

Precession

Toni Sagristà
Sellés

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The General Precession of Earth

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Mean celestial pole movement model

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Mean celestial pole movement with respect to the ICRS

- ▶ Precession of equator (lunisolar) + precession of ecliptic (planetary)
- ▶ Models ecliptic pole and celestial pole movement
- ▶ Simplified model → No nutation
- ▶ Period ~26000 years, 1° in 72 years

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Modeling Precession I

With IAU2000

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- ▶ IAU 2000 System of Astronomical Constants
- ▶ Model movement relative to epoch J2000.0
- ▶ 2 angle sets, a) $\psi, \omega, \epsilon, \chi$ and b) z, θ, ζ

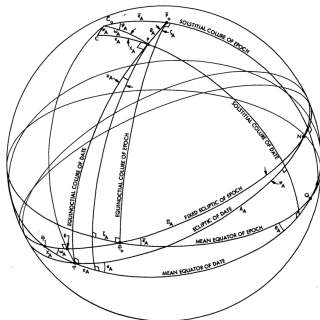


Figure: Precession angles

Modeling Precession II

With IAU2000

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We need:

- ▶ Function to get angles from time for each set

$$a) f_i(t) \rightarrow \psi, \omega, \epsilon, \chi$$

$$b) g_i(t) \rightarrow z, \theta, \zeta$$

- ▶ Matrix that uses angles to rotate the reference system from the reference time (J2000.0) to the desired time

$$a) \vec{r}(x, y, z) = R_z(\chi)R_x(-\omega)R_z(-\psi)R_x(\epsilon)\vec{r}(x_0, y_0, z_0)$$

$$b) \vec{r}(x, y, z) = R_z(-z)R_y(\theta)R_z(-\zeta)\vec{r}(x_0, y_0, z_0)$$

Modeling Precession III

With IAU2000

Precession

► Set a)

$$\psi = 5038''.47875t - 1''.07259t^2 - 0''.001147t^3$$

$$\omega = \epsilon_0 - 0''.02524t + 0''.05127t^2 - 0''.007726t^3$$

$$\epsilon = \epsilon_0 - 46''.84024t - 0''.00059t^2 + 0''.001813t^3$$

$$\chi = 10''.5526t - 2''.38064t^2 - 0''.001125t^3$$

► Set b)

$$\zeta = 2''.5976176 + 2306''.0809506t + 0''.3019015t^2$$

$$+ 0''.0179663t^3 - 0''.0000327t^4 - 0''.0000002t^5$$

$$z = -2''.5976176 + 2306''.0803226t + 1''.094779t^2$$

$$+ 0''.0182273t^3 + 0''.000047t^4 - 0''.0000003t^5$$

$$\theta = 2004''.1917476t - 0''.426953t^2 - 0''.04182t^3$$

$$- 0''.0000601t^4 - 0''.0000001t^5$$

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Execution demonstration and discussion

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- ▶ We can model the change in the orientation of Earth's rotation axis using some basic math
- ▶ Both angle sets do well in a period of ~ 6000 years
- ▶ These models only work well for a short period of time ~ 26000 years, 1 period
- ▶ The further we divert from reference time (J2000.0), the worse

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