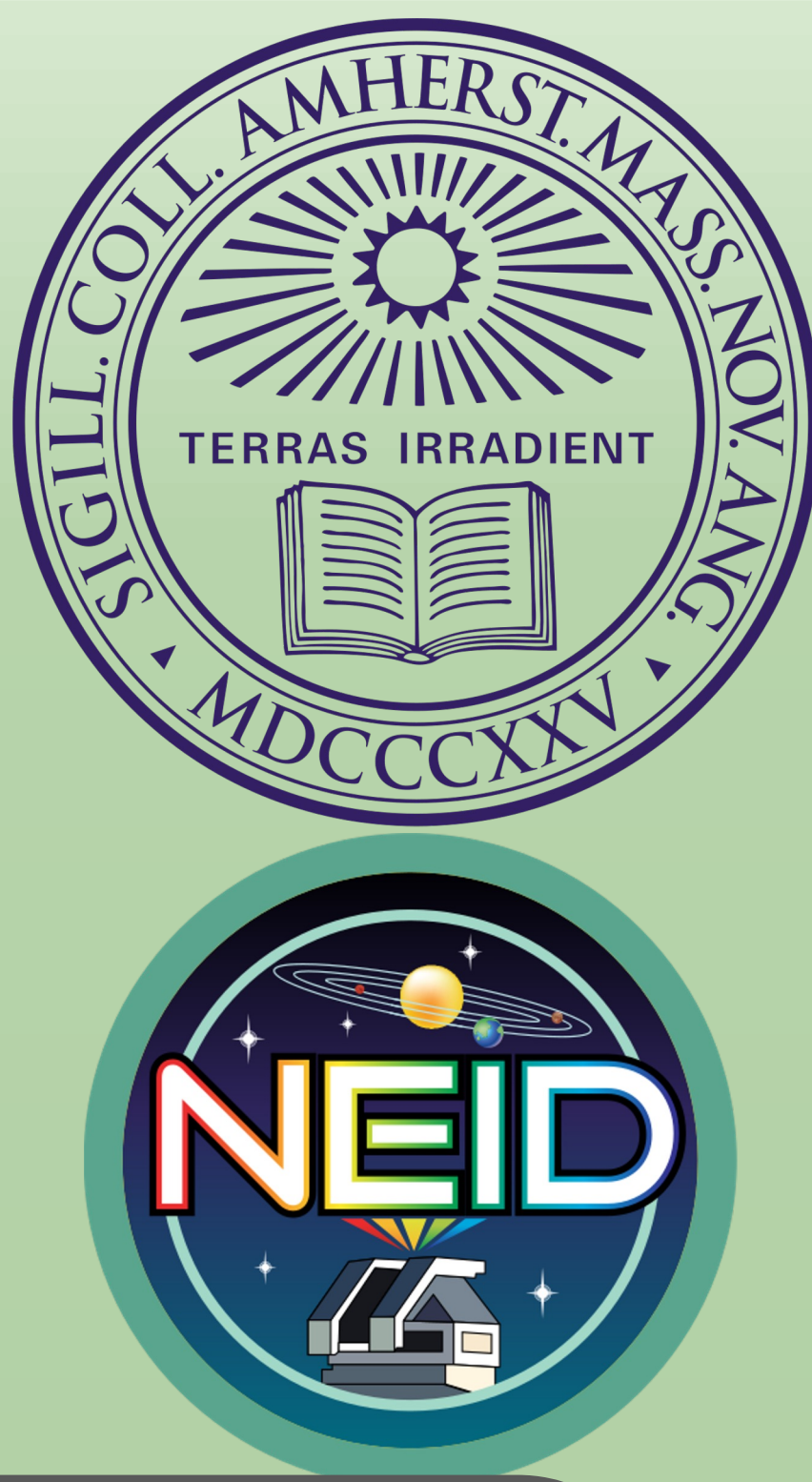


# HD 95735 c: New Dynamical Mass for a Nearby, Cold Neptune from the NEID Earth Twin Survey

