VLTI/GRAVITY measurements of the HR 8799 planets reveal **sub-stellar C/O ratios**, which decrease with orbital radius.

Four of a Kind: **HR8799**

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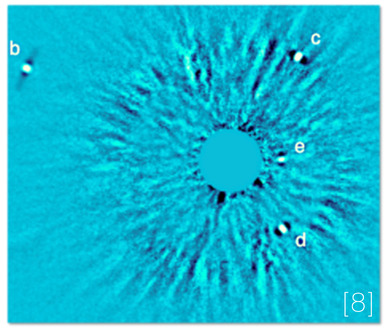
Introduction

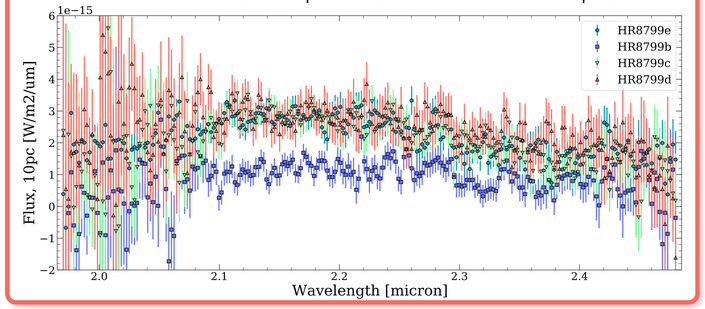
HR8799 is one of the most well-studied systems of directly imaged exoplanets.
The presence of four young, hot planets provides a unique opportunity to use the present day atmospheric properties to explore the shared formation history of the system, using tracers such as the carbon-to-oxygen ratio [7].



Data

We combined new data from VLTI/GRAVITY, VLT/SPHERE, LBT/ALES and Subaru/CHARIS with reprocessed archival datasets from SPHERE [9], GPI [2] and OSIRIS [1,3]. This covers a range from 1 to 4 μm for three of the four planets.

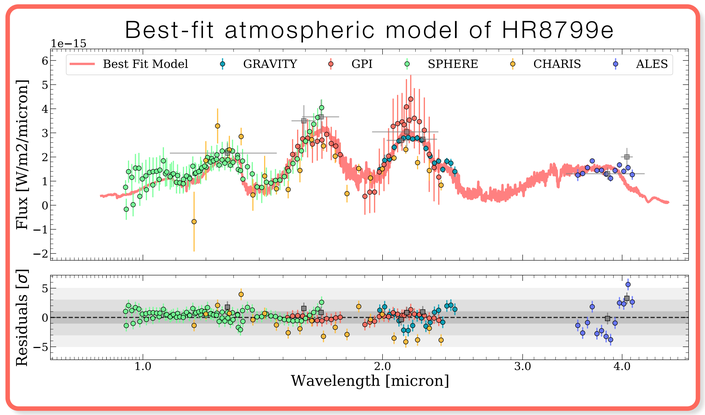
GRAVITY K-band Spectra of the HR8799 planets



Modelling

A petitRADTRANS-based atmospheric retrieval was performed to infer the atmospheric properties of each [5,6]. The emission spectrum model provides flexibility to explore different atmospheric structure, chemistry and cloud parameterisations.

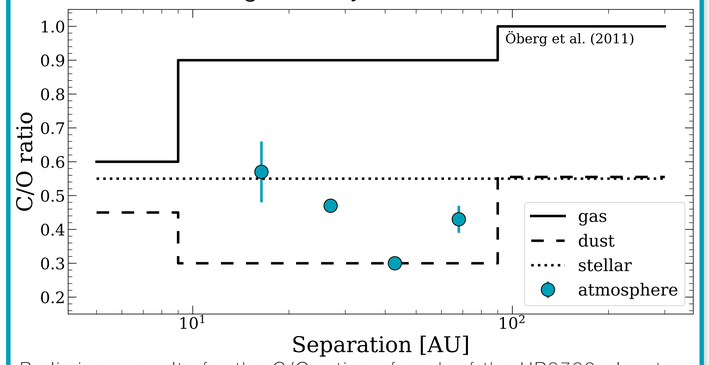
Best-fit atmospheric model of HR8799e



Results

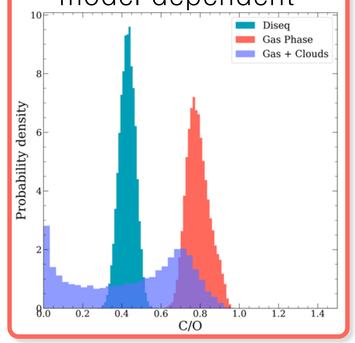
Using the model of Mollière+ (2020), we find a trend of decreasing C/O with separation from the host star, in contrast to Lavie+ (2017). The C/O ratios of the b, c, and d planets are substellar. Going forward, we hope to explain the mechanism of this trend.

C/O decreases with distance, and is generally sub-stellar

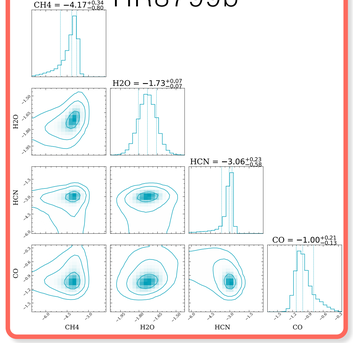


Preliminary results for the C/O ratios of each of the HR8799 planets, computed using a disequilibrium chemistry model. Retrievals are ongoing to determine error bars for the c and d planets. We compare these values to the Öberg (2011) model for an A-type star [7].

The C/O ratio is model dependent



Abundances of HR8799b



Care must be taken when measuring C/O ratios! Chemical modelling yields systematically lower ratios compared to vertically constant gas phase abundances.

Water and CO are significantly detected in the atmosphere of HR8799b. No other species are constrained at a Bayes Factor of greater than 10.

Acknowledgements

Thanks to Travis Barman, Beth Biller, David Doelman, Alex Greenbaum, Quinn Konopacky, Jason Wang, Alice Zurlo and the ExoGRAVITY team for providing the data used in this project.

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