Relativistic VLBI Delay model for finite distance radio source

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1. Introduction

VLBI (Very Long Baseline Interferometry) has

quite high delay and angular resolution for coordinates measurement of celestial radio source. It has been playing a important role to realize the International Terrestila Reference Frame (ITRF) and International Cerelstial Reference Frame (ICRF). Additionally as an engeneering application of VLBI, meausrement of gravitational field of moon (SELENE Project) and spacecraft navigation has been planed.

Usually VLBI is used for observation distant radio source at several thousands of light year or more away, hence plane wave approximation of radio signal from radio source is valid. When radio source is at 30 light year or closer, however, curvature of its wavefront is not neglisible comapred to the measurement precision. Thus new VLBI delay model corresponding to the Consensus Model [Eubanks 1991, McCarthy 1996] is required for obseration of radio sources in the solar system.

2. VLBI delay model for finite distance radio source

Fukushika (1994) showed that VLBI delay of finite distance radio source can be expressed by the same formula when pesudo radio source vector is composed from vectors from observers to the radio source. Although, practiacally useful expression including relativistic effects for Finite-VLBI delay model has not been proposed yet.

We used Fukushima's formula as a base and through four dimenstional transofrmation between Barycentric reference frame to the geocentric reference frame, a finite-VLBI model was derived. This model is expansion of normal VLBI model, which is valid for radio source at infinite distance, to finite distance radio source. Of course, this model is identical with consensus model when radio source distance is infinite.

3. Development of VLBI Delay prediction software and data analysis software.

We developed a finite-VLBI model software with based on modification of the CALC ver.9, which is a priori delay computation software world widely used in VLBI community. Our software output delay, delay rate, and partial derivatives of finite distance radio source. Additionally astrometric analysis softwere has developed for determination of interplanetary spececraft, and these software package will be used assist orbit determination of ``NOZOMI'', which is Mars surveryer launched by ISAS in July 1997.

Reference

Eubanks, T.M., A Consensus Model for Relativistic Effects in Geodetic VLBI, Proceedings of the U.S.Naval Observatory Workshop on Relativistic Models for use in Space Geodesy, (Eds. T.M.Eubanks), U.S.Naval Observatory, 1991.

McCarthy D., IERS Conventions (1996), IERS Technical Note 21, 1996.

Fukushima,T., Lunar VLBI observation model, A&A 291, pp.320-323,1994.