On Behalf of the NEID Science Team

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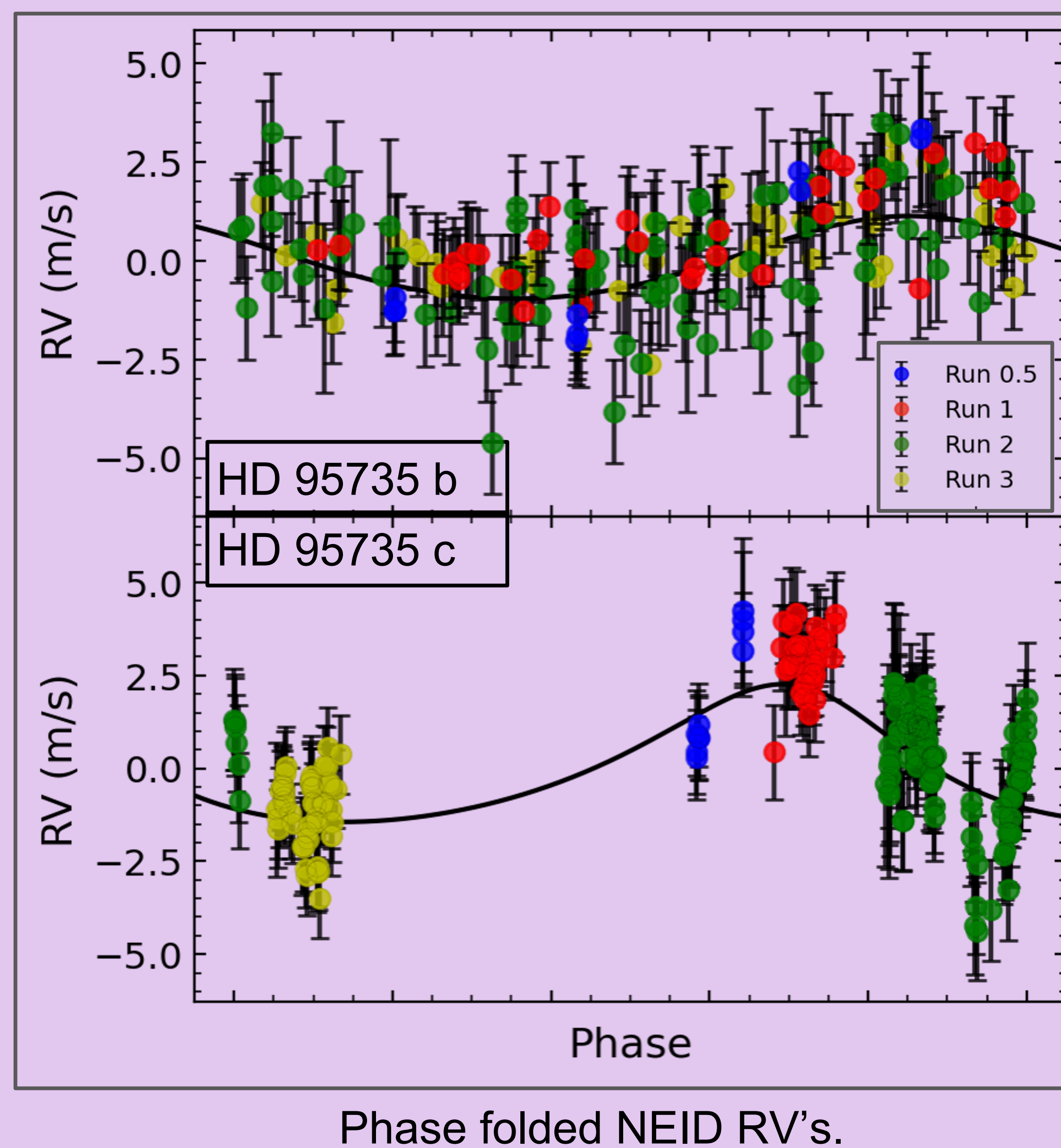


