Annual Report 2022

2022–12–30

1 Summary

This year, I mainly focused on the application of the pulsar astrometry in the celestial reference frame study. I also started to build my own platform for very long baseline interferometry (VLBI) data analyses. More work needs to done in the coming year of 2023.

2 Activities

- My paper on the evaluation of the ICRF3 axes stability is published (Liu et al. 2022b), which studied the axes stability problem of the ICRF3 by various methods and indicators. The results were consistent, leading to a conclusion that the ICRF3 axes stability is good and at a level of 10 μas to 20 μas.
- I extended the work of Liu et al. (2022b) by using all available VLBI observations in archive and reported the results in an oral presentation at the IVS General Meeting 2022. I also submitted a paper to the proceedings of this conference (Liu et al. 2022a).
- I performed a joint analysis of *Gaia*, interferometric, and timing astrometry to determine the frame tie (represented by a rigid rotation) between the ephemerides frames and *Gaia*/VLBI celestial reference frame (Liu et al. 2022c). We found that the estimation of rotation parameters strongly depends on the subset used in the comparison and they could be biased by underestimated errors in the archival timing data. This reflects the limitation of using the literature timing solutions to determine the frame rotation.
- Considering the limitations mentioned in previous item, I improved the study by reanalyzing the long-term time-of-arrival (TOA) data from several pulsar timing arrays (PTAs) using different numerical ephemerides from JPL DE series, EPM series, and INPOP series. Then we determined the transformation parameters among the reference frames realized by these ephemerides and also between the ephemerides reference frames and VLBI reference frames. The related paper was submitted to *A&A*.
- We studied the impact of the switch from ICRF2 to ICRF3 on the determination of Earth orientation parameters from VLBI observations (Yao et al. 2022). This work was initialized in 2018, when I was a joint doctoral student at Paris Observatory, and the preliminary results were presented at the EGU General Assembly 2019. After a long delay, this work was passed to a Ph.D. student in our group and he did an excellent job.
- I co-supervised a master student to complete a work on evaluating the impact of the optical axis stability on the exoplanet detection (Tan et al. 2022). This work aimed to provide some theoretical considerations on the instrumental designation for the Chinese space mission named Closely Habitable Exoplanet Suvery (CHESS).
- I submitted a proposal on designation of a new method for the parallax measurement to the second-round call of scientific topics for the Chinese Space Station Telescope (CSST) mission.
- As a co-instructor, I gave lectures on the International Celestial Reference System (ICRS) to the graduate students in the course of *Astronomical Reference System*.

3 Plans for next year

At this moment, I come up with several tasks that need to be completed in the forthcoming year, which are listed below as a to-do list:

- Continue the study of the multiwavelength positional offset of extragalactic sources using new data released recently;
- Study the properties of the *Gaia* astrometry in the light of *Gaia* scanning law;
- Learn more about *Statistical Astrometry*, a terminology I knew from Dr. Anthony Brown in the textbook entitled *Astrometry for Astrophysics: Methods, Models, and Applications* (I should read this book again and in details) .

References

Liu, N., Lambert, S., Arias, F., Liu, J.-C., & Zhu, Z. 2022a, arXiv e-prints, arXiv:2206.15038

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Tan, D.-J., Liu, J.-C., Zhu, Z., & Liu, N. 2022, Research in Astronomy and Astrophysics, 22, 025008

Yao, J., Liu, J. C., Liu, N., et al. 2022, A&A, 665, A121