Cooler than *Gaia*: Parallaxes of Ultracool Objects with *WISE*

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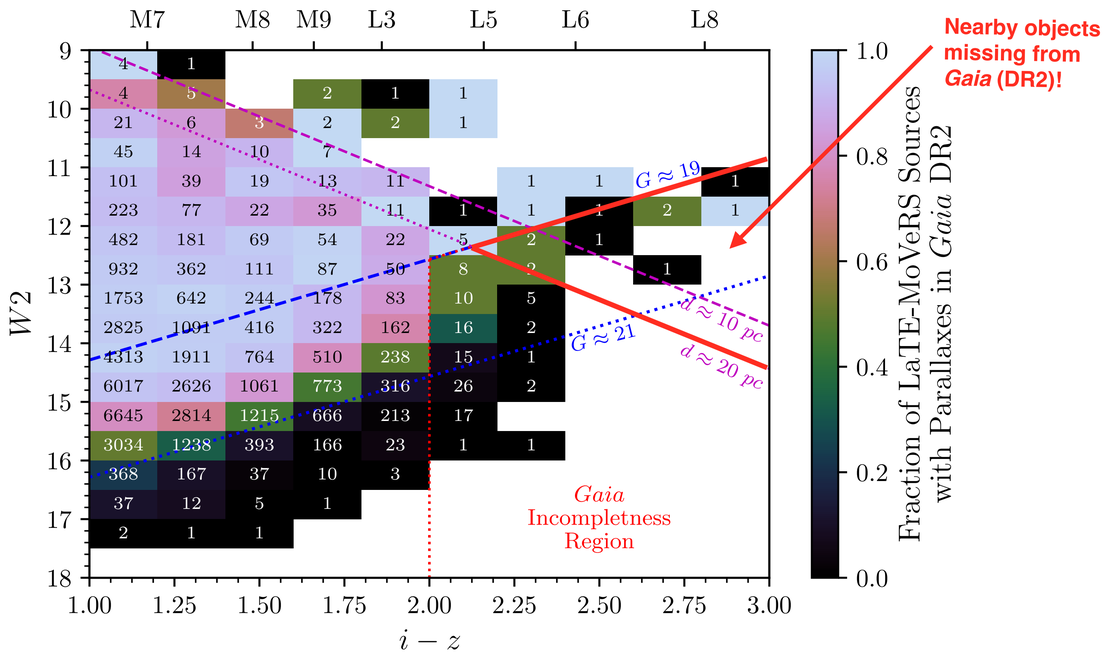
Ultracool Objects within the *Gaia* (DR2) Sample



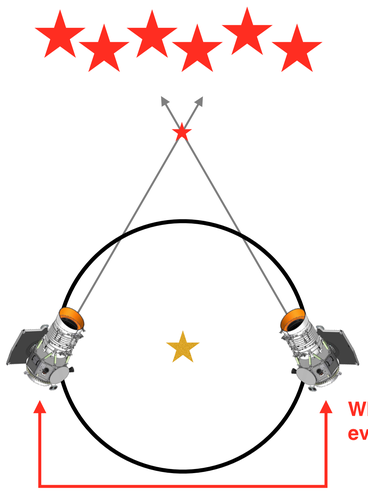
Parallaxes are an extremely important fundamental measurement for determining the census of nearby objects, studying the luminosity/ mass function, and obtaining 3-d positions and kinematics.

Gaia (DR2[1,2]) has released parallaxes for thousands of M dwarfs. However, L, T, and Y dwarfs are typically too faint to be detected by *Gaia*[3,4].

Only the closest (≤ 20 pc) ultracool objects fall within the 95% completeness limit (G = 19) for *Gaia*'s 5-parameter astrometric solution (proper motions and parallaxes)[5].

WISE[6,7,8] publicly available catalog data can be used to measure parallaxes for ultracool objects not observed by *Gaia*.

Using *WISE* to Measure Parallaxes



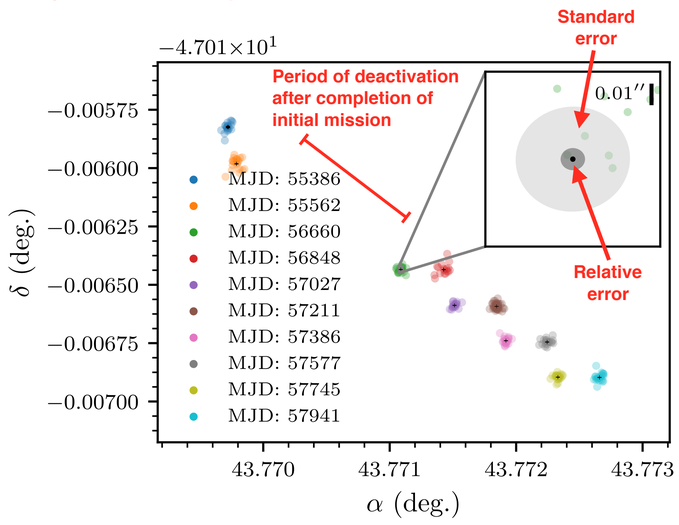
***WISE* Survey Strategy:** Observe fields at ~90° Solar elongation (maximum parallax factor) every 6 months[9].