## System Overview

HD 95735 is among the closest ( $d = 2.55$  pc) and brightest ( $V = 7.5$ ) M dwarfs, and is known to host two planets. HD 95735 b has an orbital period of  $P = 12.9$  d with a minimum mass of  $m \sin i = 3 M_{\oplus}$  [1], while HD 95735 c has an orbital period of  $P = 8$  yr with a minimum mass of  $m \sin i = 18 M_{\oplus}$  [2]. The system has a candidate third planet at  $P = 215$  d [3] that is not evident in our new NEID RVs. By including a  $2.2\sigma$  detection of astrometric acceleration between the epochs of Hipparcos and Gaia [4], we constrain the three-dimensional architecture and determine the uniquely-low dynamical mass of the cold Neptune, HD 95735 c.

## New NEID RVs

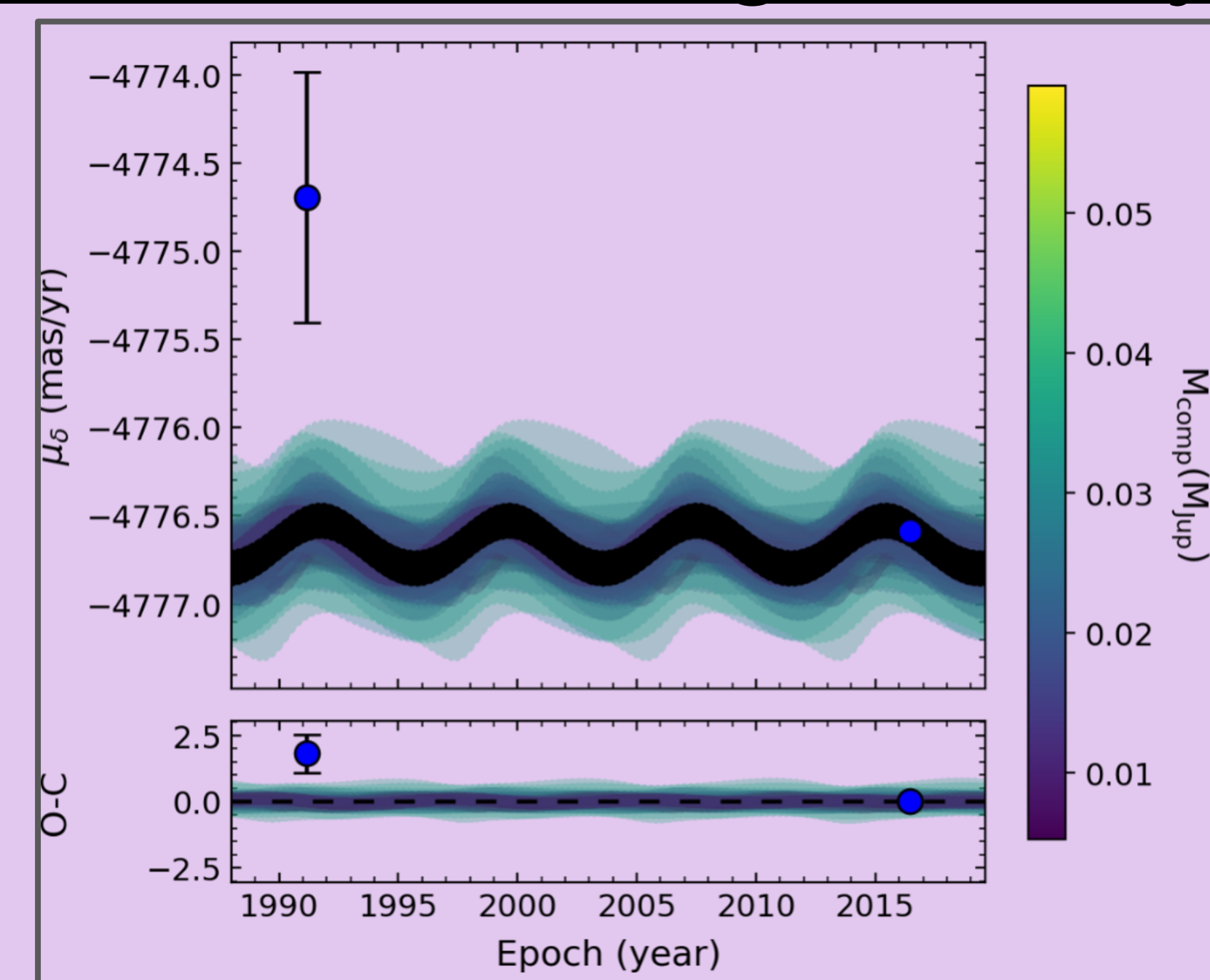
Combining over 25 years of archival radial velocities from HIRES, APF, Carmones, and LICK with 186 new high-precision (1.2 m/s) NEID RV observations from the NETS Survey spanning 2021-2025 [5] we successfully recover and improve on orbital parameters and masses of both planets.



