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Direction of the Light Deviation Vector during Satellite Laser Ranging

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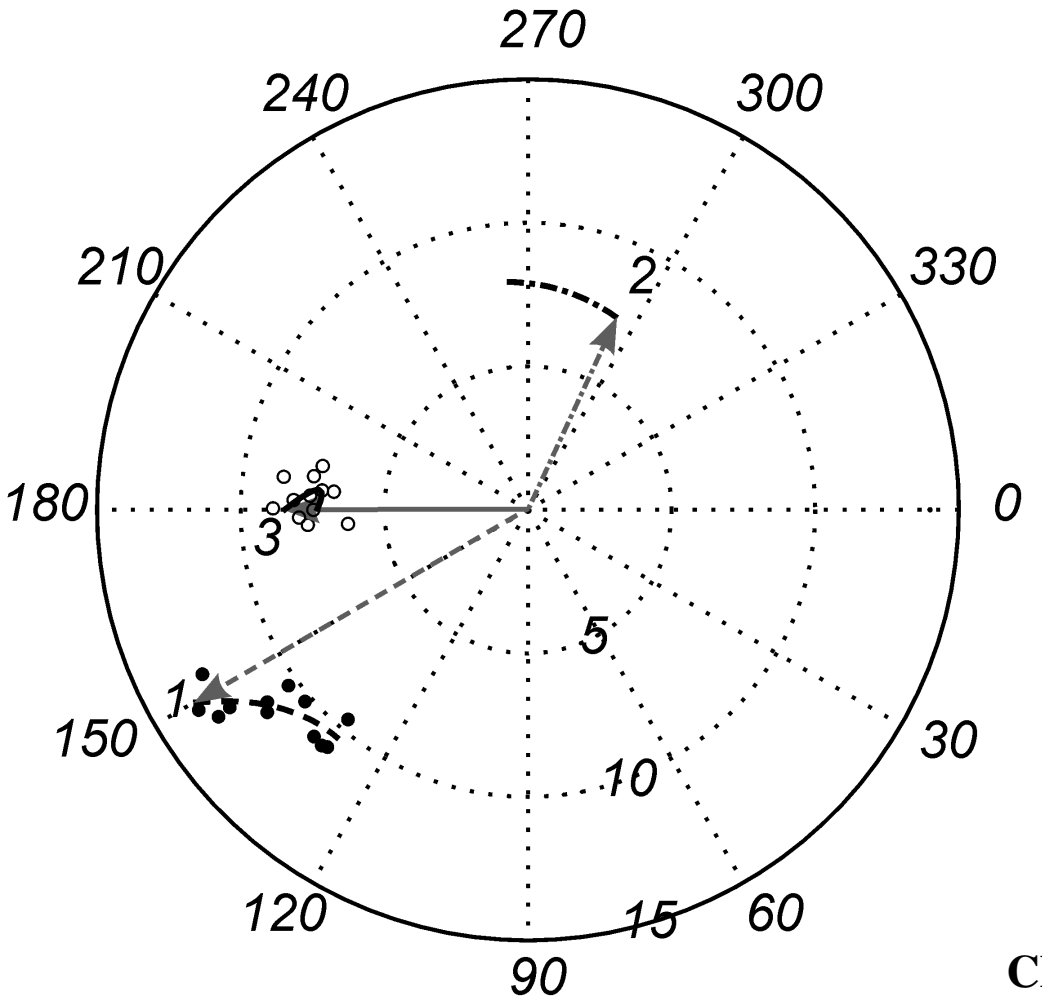
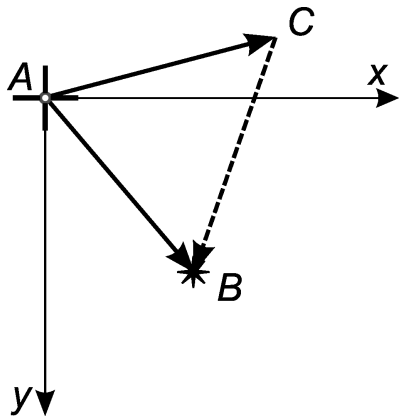
Projections (2D)



Satellite LAGEOS-1 28.07.2007
22:17-22:28 (22:22).