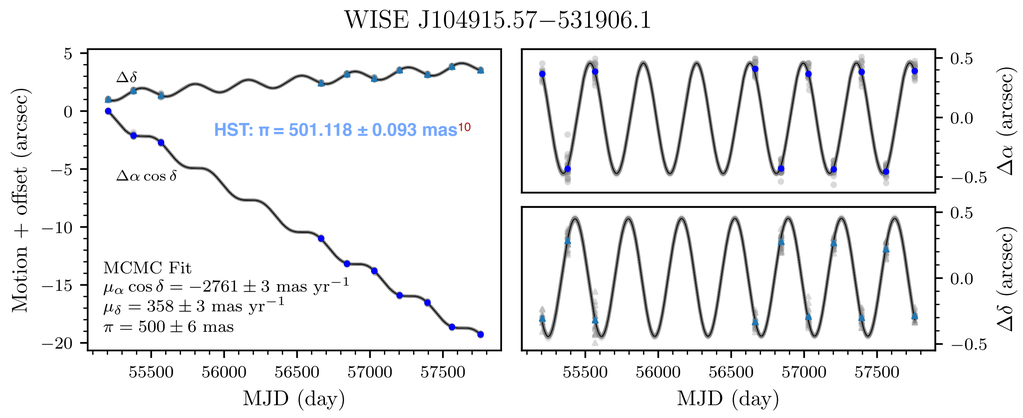
Multiple epochs over the ~7 year mission lifetime allows for parallax measurements.

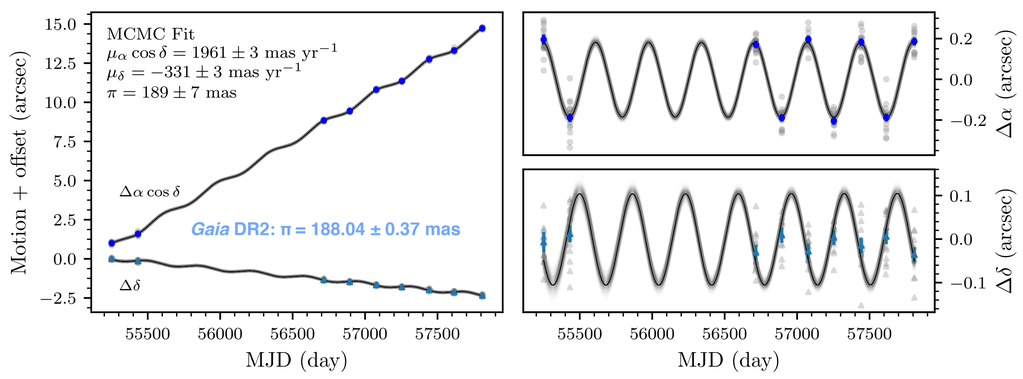
WISE observed the same fields every 6 months for deep co-adds

For any given line of sight, *WISE* has ≥ 12 exposures in *W1* (3.4 μm) and *W2* (4.6 μm).

Higher *relative* spatial precision can be obtained using multiple epochs (Level 1b data).



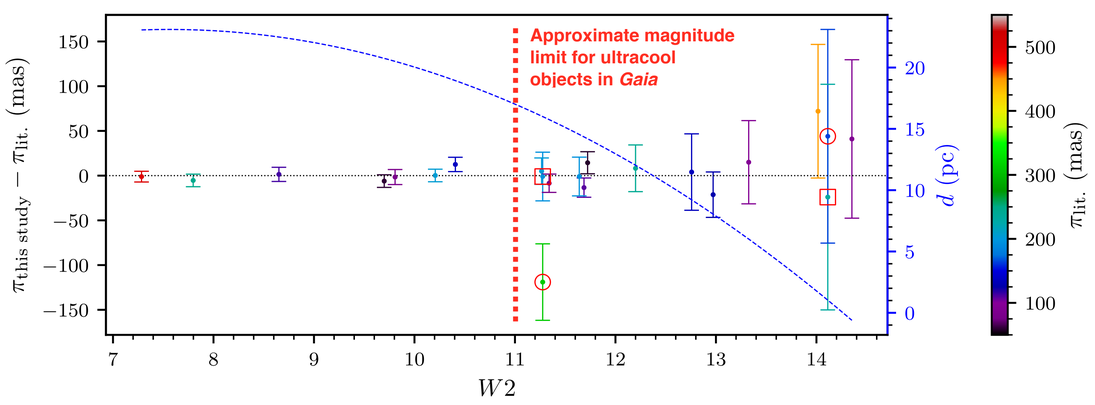




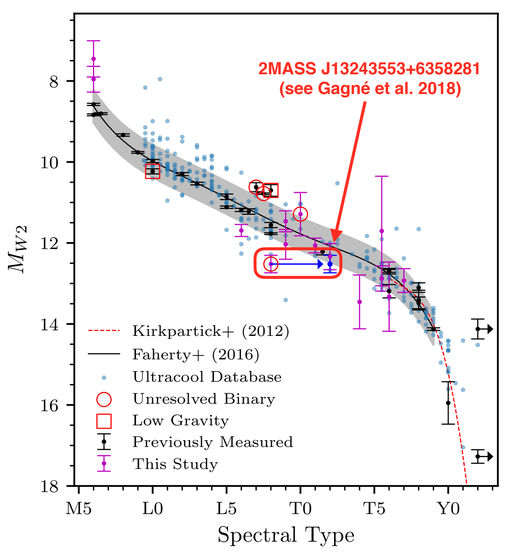
Parallax precision goes roughly as ~ (# of exposures)$^{1/2}$. Correcting for systematics using calibration sources around the target object, *WISE* can achieve a **parallax precision of ~ 6–7** mas for the brightest sources.

Limits and Future Prospects

This method can measure parallaxes with ≤ 15% uncertainties for dwarfs within ~25 pc, dependent on source brightness (blue dashed line).



This method can be used for objects past the magnitude limits of what *Gaia* will observe. Additionally, future discoveries of new, potentially nearby late-type dwarfs can have their parallaxes measured using archival *WISE* data.



ACKNOWLEDGEMENTS

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Code available on GitHub now!