Phase folded NEID RV's.

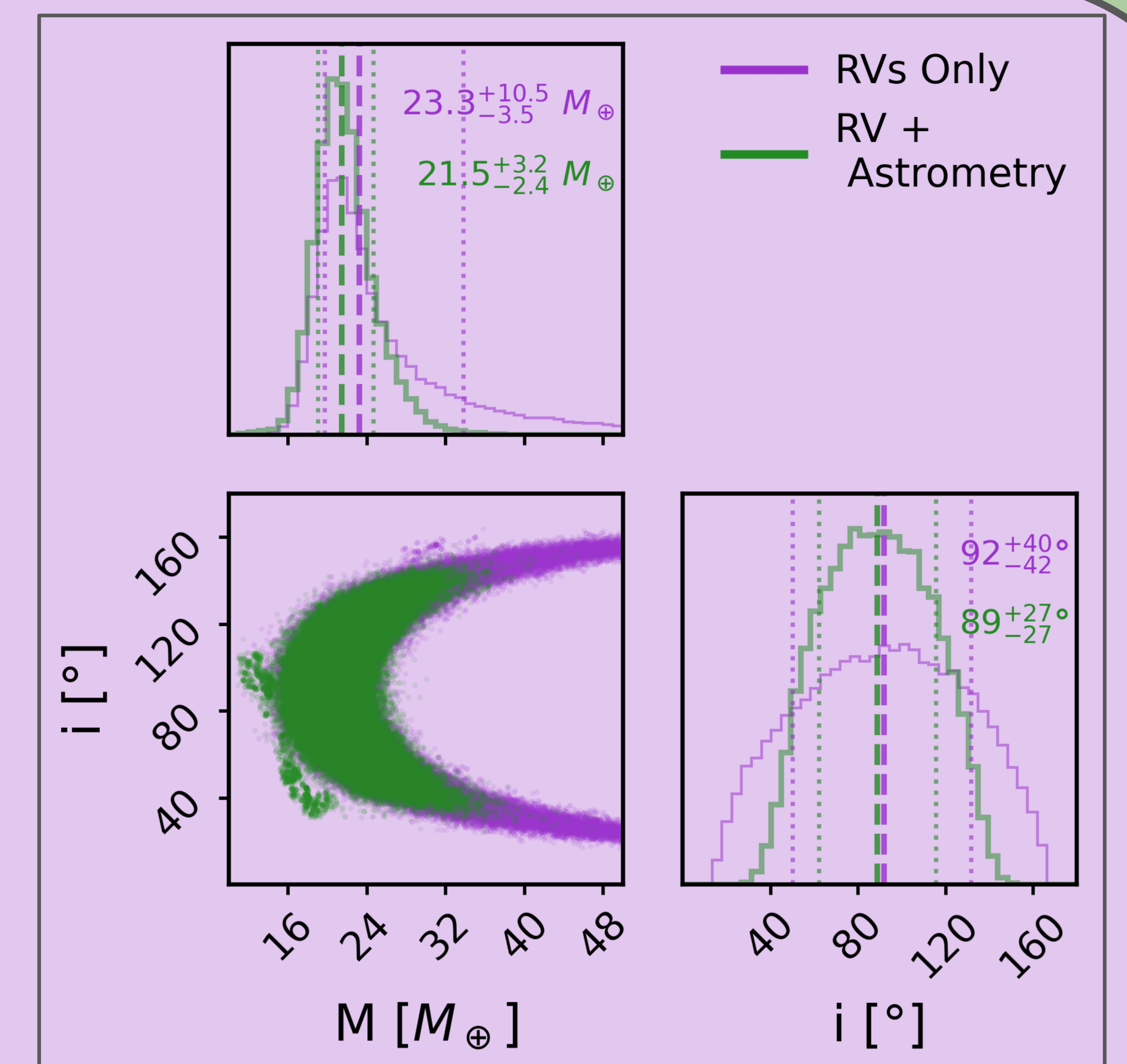
## Adding Astrometry Breaks the $m \sin i$ Degeneracy

