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Editorial: Astrometry with the Chinese space station telescope

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Editorial on the Research Topic
Astrometry with the Chinese space station telescope

The China Space Station Telescope (CSST) stands as a beacon of scientific opportunity and enduring legacy, complementing upcoming space-based and ground-based surveys with its extensive wavelength coverage and remarkable angular resolution. Ideal for astrometric studies, CSST targets celestial objects fainter than 18th magnitude, promising to expand Gaia's tomographic mapping of the Milky Way to much fainter end, which can be up to magnitude 26 at *g* band. This extension will enrich astronomical databases with critical data, including positions, parallaxes, distance estimates, and color-magnitude-based stellar parameters. CSST is anticipated to establish the densest and deepest reference frame in the world, covering magnitudes ranging from 18 to 26. Through simulation data, the astrometric performance of CSST is assessed, revealing a remarkable accuracy at such faint magnitude, see Figure 1 (Fu et al.). Specifically, for sources within the 18–22 mag range in the g band, CSST achieves a precision better than 1 mas ($\cdot$ yr^{-1}). Moreover, for sources falling within the 22–26 mag range in the g band, CSST demonstrates a precision ranging from approximately 1–10 mas ($\cdot$ yr^{-1}). It is noted that optimizing the survey schedule holds the potential to further enhance CSST's astrometric accuracy. Addressing the crucial matter of preserving and enhancing the Gaia catalogue, CSST proposes a novel approach. By modeling the astrometric fit of sources in the extragalactic region of the Gaia sample using new observations and local stars as references, this method effectively mitigates the degradation of Gaia's coordinate precision over time. Simulations indicate a reduction in precision degradation by a factor of > 3, concurrently densifying the catalogue below Gaia's limiting magnitude. CSST data is projected to decrease Gaia's precision degradation on positions by a factor of 2.7 and boost available reference sources by over 40% of the sky (Gai et al.).

CSST emerges as a powerful tool for studying binaries, especially wide binary systems. The telescope's ability to detect astrometric wobble at a milliarcsecond level opens avenues for capturing the full motion of astrometric binaries, offering unique insights into their dynamics. Moreover, CSST also provides an opportunity to study the Single Lined-Spectroscopic Binaries (SB1s), particularly those in proximity (Wang et al.; Xia et al.).

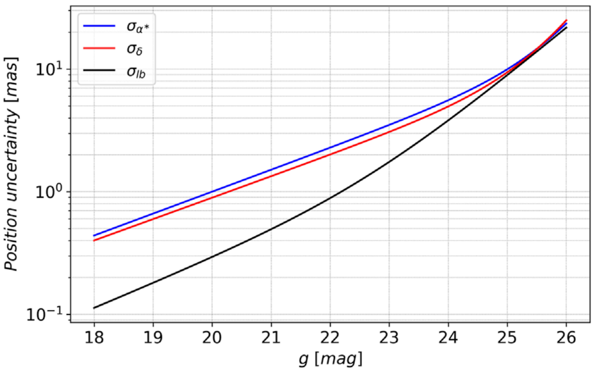

FIGURE 1
Magnitude dependence of the astrometric uncertainty in α and δ. The blue solid line is the standard uncertainty of the right ascension, the red solid line is the standard uncertainty of the declination, and the black solid line is the theoretical reference lower bound of the positional precision σ_{lb} for a diffraction-limited image. More details can be found in (Fu et al.).

In the realm of asteroid mass determination through close encounters, CSST's potential is explored. With anticipated accuracies in the milliarcsecond range and a limiting magnitude of 26 (AB mag) or higher, CSST's observations, when combined with ground-based data, promise significant enhancements in asteroid mass precision. While limitations exist, including strong perturbations during close encounters, the improvement brought by CSST data is evident. Dedicated observations during strong encounters, with a specific focus over 7.2 observation hours spanning 3 years, could yield precise determinations for a significant number of asteroids, with 10 expected to achieve precision better than 10% (Li et al.).

Mira variables, essential distance indicators, benefit from CSST's multi-band sky survey, particularly in the near-infrared y band (927–1,080 nm). Despite uncertainties, this survey holds promise for constructing more reliable and accurate Period-Luminosity Relations (PLRs) for Miras (Sun et al.).

The Multi-Channel Imager (MCI), a key component of CSST, designed for high-precision astronomical observations, is evaluated for proper motion derivation. The MCI's precision hinges on astrometric epochs per year, showcasing uncertainties of 10 µas/yr with 10 epochs and 5 µas/yr with 50 epochs (Fang et al., 2024). Symmetrically distributed fields enhance M31 kinematic parameter determination.

In summary, the versatile capabilities of CSST extend from establishing reference frames to studying binary systems, asteroid dynamics, and more. Its potential to provide high-precision data across various astronomical fields highlights its importance in advancing our knowledge of the Universe. With its exceptional astrometric accuracy, CSST will greatly contribute to astrometry, particularly in reference systems and related astronomical studies. Therefore, optimizing the survey schedule and refining astrometric data analysis models, methods, and strategies are crucial steps to further enhance CSST's astrometric accuracy and impact in astronomy.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Fang, W., Yu, Y., Peng, X., Yan, Z., Hao, Y., Shan, H., et al. (2024). Evaluation of the astrometric capability of Multi-Channel Imager and simulated calculation of proper motion of M31. *Front. Astronomy Space Sci.* 11, 1250571. doi:10.3389/fspas.2024.1250571