Projections onto the telescope's field of view of
1) Measured apparent deviation **AB**,
2) Vector opposite to velocity aberration **(–AC)=CA,**
3) True anomalous deviation **CB.**
Absolute values are in arcseconds, directions are in degrees relatively to the abscissa axis in the field of view. Arrows indicate the start of the pass.

$$\mathbf{CB} = \mathbf{AB} + (-\mathbf{AC})$$



[Ignatenko et al., Poznań, 2008]

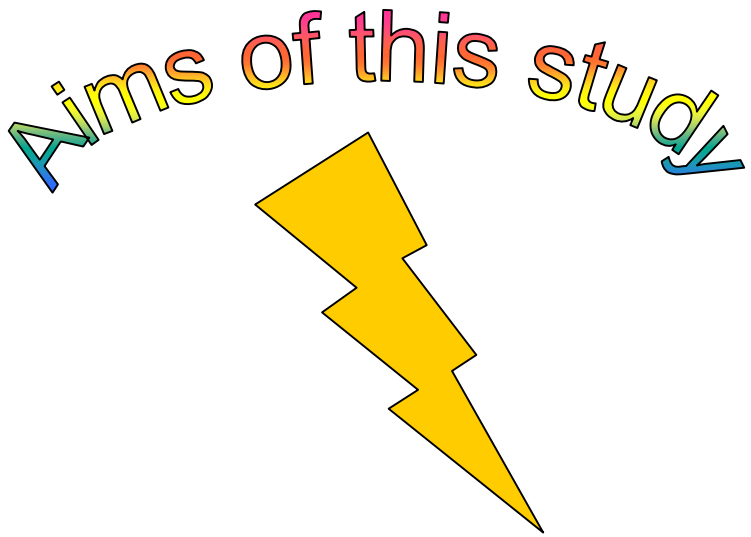
Light Deviation Vector Reconstruction (3D)

and

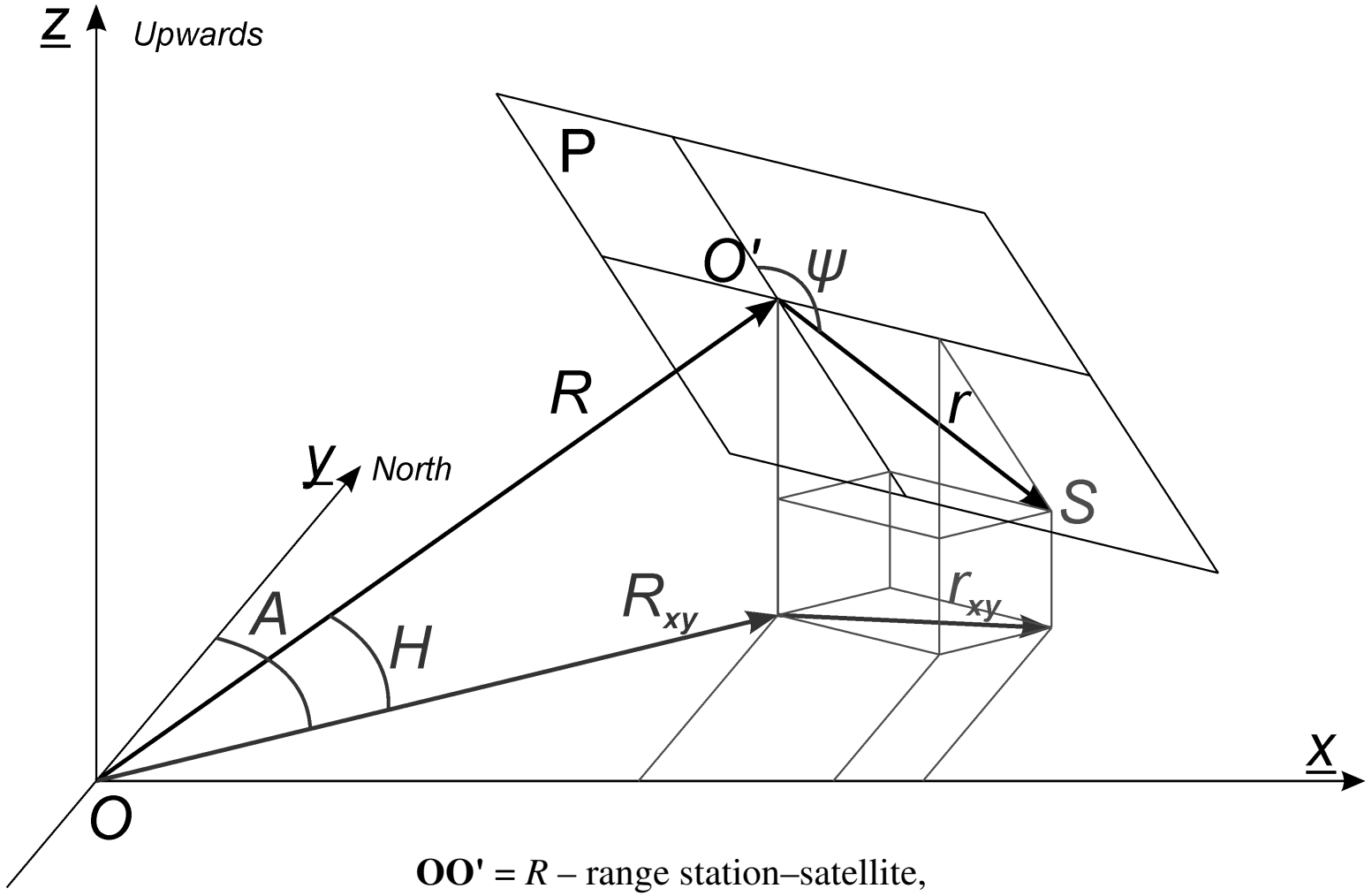
Determination of Its Direction in the Near-Earth Space

