earth's rotation rate are discussed. The paper provides a comprehensive overview of the historical development, practical methodologies, and scientific significance of time measurement and its various forms, serving as a comprehensive reference for understanding the complexities and importance of accurate timekeeping in astronomical and navigational contexts.

The research paper discusses the adoption of Ephemeris Time (E.T.) as the fundamental unit of time, along with the redefinition of the second to be based on the tropical year for 1900. It details the historical process of adopting Ephemeris Time, including the recommendation by the International Astronomical Union and the subsequent approval of the definition by the Comite International des Poids et Mesures. The paper also outlines the establishment of a committee to coordinate the work of physicists on atomic standards and astronomers on the astronomical standard of ephemeris time. Additionally, the paper provides detailed information on the fundamental epoch of ephemeris time defined in 1958, as well as the tabular argument for the ephemerides expressed in ephemeris time. The discussion also covers the means of conversion from ephemeris time to Universal Time, the tabulation of the apparent positions and orbits of various planets, and the characteristics of osculating elements for outer planets. Finally, the paper underscores the precision of the ephemeris for accurate observation and data interpolation.

The research paper discusses the ephemerides and observational requirements for the Sun, Moon, and planets, focusing on determining precise transit times over specific meridians on Earth's surface to aid in observations. It emphasizes the precision needed in equatorial coordinates, rates of change, and osculating elements for accurate ephemerides. The paper provides guidance on calculating transit times and positional data for observatories, including the E.T. of transit over the observer's meridian, local mean time, local sidereal time, parallax correction, and determining the sidereal time of the semi-diameter crossing the meridian. It also addresses the required precision for determining horizontal parallax, semi-diameters, and the apparent topocentric semi-diameter for observations. The research provides valuable insights into the methods and calculations necessary for accurately determining celestial transit times and positional data for astronomical observations.

The article discusses the calculations and corrections needed for determining the apparent places of stars, particularly focusing on the reduction from mean to apparent place using Besselian and independent day numbers. The paper provides detailed formulas and explanations for the correction procedures involving precession, nutation, aberration, parallax, proper motion, and orbital motion. The significance of short-period nutation and its incorporation into the calculations is emphasized. The article also includes numerical illustrations to demonstrate the application of the methods and the significance of including second-order terms in the calculations. The example uses the apparent place of the star a Ursae Minoris, also known as Polaris or the Pole Star, to illustrate the practical application of the discussed methods. This research aims to provide a comprehensive and practical guide for the accurate determination of star positions and their relevance to various domains such as navigation, surveying, and astronomy.

The research paper discusses the precision required in navigation and surveying, with a focus on the use of navigational tables and ephemerides for accurate positioning. It provides detailed calculations and tabulations for the polar distance of Polaris, including its altitude and azimuth as seen from different latitudes and local hour angles. The paper offers expansions, functions, and detailed tables for celestial navigation and surveying purposes. It also delves into the conventions and values of astronomical constants, including the system of fundamental astronomical constants, solar parallax, equatorial radius, flattening, and precessional constants.

The paper gives insights into the complexities, precision, and accuracy required for tabulations and ephemerides for the navigation, positioning, and surveying of celestial bodies. It also highlights the historical evolution of the conventional values of astronomical constants, emphasizing the necessity for self-consistency in the system and the potential impact of inconsistencies on data interpretation. The author further emphasizes the importance of maintaining the present system, despite its imperfections, due to its usefulness and historical significance. The paper includes references to historical and contemporary authorities and values for astronomical constants and ephemerides.

The research paper titled "Astronomical Phenomena in the American Ephemeris and Nautical Almanac" details the tabulation of various astronomical phenomena such as phases of the Moon, times of eclipse, perihelion, aphelion, equinoxes, solstices, and heliocentric phenomena of the planets. It provides detailed methods for computing these astronomical events such as inverse interpolation of differences in longitudes for determining the times of phases of the Moon, computation of times of apogee of the Moon through interpolation of horizontal parallax, and determination of dates for perihelion, aphelion, nodes on the ecliptic, and greatest latitudes north or south for planets. The paper also includes descriptions of the cyclical recurrence of phases of the Moon, details about the visibility and areas of solar and lunar eclipses, transits of Mercury, and occultations of planets and bright stars. Overall, the paper comprehensively explains the methods and tabulations used to calculate these key astronomical events and phenomena.

The paper discusses the calculation and determination of various phenomena related to eclipses and planetary movements. It outlines methods for calculating the geometric positions of celestial bodies, including the Sun, Moon, and planets, at various specific times and events such as conjunctions, oppositions, and points of maximum eclipse. The paper provides mathematical formulas and computational procedures for determining the times and positions of these celestial events with regards to the Earth's coordinates. Additionally, it also covers the determination of synodic periods, elongations, magnitudes, and the effects of light-time on the positions of celestial bodies. The paper includes numerous illustrative examples to demonstrate the application of the formulas and procedures discussed. Overall, the paper provides a comprehensive framework for accurately calculating and predicting various celestial events and phenomena.

The research paper presents a detailed analysis and calculation of the local circumstances of solar and lunar eclipses, as well as the transits of Mercury. The paper outlines formulas and methods for determining the time of greatest eclipse, position of the point of greatest eclipse, magnitude of the eclipse, and position angles for different phases of the eclipse. The paper introduces mathematical expressions to calculate the coordinates of the observer, magnitude of the eclipse, and position angles during different stages of the eclipse. It also provides detailed examples of calculations for specific solar and lunar eclipses, along with the application of correction factors for precise predictions. Additionally, the paper discusses the computation of transits of Mercury and the methods for determining the times of interior and exterior contacts during the transit. The paper emphasizes the importance of accuracy in eclipse calculations, outlines various equations and methods for precise predictions, and provides practical examples to demonstrate the application of the presented formulas and techniques.