HD 95735 exhibits a  $2.2\sigma$  detection of astrometric acceleration, owed to the discrepancy between Gaia's proper motion measurement and the long-term proper motion estimate built between the Hipparcos and Gaia positions. The astrometric amplitude of this signal is consistent with orbital motion of the long-period companion HD 95735 c.



## The New Dynamical Mass

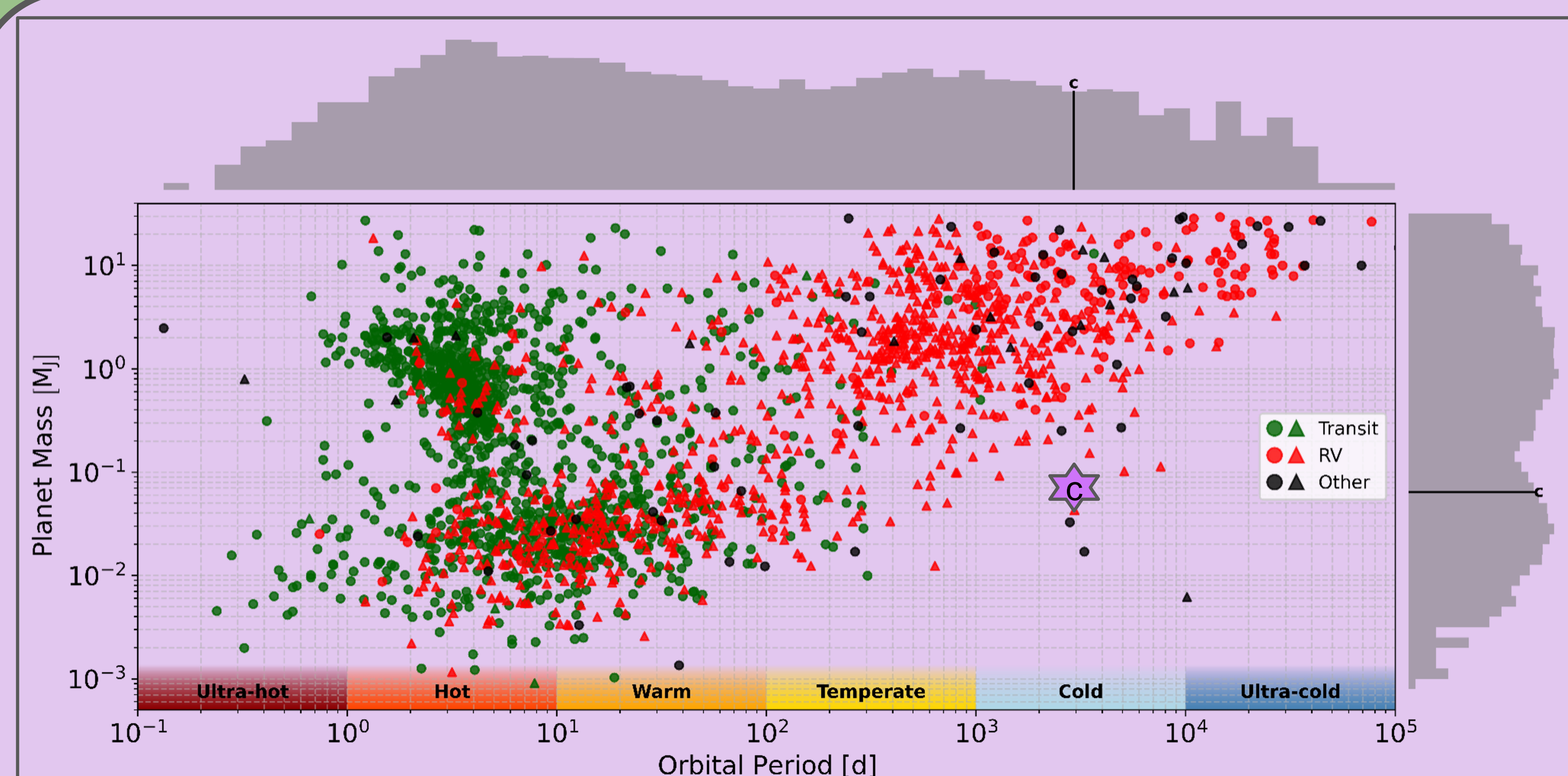
Combining astrometry and RVs using **orvara** [6], the disentanglement of inclination and mass is evident in the decrease in covariance between the two. Our new dynamical mass constraint is 18% more constrained than our RV only solution. Comparisons of our constraints to previous studies is shown below.