1) Combination of a three-dimensional vector of anomalous light deviation from its different projections onto the telescope's field of view in different instants of time during a satellite pass.

2) Elimination of the Earth orbital motion to obtain "pure" light deviation vector in the near-Earth space.



Crucial points' O, O', S topocentric coordinates determination for 3D light deviation vector reconstruction



OO' = R – range station–satellite,
O'S = r – anomalous deviation of light in the telescope's focal plane P,
A – azimuth, H – elevation, ψ – rotation angle of the **O'S** vector in the telescope's field of view

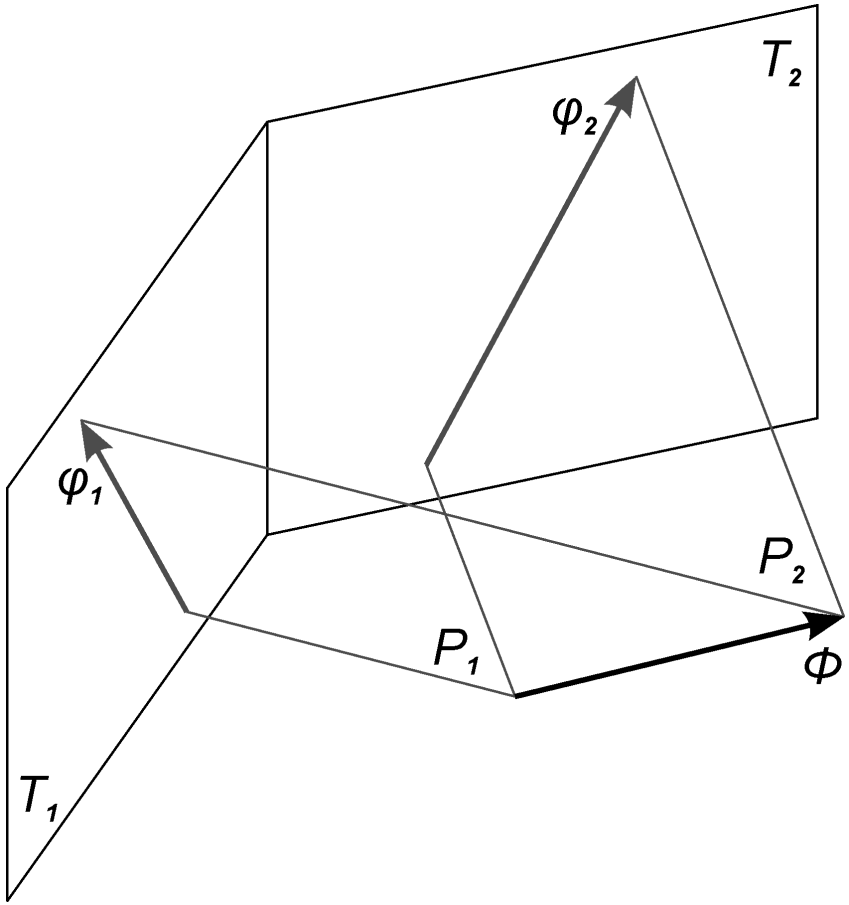
O (0,0,0); O' (R cos H sin A, R cos H cos A, R sin H);
S (R cos H sin A + r (cos A sin ψ – sin A sin H cos ψ), R cos H cos A – r (sin A sin ψ + cos A sin H cos ψ),
R sin H + r cos H cos ψ)

