



15892 - Probing the Jet at the Heart of the Coldest Object in the Universe

Cycle: 27, Proposal Category: GO

(Availability Mode: SUPPORTED)

INVESTIGATORS

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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) IRAS12419-5414	STIS/CCD	4	08-Apr-2020 10:00:17.0	yes

4 Total Orbits Used

ABSTRACT

The Boomerang Nebula, is the coldest (naturally occurring) object in the Universe. CO(1-0) observations of it show a massive ultra-cold outflow in absorption against the microwave background, implying that the nebula has cooled below the temperature of the cosmic background radiation. Its extreme properties make it the Rosetta Stone for understanding the mass-loss processes that govern late stellar evolution. Our recent ALMA study shows that the Boomerang is the product of a common-envelope event (CEE) in a binary system, while the primary was an RGB/early-AGB star, which ejected the primary's envelope that now forms the ultra-cold outflow. It is likely that the companion merged into the primary's core, leaving a single G-type star with a large dusty disk. This disk may be the launch site of a jet that has sculpted the inner regions

Proposal 15892 (STScI Edit Number: 0, Created: Wednesday, April 8, 2020 at 9:00:20 AM Eastern Standard Time) - Overview of the ultra-cold outflow, producing the bipolar nebula at the center.

HST polarised-light imaging shows the presence of two point-symmetric spurs around the central star, that likely result from such a jet. Previous ground-based spectroscopy shows absorption and emission lines that are likely associated with this jet. We propose to obtain long-slit spectroscopy with STIS in order to confirm the presence of the jet and probe its spatio-kinematic structure. These data will provide us with unprecedented details of the product of a CEE event, and the launching of jets from the central source - a fundamental, yet very poorly understood astrophysical process. Our analysis will use the results of a recent theoretical study that shows how one can constrain basic properties of the jet engine by studying the jet properties.

OBSERVING DESCRIPTION

We will use STIS with G750M centered at 6581\AA and a mosaic of 10 parallel slits aligned along the axis of the central bipolar nebula (i.e. $PA=353\text{arcdeg}$), to probe the spatio-kinematic structure of the jet and shocked regions where it impacts the walls of the bipolar cavity. We will use the $52''$ slit to obtain spectra in the $\lambda\lambda 6295-6867\text{\AA}$ range with $\sim 50\text{ km/s}$ spectral and 0.05 arcsec spatial resolution. We will thus cover the $H\alpha$, [NII] $\lambda\lambda 6548,6583$ and [SII] $\lambda\lambda 6717,6731$ lines, the [OI] $\lambda 6300$ line will be near the edge, but still visible. The average $H\alpha$, [NII] and [SII] average line intensities are in the range $\sim 3.5 \times 10^{-15} - 1.5 \times 10^{-15}\text{ erg cm}^{-2}\text{ arcsec}^{-2}$. The line-widths (marginally resolved) are about $70-90\text{ km/s}$. Since the line intensities are likely not uniform, we assume a variation of a factor 3, and a minimum S/N ratio of about 10 in the regions of lowest intensity in our weakest lines, i.e., [SII] $\lambda\lambda 6717,6731$, which are important for measuring the densities in the jet; the S/N obtained on the $H\alpha$ absorption line will be larger. A high S/N for the latter is important, as it is the only tracer that we have for the unshocked gas in the jet. Using the STIS Exposure Time Calculator, we estimate that an exposure time of about 1100 s will be needed. Thus, for our mosaic of 10 slits, we will need 183 minutes of exposure time, i.e., 4 orbits (with 50 min per orbit to allow increase in Scheduling Flexibility, as per the APT).

From the observed PA of the bipolar nebula (353arcdeg), we compute an $ORIENT=PA+46.3\text{arcdeg}\sim 39\text{arcdeg}$ or $PA+226.3\text{arcdeg}\sim 219\text{arcdeg}$ (as per the STIS handbook). We therefore request a slit ORIENT range $PA=34\text{arcdeg}-44\text{arcdeg}$, or $214\text{arcdeg}-224\text{arcdeg}$, in order to probe the emission from the highly-collimated jet precisely. This ORIENT range, although restricted, allows a substantial ~ 1 -month long window for scheduling.

Proposal 15892 - Visit 01 - Probing the Jet at the Heart of the Coldest Object in the Universe

Wed Apr 08 14:00:20 GMT 2020

Visit	Proposal 15892, Visit 01, implementation Diagnostic Status: No Diagnostics Scientific Instruments: STIS/CCD Special Requirements: PCS MODE FINE; SCHED 30%; ORIENT 34D TO 44 D; ORIENT 214D TO 224 D					
	Patterns	#	Primary Pattern	Secondary Pattern	Exposures	
		(1)	Pattern Type=STIS-PERP-TO-SLIT Coordinate Frame=POS-TARG Purpose=MOSAIC Pattern Orientation=0.0 Number Of Points=10 Angle Between Sides= Point Spacing=0.2 Center Pattern=true Line Spacing=	Pattern Type=STIS-ALONG-SLIT Coordinate Frame=POS-TARG Purpose=DITHER Pattern Orientation=90.0 Number Of Points=3 Angle Between Sides= Point Spacing=0.380325 Center Pattern=false Line Spacing=	(2)	
Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
	(1)	IRAS12419-5414	RA: 12 44 46.0900 (191.1920417d) Dec: -54 31 13.36 (-54.52038d) Equinox: J2000		V=12.8+/-0.3	Reference Frame: ICRS
	<i>Comments:</i> Category=STAR Description=[POST-AGB STAR] Extended=YES					

