Offsets between VLBI and *Gaia* positions of extragalactic sources: global and individual characteristics

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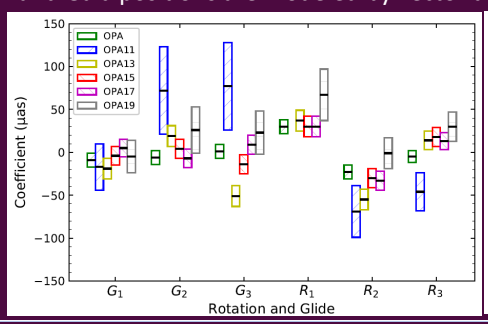
Introduction

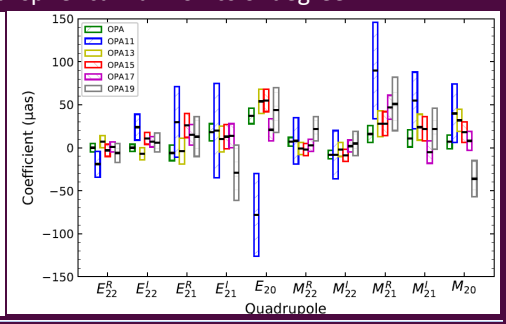
Comparisons of Very Long Baseline Interferometry (VLBI) catalogs against the Gaia data have revealed large-scale differences of a few tens of microarcseconds as well as significant offsets for a hundred of extragalactic sources. Understanding these differences improves our knowledge of VLBI and *Gaia* astrometry. This poster investigates the positional differences of ICRF sources as obtained from a special VLBI solution and the *Gaia* Data release 3 (*Gaia* DR3). Using data from the permanent geodetic VLBI program at 8 GHz restricted to the observational time span used for *Gaia* DR3 astrometric solution (August 2014 to May 2017), we determined positions of extragalactic sources through a standard geodetic VLBI data reduction scheme (OPA15). VLBI solutions with same parameterization based on all available data (OPA) and data within time spans with the same length to OPA15 (OPA11, OPA13, OPA17, and OPA19) were also performed. These VLBI solutions were compared with the *Gaia* DR3 solution to quantify the global and individual characteristics.

Global Characteristics

The global differences between VLBI and Gaia positions are modeled by vectorial spherical harmonics of degree2.

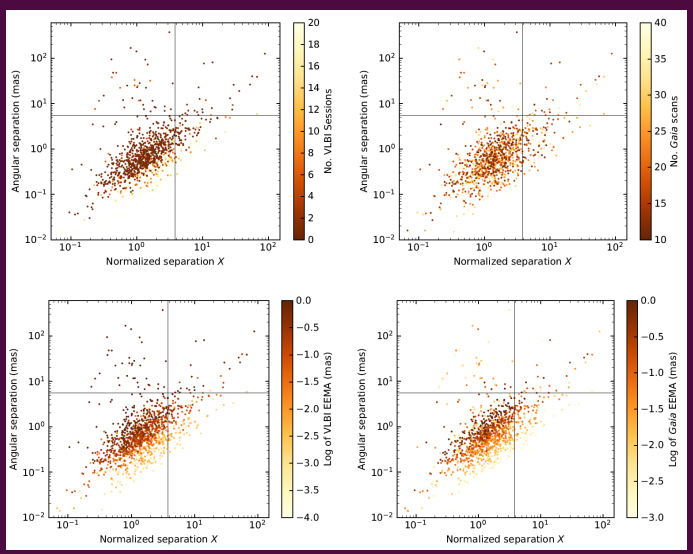
$$
\begin{aligned}
\Delta\alpha\cos\delta &= R_1\cos\alpha\sin\delta + R_2\sin\alpha\sin\delta - R_3\cos\delta \\
&- D_1\sin\alpha + D_2\cos\alpha \\
&+ M_{20}\sin 2\delta \\
&+ \left(E_{21}^{\mathrm{Re}}\sin\alpha + E_{21}^{\mathrm{Im}}\cos\alpha\right)\sin\delta \\
&- \left(M_{21}^{\mathrm{Re}}\cos\alpha - M_{21}^{\mathrm{Im}}\sin\alpha\right)\cos 2\delta \\
&- 2\left(E_{22}^{\mathrm{Re}}\sin 2\alpha + E_{22}^{\mathrm{Im}}\cos 2\alpha\right)\cos\delta \\
&- \left(M_{22}^{\mathrm{Re}}\cos 2\alpha - M_{22}^{\mathrm{Im}}\sin 2\alpha\right)\sin 2\delta, \\
\Delta\delta &= R_2\cos\alpha - R_1\sin\alpha \\
&- D_1\cos\alpha\sin\delta - D_2\sin\alpha\sin\delta + D_3\cos\delta \\
&+ E_{20}\sin 2\delta \\
&- \left(E_{21}^{\mathrm{Re}}\cos\alpha - E_{21}^{\mathrm{Im}}\sin\alpha\right)\cos 2\delta \\
&- \left(M_{21}^{\mathrm{Re}}\sin\alpha + M_{21}^{\mathrm{Im}}\cos\alpha\right)\sin\delta \\
&- \left(E_{22}^{\mathrm{Re}}\cos 2\alpha - E_{22}^{\mathrm{Im}}\sin 2\alpha\right)\sin 2\delta \\
&+ 2\left(M_{22}^{\mathrm{Re}}\sin 2\alpha + M_{22}^{\mathrm{Im}}\cos 2\alpha\right)\cos\delta,
\end{aligned}
$$

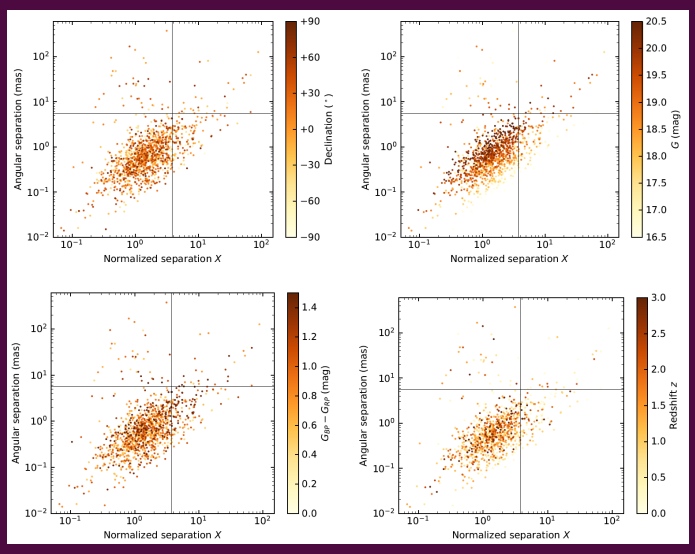




Individual Characteristics

- OPA5-to-*Gaia* angular separation versus normalized separation with the color tracing (i) number of VLBI sessions, (ii) number of *Gaia* scans, formal error along the error ellipse major axis (EEMA) of (iii) VLBI and (iv) *Gaia*, (v) declination, (vi) *G*-magnitude, (vii) color, and (viii) the redshift for common sources.





Preliminary Results

- No significant global difference is found between special and routine VLBI solutions with respect to *Gaia*-CRF.
- Radio-to-optical angular separation is generally overestimated by some tenth of mas for sources having a poor VLBI observational history (also with large VLBI positional error), and for fainter sources in the optical band (also sources with large *Gaia* positional error).