Planes' P_1 and P_2 equations

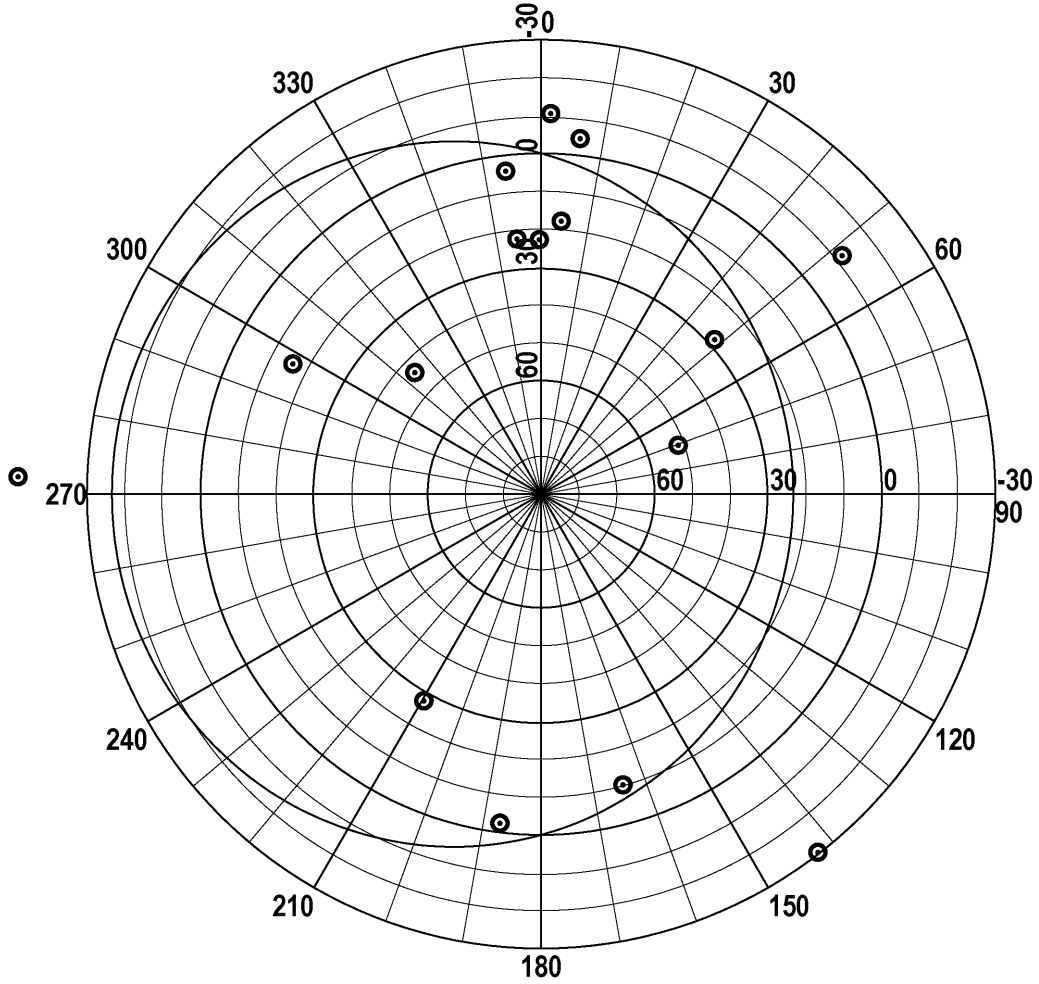
$$\begin{cases} A_1 x + B_1 y + C_1 z + D_1 = 0 \\ A_2 x + B_2 y + C_2 z + D_2 = 0 \end{cases}$$