The paper discusses the calculation and observation of occultations, specifically focusing on the prediction and reduction of lunar occultations. The author investigates the method of calculating the geocentric phases of transits of Mercury and emphasizes the importance of predictions for the observation and reduction of occultations. The research also details the process of predicting occultations for stars and planets, including the preparation of initial information and the calculation of Besselian elements.

Additionally, the paper looks at the reduction of observed occultations and the application of corrections for irregularities of the Moon's limb, using examples to illustrate the methodology. It highlights the importance of systematic reduction and discussion of lunar occultations and discusses the process of making solutions for each lunation using the observational equation of condition. The author also indicates that the results of the observations from 1960 to 1966 have been analyzed and discusses the potential of using occultations of radio sources by the Moon for determining the positions and intensity distributions of discrete radio sources.

The paper discusses the process of predicting the occultation of celestial objects, including stars, by other celestial bodies such as planets. It provides detailed information on the method of predicting the approximate times of disappearance and reappearance of celestial sources and the calculation of topocentric positions of the Moon. The paper also covers the predictions of occultations of stars by planets and the comparison of star catalogues with the ephemerides of the planets to yield observable phenomena. Additionally, it explains the process of identifying physical observations of the Sun, Moon, and planets and provides detailed information on the physical ephemerides for each planet, including factors such as the mean rotational motion, the apparent disks, and the conditions of illumination. The paper concludes by discussing the variations in phase for different planets and the observed aspects of the disks based on the positions of the Earth and the Sun relative to the different areas of the surface of the planet.

The research paper discusses the celestial positions of the Earth and the Sun on the planetocentric celestial sphere at different points of the surface. It explains the coordinate systems defined on the planetocentric sphere, and the angles and distances denoted by DE, AE, and Ls. These angles and distances determine the geocentric and heliocentric aspects of the planetographic coordinate systems on the surface of the planet. The paper also discusses the position angle of the axis of the planet, the correction for aberration, and the adopted rotation elements of Mars. It covers the elements of the equator of Jupiter and the values of r6, the calculation of the phase, and tabulated values of uo and 00. It also contains detailed calculations and tabulated data for the physical ephemerides of Mars, Jupiter, and other planets, as well as practical instructions for determining the celestial positions and phenomena of the satellites of Mars, Jupiter, and other celestial bodies.

The research paper discusses the orbital positions and calculations for the satellites of Saturn and Jupiter. It first covers the calculations for the orbital positions of the satellites, including the differential right ascension and declination, as well as the transformation of the coordinates to the equator of the Earth. The paper also includes discussions on the elements and ephemerides of Phoebe, including its position angle and apparent distance. Additionally, it provides tabulated examples for the eastern and western elongations, inferior and superior conjunctions, and differential coordinates for Hyperion and Iapetus. The precision of the data and calculations is also highlighted, ensuring accuracy within the given precision of the tables.

The paper discusses the ephemerides and calendars of ancient civilizations, focusing on the Egyptian, Babylonian, and early Greek calendars. It describes the fixed Egyptian calendar, based on 12 months of 30 days each, with 5 additional days at the end of the year. The paper also discusses attempts to reform the Egyptian calendar and the introduction of a 19-year cycle for intercalations in the Babylonian calendar. It provides insights into the challenges of restoring and correlating ancient calendars due to the lack of complete and continuous records. The research highlights the complexity and incommensurability of lunar and solar periods, and the influence of local authorities on calendar intercalations.

The paper discusses the historical development and use of various calendars, including the Metonic and Callippic cycles used for dating observations. It provides a historical overview of the Roman, Julian, and Gregorian calendars, detailing their establishment, adjustments, and adoption for civil and religious purposes. It also explains the Christian era, its adoption, and the controversy surrounding the beginning of centuries. Additionally, it addresses the structure of the Jewish and Islamic calendars, their historical eras, and reforms. Furthermore, it explores the Indian calendar, its reform, and the adoption of the Gregorian and Islamic calendars in India for religious purposes. The paper also includes detailed tables to aid in calculating calendars, leap years, day fractions, Julian and Greenwich sidereal day numbers, and Besselian years.

The paper discusses the Julian day number and the Greenwich sidereal day number as tools for facilitating the enumeration of days and revolutions of the equinox, particularly during the 20th century. It emphasizes that these tools can be used to obtain the Julian day number and the Greenwich sidereal day number for any calendar date by adding the difference for the centurial year, the value for the corresponding month and year, and the day of the month. The paper also highlights the importance of determining time and maintaining a national standard of time, with a focus on the role of national observatories in using astronomical observations to assess the performance of standard clocks and establish a uniform time system. Moreover, it touches upon the use of radio time signals and standard frequency transmissions, providing details about the specific signals employed and their coordination between countries for accuracy and precision in timekeeping. Furthermore, the paper delves into the use of quartz clocks and atomic and molecular clocks, emphasizing their role in establishing internationally coordinated time scales. It also covers the mathematical and computational techniques used in astronomy, particularly highlighting the precision of calculation based on the precision of the data entering into it, the use of formulas, and the application of inverse interpolation for solving transcendental equations and complicated algebraic equations. The paper concludes by acknowledging the impact of high-speed electronic computing machines on computational precision and efficiency, particularly in transforming coordinates for corrections such as precession and nutation.