



17303 - The primordial helium isotope ratio

Cycle: 30, Proposal Category: GO

(UV Initiative)

(Availability Mode: SUPPORTED)

INVESTIGATORS

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Dr. Celine Peroux (CoI) (ESA Member)	European Southern Observatory - Germany
Mr. James William Johnson (CoI)	The Ohio State University

VISITS

<i>Visit</i>	<i>Targets used in Visit</i>	<i>Configurations used in Visit</i>	<i>Orbits Used</i>	<i>Last Orbit Planner Run</i>	<i>OP Current with Visit?</i>
01	(1) RAFGL-5223	COS/FUV COS/NUV	1	25-Apr-2023 17:00:12.0	yes

1 Total Orbits Used

ABSTRACT

The cosmic abundance of helium-3 (^3He) is a key probe of cosmology and galactic chemical evolution. However, ^3He is extremely difficult to measure. Recently, metastable ^3He ($^3\text{He I}^*$) was detected for the first time in absorption against the light of an O star in the Orion Nebula. Motivated by their discovery, we searched the world's optical and near-infrared data archives for new examples of He I^* absorbers. With this 1 orbit mid-cycle application, we propose to record HST/COS FUV data of the highest value target that we have only just identified - a young O star in the outer Milky

Way (at a galactocentric radius of ~ 12.5 kpc) that intersects previously unidentified strong He I* absorption. Galactic chemical evolution models predict that the helium isotope ratio ($3\text{He}/4\text{He}$) in this distance regime is enhanced by just ~ 10 percent relative to a primordial composition. The key goal of these HST data is to measure the gas-phase metallicity of the cloud that gives rise to the near-infrared He I* absorption. Combining our new result with literature measurements, we will fit a linear relationship between metallicity and the $3\text{He}/4\text{He}$ ratio, and extrapolate this relationship to zero-metallicity; such an extrapolation will deliver our current best opportunity to deduce - for the first time - the primordial $3\text{He}/4\text{He}$ value. As an added bonus, with the same data we will: (1) compare absorption and emission line abundances of this outer Milky Way H II region; (2) search for evidence of a radial abundance gradient in the Milky Way using absorption line techniques; and (3) assess the prospects of measuring D/H with a future application.

OBSERVING DESCRIPTION

Our aim is to measure the metallicity of the H II region PDS 241, which intersects strong metastable He I* absorption. The star that we will target is the brightest in the H II region. We will use COS/FUV (G130M with CENWAVE=1291) to measure the H I column density from Ly α (1215A) and a column density of a volatile metal (N I, O I, or S II). We note that the H I column density of this sightline has never been measured, and its FUV flux is not known. Based on the U band magnitude ($U=12.5$) and the extinction ($E(B-V)=0.6$) we have estimated that with one orbit, we will achieve a $S/N=20$ per resolution element. We will also use these data to assess the feasibility of measuring D I with future observations.

Proposal 17303 - PDS241 (01) - The primordial helium isotope ratio

Tue Apr 25 21:00:12 GMT 2023

Visit	Proposal 17303, PDS241 (01), implementation Diagnostic Status: Warning Scientific Instruments: COS/FUV, COS/NUV Special Requirements: (none) <i>Comments: We only use FP-POS=3, as per the guidelines for G130M/1291.</i>																																												
	Diagnosics (PDS241 (01)) Warning (Form): For the best data quality, it is generally required to use all four FP-POS positions when observing at a given COS cenwave. See the COS Instrument Handbook for exceptions that may apply to observations with G130M/1291 or G160M.																																												
Fixed Targets	<table border="1"> <thead> <tr> <th>#</th> <th>Name</th> <th>Target Coordinates</th> <th>Targ. Coord. Corrections</th> <th>Fluxes</th> <th>Miscellaneous</th> </tr> </thead> <tbody> <tr> <td>(1)</td> <td>RAFGL-5223 Alt Name1: PDS-241</td> <td>RA: 07 08 38.7907 (107.1616279d) Dec: -04 19 4.85 (-4.31801d) Equinox: J2000</td> <td>Proper Motion RA: -7.668433420523167E-5 sec of time/yr Proper Motion Dec: 1.1399999999999999E-4 arcsec/yr Parallax: 0.0001682" Epoch of Position: 2000.0</td> <td>V=12.06 U=12.48, B=12.71</td> <td>Reference Frame: ICRS</td> </tr> </tbody> </table> <p><i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database. The PI confirms the coordinates. Note that the target is a point source, but it resides in an H II region that is extended. The FUV and NUV magnitudes of the target are not known, so the buffer time is estimated based on a B0V star with E(B-V)=0.95, and U=12.5.</i> Category=STAR Description=[B0-B2 V-IV, BE, EMISSION LINE NEBULA, STAR FORMING REGION] Extended=NO</p>						#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous	(1)	RAFGL-5223 Alt Name1: PDS-241	RA: 07 08 38.7907 (107.1616279d) Dec: -04 19 4.85 (-4.31801d) Equinox: J2000	Proper Motion RA: -7.668433420523167E-5 sec of time/yr Proper Motion Dec: 1.1399999999999999E-4 arcsec/yr Parallax: 0.0001682" Epoch of Position: 2000.0	V=12.06 U=12.48, B=12.71	Reference Frame: ICRS																											
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