HD 95735 b

HD 95735 c

| Reference                    | $m \sin i$ ( $M_{\oplus}$ ) | Period (days)             | Ecc                       | $m \sin i$ ( $M_{\oplus}$ )                         | Period (years)         | Ecc                      |
|------------------------------|-----------------------------|---------------------------|---------------------------|---|------------------------|--------------------------|
| Rosenthal et al. 2021 [2]    | $2.80^{+0.29}_{-0.31}$      | $12.90 \pm 0.13$          | $0.095^{+0.099}_{-0.066}$ | $18.0^{+2.9}_{-2.6}$                                | $8.73^{+0.55}_{-0.47}$ | $0.14^{+0.095}_{-0.190}$ |
| Hurt et al. 2022 (3p) [3]    | $2.69^{+0.19}_{-0.18}$      | $12.94^{+0.001}_{-0.001}$ | $0.063^{+0.061}_{-0.043}$ | $13.6^{+2.4}_{-2.3}$                                | $8.07^{+0.57}_{-0.49}$ | $0.132^{+0.19}_{-0.091}$ |
| Literature + NEID RVs        | $1.98^{+1.40}_{-1.31}$      | $12.94^{+0.001}_{-0.001}$ | $0.11 \pm 0.08$           | $19.97^{+3.51}_{-10.05}$                            | $8.06 \pm 0.17$        | $0.21^{+0.07}_{-0.08}$   |
| Literature + NEID RVs + HGCA | $1.98^{+0.18}_{-0.18}$      | $12.94^{+0.001}_{-0.001}$ | $0.11 \pm 0.09$           | <b><math>21.55^{+3.2}_{-2.4}</math> (True Mass)</b> | $8.06 \pm 0.18$        | $0.21 \pm 0.08$          |



HD 95357 c in Mass-Period space. Other planets are color coded by detection method. Triangles are  $m \sin i$ 's, and circles represent dynamical masses

## Lowest Mass RV + Acceleration Planet

At  $M = 21.55 M_{\oplus}$  and  $P = 8$  yr, HD 95735 c becomes the lowest (dynamical) mass long-period planet. With continued RV monitoring and the release of Gaia DR4 (projected December 2026) we can probe the low-mass long period area of parameter space.

Widely separated planets such as HD 95735 c ( $\rho = 1.3''$ ) will be excellent targets for the next generation of space telescopes (includes JWST GO-8581, PI: Bowens-Ruben).

## Acknowledgements

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## References

1. Díaz et al. 2019
2. Rosenthal et al. 2021
3. Hurt et al. 2022
4. Brandt 2021
5. Gupta et al. 2025
6. Brandt et al. 2021