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#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	(1437100)	(1) IRAS12419-5414	STIS/CCD, ACQ, F28X50LP	MIRROR	ACQTYPE=POINT			0.5 Secs (0.5 Secs) [==>]	[1]

Exposures

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2	(1) IRAS12419-5414 STIS/CCD, ACCUM, 52X0.2	G750M 6581 A	Pattern 1, Exps 2-2 i n Visit 01 (1)	200 Secs (7872 Secs) [=>136.0 Secs (Pattern 1,1, Split 1)] [=>136.0 Secs (Pattern 1,1, Split 2)] [=>136.0 Secs (Pattern 1,2, Split 1)] [=>136.0 Secs (Pattern 1,2, Split 2)] [=>136.0 Secs (Pattern 1,3, Split 1)] [=>136.0 Secs (Pattern 1,3, Split 2)] [=>136.0 Secs (Pattern 2,1, Split 1)] [=>136.0 Secs (Pattern 2,1, Split 2)] [=>136.0 Secs (Pattern 2,2, Split 1)] [=>136.0 Secs (Pattern 2,2, Split 2)] [=>136.0 Secs (Pattern 2,3, Split 1)] [=>136.0 Secs (Pattern 2,3, Split 2)]	[1]
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	<p>[==>130.0 Secs (Pattern 3,1, Split 1)]</p> <p>[==>130.0 Secs (Pattern 3,1, Split 2)]</p> <p>[==>130.0 Secs (Pattern 3,2, Split 1)]</p> <p>[==>130.0 Secs (Pattern 3,2, Split 2)]</p> <p>[==>130.0 Secs (Pattern 3,3, Split 1)]</p> <p>[==>130.0 Secs (Pattern 3,3, Split 2)]</p> <p>[==>130.0 Secs (Pattern 4,1, Split 1)]</p> <p>[==>130.0 Secs (Pattern 4,1, Split 2)]</p> <p>[==>130.0 Secs (Pattern 4,2, Split 1)]</p> <p>[==>130.0 Secs (Pattern 4,2, Split 2)]</p> <p>[==>130.0 Secs (Pattern 4,3, Split 1)]</p> <p>[==>130.0 Secs (Pattern 4,3, Split 2)]</p> <p>[==>130.0 Secs (Pattern 5,1, Split 1)]</p> <p>[==>130.0 Secs (Pattern 5,1, Split 2)]</p> <p>[==>130.0 Secs (Pattern 5,2, Split 1)]</p> <p>[==>130.0 Secs (Pattern 5,2, Split 2)]</p>	<p>[2]</p>
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	<p>[==>130.0 Secs (Pattern 5,3, Split 1)]</p> <p>[==>130.0 Secs (Pattern 5,3, Split 2)]</p> <p>[==>130.0 Secs (Pattern 6,1, Split 1)]</p> <p>[==>130.0 Secs (Pattern 6,1, Split 2)]</p> <p>[==>130.0 Secs (Pattern 6,2, Split 1)]</p> <p>[==>130.0 Secs (Pattern 6,2, Split 2)]</p> <p>[==>130.0 Secs (Pattern 6,3, Split 1)]</p> <p>[==>130.0 Secs (Pattern 6,3, Split 2)]</p> <p>[==>130.0 Secs (Pattern 7,1, Split 1)]</p> <p>[==>130.0 Secs (Pattern 7,1, Split 2)]</p> <p>[==>130.0 Secs (Pattern 7,2, Split 1)]</p> <p>[==>130.0 Secs (Pattern 7,2, Split 2)]</p> <p>[==>130.0 Secs (Pattern 7,3, Split 1)]</p> <p>[==>130.0 Secs (Pattern 7,3, Split 2)]</p> <p>[==>130.0 Secs (Pattern 8,1, Split 1)]</p> <p>[==>130.0 Secs (Pattern 8,1, Split 2)]</p>	<p>[3]</p>
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	<p>[==>130.0 Secs (Pattern 8,2, Split 1)]</p> <p>[==>130.0 Secs (Pattern 8,2, Split 2)]</p> <p>[==>130.0 Secs (Pattern 8,3, Split 1)]</p> <p>[==>130.0 Secs (Pattern 8,3, Split 2)]</p> <p>[==>130.0 Secs (Pattern 9,1, Split 1)]</p> <p>[==>130.0 Secs (Pattern 9,1, Split 2)]</p> <p>[==>130.0 Secs (Pattern 9,2, Split 1)]</p> <p>[==>130.0 Secs (Pattern 9,2, Split 2)]</p> <p>[==>130.0 Secs (Pattern 9,3, Split 1)]</p> <p>[==>130.0 Secs (Pattern 9,3, Split 2)]</p> <p>[==>130.0 Secs (Pattern 10,1, Split 1)]</p> <p>[==>130.0 Secs (Pattern 10,1, Split 2)]</p> <p>[==>130.0 Secs (Pattern 10,2, Split 1)]</p> <p>[==>130.0 Secs (Pattern 10,2, Split 2)]</p> <p>[==>130.0 Secs (Pattern 10,3, Split 1)]</p> <p>[==>130.0 Secs (Pattern 10,3, Split 2)]</p>	<p>[4]</p>
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