

REDUCTION OF THE PAST ILS DATA IN A UNIFORM SYSTEM

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Analyses of the nutation terms based on the results of astronomical observations of time and latitude provide valuable information to promote studies on the constitution of the Earth's interior. Indeed, the results of analyses of the nutations agree well with those predicted by theory for a fluid core. This shows that the matter of the outer core, 3,000 km and more below the Earth's surface, is not only in a fused state but also is a "fluid" which can move in response to the external forces. Many additional studies on the nutation terms are now in progress, for example, to estimate an extreme value of viscosity of the fluid core, to discuss the possibility of the geomagnetic dynamo being driven by the precession, and so on.

Chandler motion of the pole and irregular changes in the rotation speed of the Earth are the phenomena measured by the machine which is called "Rotation of the Earth." Research on these phenomena and on their causes is closely concerned with research on large-scale variations of the outer and inner parts of the Earth, such as the following: motions in the atmosphere, ocean, and fluid core; earthquakes; and so on. On the other hand, the studies of nutation correspond also to measuring the response of the machine to the external force known as the luni-solar torque. This means that fundamental knowledge about our Earth, its characteristics and functions, can be obtained from studies of the polar motion and of the nutation terms. It is to be stressed that these two types of research can be encouraged more than ever, and lastly that they should be synthesized.

Analyses of the nutation terms have been carried out at the Central Bureau of the IPMS as a matter of importance in parallel with the derivation and analyses of the polar motion. In other words, the z and τ terms have been analyzed very carefully in parallel with the pole coordinates x and y , which were derived from the world-wide data on time and latitude.

It is well known that H. Kimura, the discoverer of the z term, wrote the annual z term in the form $(20-\alpha)$. This shows that he must have been very anxious to find a relation between the z term and the nutation. It was, however, impossible at that time to prove his idea from the two-group observation scheme of the ILS. He proposed the three-group observation scheme, and it was adopted in 1955. There is one episode reported where Kimura, who was asked about the origin of the z term, answered "it is underneath," tapping the floor. It is easily imagined from this episode that Kimura must have been aware that the origin would be in the interior of the Earth.

It was very fortunate for researchers in the field of the Earth's rotation that theories of nutation based on the realistic Earth model of elastic mantle and fluid core were developed by Jeffreys and Vicente (1957) and also by Molodensky (1961). The idea of Kimura was proved correct by Wako (1970) and Yokoyama (1973). They analyzed the results of three-group observations of latitude adopted by the ILS since 1955, and they made clear that a main part of the annual z term could be attributed to a deviation of the semi-annual nutation term based on the theory of rigid Earth from that for the actual Earth. They concluded that the dynamical effect of the fluid core should be taken into account when the nutation terms are discussed. The z term is also utilized effectively for derivations of the 18.6 year nutation, the annual nutation, and the free core nutation or nearly diurnal nutation.

Yokoyama *et al.* succeeded recently in deriving nutation terms from analyses of the τ -term, which was introduced in the analysis of global time data after this was proposed by Yokoyama (1976). Thus a two-dimensional system of research for understanding nutation is in progress at Mizusawa.

There may be no doubt that the z and τ terms are of importance for accurate determination of the pole coordinates x and y . However, it has become more important that the z and τ terms themselves should be recognized as terms which have a physical meaning, and not just as the correction terms for derivation of x and y .

This idea is being taken into account during the recalculation in a uniform system of the past ILS data over 77 years. Reduction of the data should be made most carefully so that:

- 1) uniformity in the system will be preserved throughout the whole period at any station of the ILS, and
- 2) information for studying nutation should not be lost out in the course of the reduction.

Almost all of the original data on latitude observations made at the ILS stations from the end of 1899 have been punched on about 1,800,000 cards. The working group on pole coordinates met several times since

its organization in 1970 at the Brighton meeting of the IAU and discussed how to promote effectively and reasonably improvements in technique and also in finance. Agreements on the method of reduction which have been adopted by the working group members are:

- 1) Data should be converted into a machine readable form.
- 2) The Melchior-Dajaffe Catalogue (1969) is adopted as the fundamental catalogue.
- 3) Astronomical constants of the IAU System are adopted.
- 4) Apparent places of the stars are calculated by the method proposed by Yumi et al. (1974).
- 5) Declination and proper motion errors are calculated as a first approximation by the method proposed by Yumi (1972).
- 6) The micrometer value is improved by the method of using the "Reduction to Group Mean."

During IAU Symposium No. 78 in Kiev, 1977, the working group members met again. They agreed to adopt the following:

- 1) The general reduction method employed at the present time by the Central Bureau of the IPMS will be used.
- 2) Computations of the micrometer value will be done as follows:
 - I - A first approximation employing the original micrometer values will be used in the reduction of observations.
 - II - In addition, computations will be carried out by the following techniques for a trial period (about 2 years before the end of the program that finished in 1955),
 - a) by Kimura's method (1935, 1940)
 - b) by Yumi and Yokoyama's method (use of R.G.M.),
 - c) by daily values and considering the mean for the whole year for each station (method applied by Fedorov to three or more stations of the ILS), taking account of the provisional pole coordinates,
 and the results of these three methods will be examined by the working group members.
- 3) The working standard values adopted at this Symposium will be employed for the nutation terms.
- 4) Effects of the personal equation of the observers are to be investigated, but not applied to the reductions.
- 5) Temperature corrections to the micrometer values are to be computed by Kimura's method (1935, 1940) in order to decide if this correction should or should not be applied.

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