and their intersection line

$$\frac{x - x_1}{x - x_2} = \frac{y - y_1}{y - y_2} = \frac{z - z_1}{z - z_2}$$



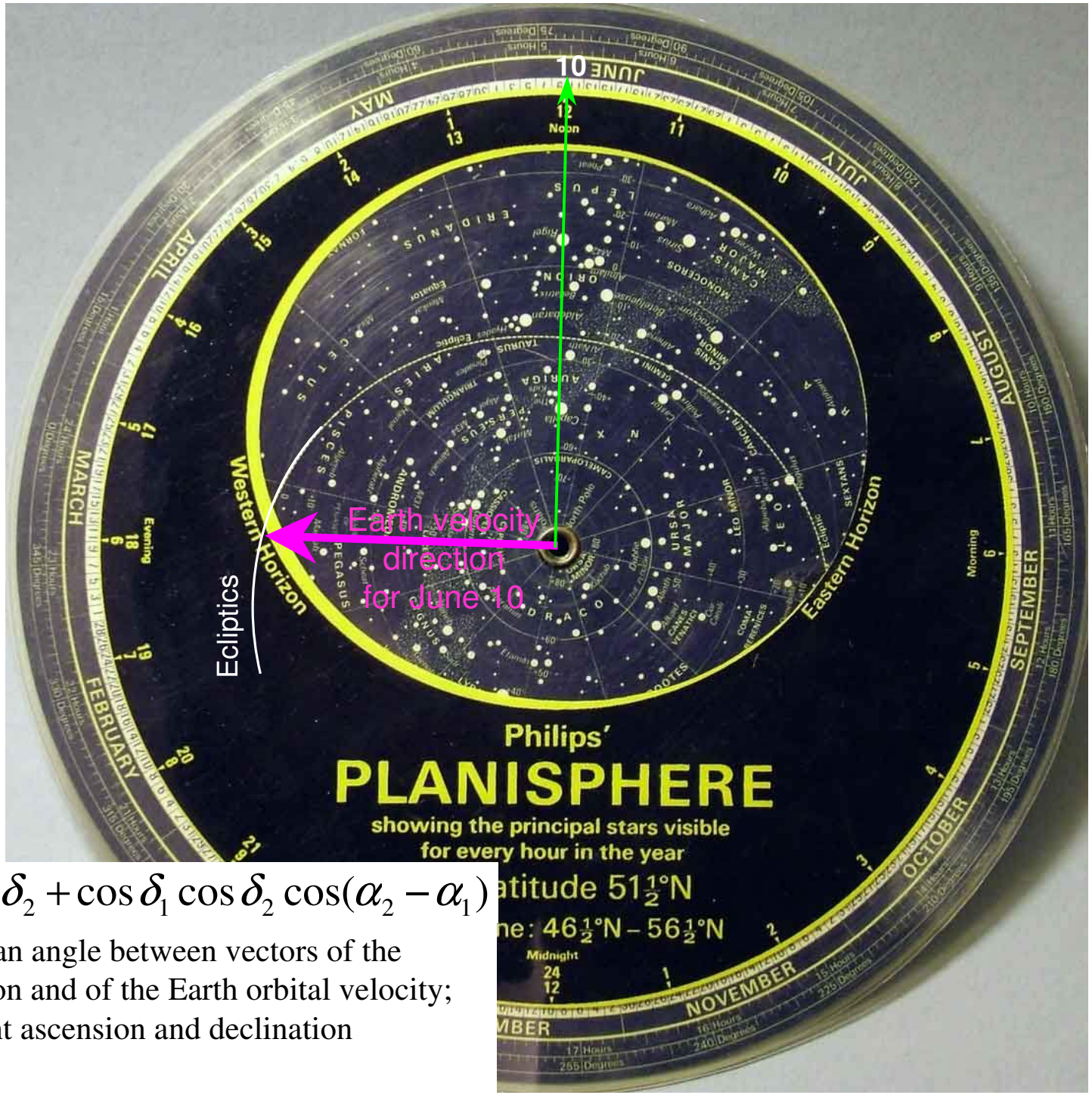
T_1 and T_2 – telescope's focal planes at two instants of time,
P_1 and P_2 – additional planes perpendicular to T_1 and T_2 for 3D light deviation vector $\boldsymbol{\Phi}$ reconstruction



Reconstructed directions of the anomalous light deviation 3D-vector for LAGEOS passes during 2007 and 2008 are shown in the equatorial RA/Dec coordinate system.
Each point corresponds to one pass

