



7188 - All you need is Love numbers: simultaneous measurement of the oblateness and atmospheric composition of a warm gas giant

Cycle: 4, Proposal Category: GO

INVESTIGATORS

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Mr. Juan Ignacio Espinoza-Retamal (CoI)	Pontificia Universidad Catolica de Chile

OBSERVATIONS

<i>Folder</i>	<i>Observation</i>	<i>Label</i>	<i>Observing Template</i>	<i>Science Target</i>
Observation Folder				
	1	TOI-199	NIRSpec Bright Object Time Series	(1) CD-60-1144
	2	TOI-199	NIRSpec Bright Object Time Series	(1) CD-60-1144

ABSTRACT

A key open question for gas giant exoplanets is how heavy elements are distributed between the core and the envelope. With the combination of two observables uniquely accessible with JWST, the Love number and atmospheric metallicity, it is possible to break degeneracies in theoretical models and uniquely determine the interior structure. The Love number quantifies the deviation of the planet's shape from a perfect sphere due to rotational

or tidal forces. For the same force, the deformation will be greater for planets with well-mixed regions between the core and the envelope (known as dilute cores) than for planets with well-differentiated cores. We will observe a long-period gas giant, TOI-199 b, and measure its rotation-induced oblateness from a precise transit light curve. We will also measure the atmospheric composition with transmission spectroscopy, determining the atmospheric metallicity and C/O ratio to a precision better than 0.28 and 0.04 dex, respectively. Taken together, these measurements will provide constraints on the mass and dilution of the core of a cold gas giant exoplanet. Jupiter and Saturn both have dilute cores. Thus, if we find the same is true for TOI-199 b, that would be a positive indication that dilute cores are a typical outcome of gas giant formation both in and out of the Solar System.

OBSERVING DESCRIPTION

We will observe two primary transits of TOI-199 b with NIRSpec/G395H. This is the most favourable planet for the simultaneous detection of planet oblateness and the measurement of the transmission spectrum, given its high TSM and low ratio between its age and tidal despinning timescale.

The two transit observations with NIRSpec/G395H will provide the required noise level to perform a strong detection of the planet's oblateness if the deformation of TOI-199 b is similar to that of Jupiter, even in the worst-case scenario on a null projected obliquity. NIRSpec/G395H provides also the wavelength coverage required to estimate the atmospheric metallicity to the accuracy we require for our science case.

The two visits must be scheduled to begin before the transit and end before the transit with a baseline on both sides. We specify the phase constraints to guarantee this.

Proposal 7188 - Targets - All you need is Love numbers: simultaneous measurement of the oblateness and atmospheric composition ...

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	CD-60-1144	RA: 05 20 25.4127 (80.1058862d) Dec: -59 53 43.53 (-59.89542d) Equinox: J2000	Proper Motion RA: 45.8641 mas/yr Proper Motion Dec: 58.4447 mas/yr Parallax: 0.0098296" Epoch of Position: 2016	
<i>Comments: Comments from PI: ICRS coordinates, epoch, proper motions and parallax from Gaia DR3.</i>				
<i>Cross-checked with simbad and the Gaia archive</i>				
<i>ID: Gaia DR3 4762582895440787712</i>				
<i>Category=Star</i>				
<i>Description=[G stars]</i>				
(2)	TA_target	RA: 05 20 24.6696 (80.1027900d) Dec: -59 53 51.80 (-59.89772d) Equinox: J2000	Proper Motion RA: 45.1600 mas/yr Proper Motion Dec: 58.1703 mas/yr Parallax: 0.0097964" Epoch of Position: 2016	
<i>Comments: Comments from PI: ICRS coordinates, epoch, proper motions and parallax from Gaia DR3.</i>				
<i>Cross-checked with simbad and the Gaia archive</i>				
<i>ID: Gaia DR3 4762582861080613248</i>				
<i>Gaia spectrum indicates that it is a star (100% probability). The spectral type is unknown</i>				
<i>Category=Star</i>				
<i>Description=[M dwarfs]</i>				

Fixed Targets

Proposal 7188 - Observation 1 - All you need is Love numbers: simultaneous measurement of the oblateness and atmospheric compo...

Thu Oct 02 13:00:08 GMT 2025

Observation	<p>Proposal 7188, Observation 1: TOI-199</p> <p>Diagnostic Status: Warning</p> <p>Observing Template: NIRSpec Bright Object Time Series</p>																																										
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Proposal 7188 - Observation 1 - All you need is Love numbers: simultaneous measurement of the oblateness and atmospheric compo...

Special Requirements

Phase 0.9967007137012 to 0.997098026598454 with period 104.871165659651 Days and zero-phase 2460668.21986812 HJD
Time Series Observation
No Parallel Attachments

Proposal 7188 - Observation 2 - All you need is Love numbers: simultaneous measurement of the oblateness and atmospheric compo...

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