VLBI RELATIVISTIC TIME DELAY MODEL WITH PICOSECOND PRECISION

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ABSTRACT. The VLBI relativistic time delay model of transformation is reformuled with a precision of better than 1 ps, which is given as follows

$$d\tau = \delta t_0 \cdot \{1 - 2\Phi - \frac{\vec{V}_E'\vec{V}_E}{2c^2} - \frac{(\vec{V}_E + \vec{v}_2)'\hat{S}}{c} + \frac{(\vec{V}_E'\hat{S})^2}{c^2} + \frac{2(\vec{V}_E'\hat{S})(\vec{v}_2'\hat{S})}{c^2} - \frac{\vec{V}_E'\vec{v}_2}{c^2}\} + \frac{\vec{V}_E'\vec{b}_0}{c^2} + \frac{(\vec{V}_E'\vec{b}_0)(\vec{V}_E'\hat{S})}{2c^3} + \frac{(\vec{V}_E'\vec{b}_0)(\vec{v}_2'\hat{S})}{c^3} + \delta t_v \quad (1)$$

where $\Phi = \phi/c^2$, ϕ is geocentric newtonial potential, $\vec{V}_E$ and $\vec{v}_i$ are the barycentric velocity vector in B-frame and the geocentric velocity vector of antenna i. $\hat{S}$ is the unit vector of the direction from the barycenter of solar system to the source. c is the speed of light in vacuum. $\delta t_0 = \vec{b}_0'\hat{S}/c$, where $\vec{b}_0$ is the geocentric baseline vector. δt_v can be expressed as

$$\delta t_v = \triangle t_v - \triangle t_v^* \quad (2)$$

in which

$$\triangle t_v = \triangle t_{atm} + \triangle t_{ion} + \triangle t_{axo} + \triangle t_{grav} + \cdots \quad (3)$$

and

$$\triangle t_v^* = \triangle t_v \cdot \frac{(\vec{V}_E + \vec{v}_2)'\hat{S}}{c} \quad (4)$$

where $\triangle t_{atm}$, $\triangle t_{ion}$ and $\triangle t_{axo}$ are the tropospheric, the ionospheric and the axio offset refraction delays respectively, and $\triangle t_{grav}$ is called the gravitational time delay. A straightforward differentation of expression (1), the equation of d(dτ)/dt can be obtained. The $\triangle \dot{t}_v^*$ included in the $\delta \dot{t}_v$ can be expressed as

$$\triangle \dot{t}_v^* = \triangle \dot{t}_v \cdot \frac{(\vec{V}_E + \vec{v}_2)'\hat{S}}{c} + \triangle t_v \cdot \frac{(\vec{A}_E + \vec{a}_2)'\hat{S}}{c} \quad (5)$$

The orders of magnitude of the various correction terms in expression (4) and (5) are estimated respectively. Conclusion: expression (4) and (5) should be taken into account in the VLBI relativistic model of transformation for the 1 ps precision. Equation (1) and the expression of its differentation differ from all the models which have been published earlier.

I.I. Mueller and B. Kołaczek (eds.),
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