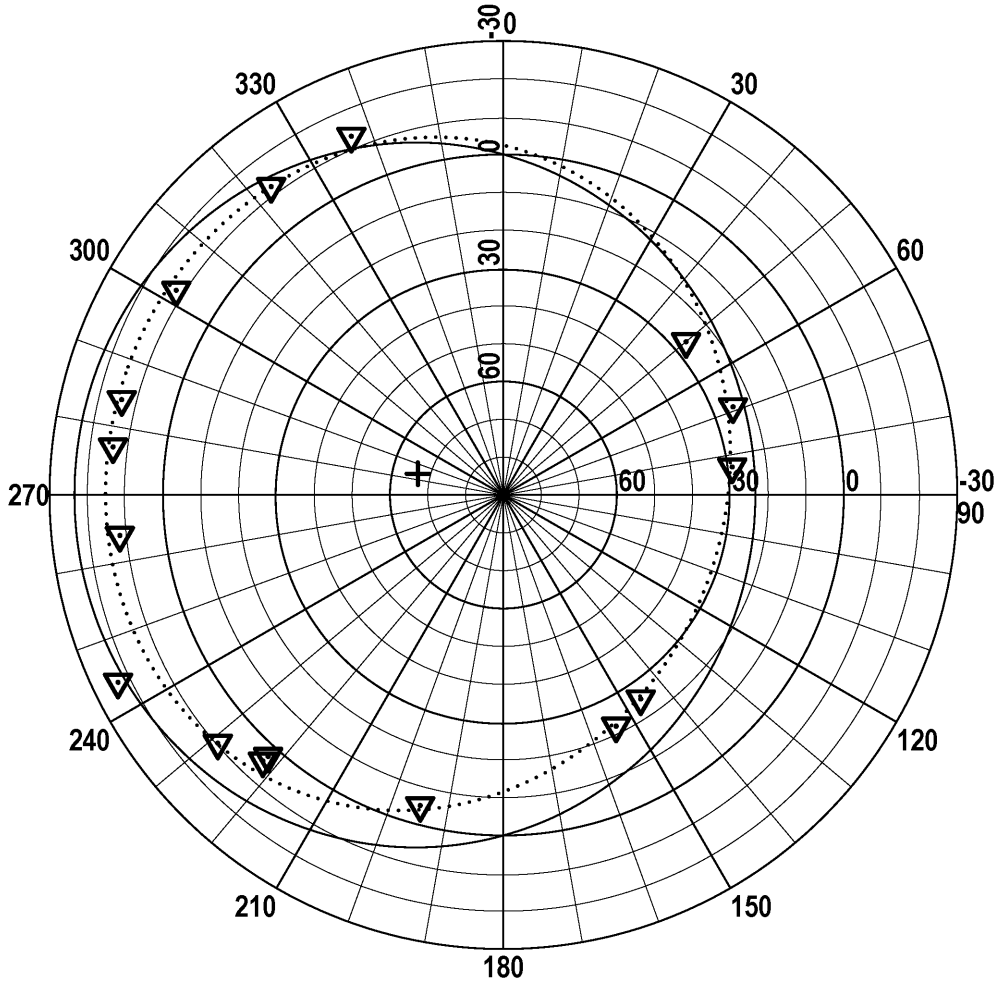
$$\varphi = \frac{2v_{\oplus}}{c} \approx 41''$$

Value of the Earth velocity vector in arcseconds



$$\cos AB = \sin\delta_1 \sin\delta_2 + \cos\delta_1 \cos\delta_2 \cos(\alpha_2 - \alpha_1)$$

Arc AB corresponds to an angle between vectors of the anomalous light deviation and of the Earth orbital velocity; α and δ denote their right ascension and declination



Directions of the purified anomalous light deviation 3D-vector in the near-Earth space (influence of the Earth orbital motion is excluded) are shown in the equatorial RA/Dec coordinate system for LAGEOS passes during 2007 and 2008.
Points are located on the ellipse with center coordinates $\alpha = 284°$ and $\delta = 67°$.

Conclusion

According to obtained results it is concluded that the luminiferous medium moves in the near-Earth space with velocity slightly different by absolute value and direction from the Earth orbital velocity. Observed deviation of light from preset direction is a result of composition of the satellite relative-to-observer velocity, the Earth orbital velocity, and velocity of the luminiferous medium.

THANKS!