12588 - Accurate Mass Determination of the Old White Dwarf G105-30 through Astrometric Microlensing

Cycle: 19, Proposal Category: GO

(Availability Mode: SUPPORTED)

INVESTIGATORS

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VISITS

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
01	(3) G105-30-SOURCE	WFC3/UVIS	1	18-Sep-2013 21:01:17.0	yes
02	(3) G105-30-SOURCE	WFC3/UVIS	1	18-Sep-2013 21:01:29.0	yes
04	(3) G105-30-SOURCE	WFC3/UVIS	1	18-Sep-2013 21:01:39.0	yes

3 Total Orbits Used

ABSTRACT

We propose to determine the mass of the cool, nearby, high-proper-motion white dwarf (WD) G 105-30 (LHS 1838) through astrometric microlensing. In a reprise of the famous 1919 solar eclipse that verified general relativity, G 105-30 will pass very close in front of a 19.5-mag background star in June 2012, with an impact parameter of only ~0.08 arcsec. As it passes in front, it will cause a relativistic deflection of the background star's image by >2 milliarcsec, an amount easily detectable with HST/WFC3. The gravitational deflection angle depends only on the distances and relative positions of the stars, and on the mass of the WD. Since the distance to G 105-30 is already known from an accurate parallax,

and the relative positions can be determined precisely before the event, the astrometric measurement offers a unique and direct method to measure the mass of the WD to high accuracy (<5%, potentially <1% for favorable circumstances).

One key astrophysical prediction for WDs is the existence of a mass-radius relation (MRR), which depends on the WD's core composition. Since the luminosity and distance of G 105-30 are known, its radius is known. Our measurements will thus provide a new, precise point in the MRR. The mass of G 105-30 is of special interest because it is an old and relatively massive WD, which would provide new constraints near the bottom of the WD cooling curve, currently being used to age-date stellar populations.

OBSERVING DESCRIPTION

First, we need to know accurate locations and proper motions for G105-30 and the source star, in order to predict the precise circumstances of the event, including the date and impact parameter. We will use direct imaging with WFC3 to determine the astrometric parameters of G105-30, the source star, and the surrounding reference field.

We need to know the time of closest approach as accurately as possible in order to schedule subsequent critical observations. We have a four-phase observing program:

(1) In the first phase, we will obtain the HST observations needed to make the final predictions of the circumstances of the event (impact parameter and time of closest approach) with high accuracy. At the beginning of Cycle~19 we will image the field twice at about a 3-month separation for this purpose.

(2) Based on the early Cycle~19 astrometry, we will refine the predicted dates between which the images will be blended, so that we will know the optimal observation dates just before and after those times.

(3) We will obtain one more observation in cycle 19 just before the onset of blending (and before the peak of the microlensing), when the astrometric deflection is at its largest observable value. (If this epoch turns turns out to lie in the solar-avoidance interval, May--August 2012, we would make sure to obtain this observation just before the
solar-avoidance interval.)

(4) We will obtain 4 more observations after the peak of the microlensing, beginning just after the time when the source and the lens are no more blended.

Visit

Proposal 12588, Visit 01, completed Thu Sep 19 01:01:47 GMT 2013

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/UVIS

Special Requirements: ORIENT 258D TO 258 D; BEFORE 25-AUG-2011

Fixed Targets

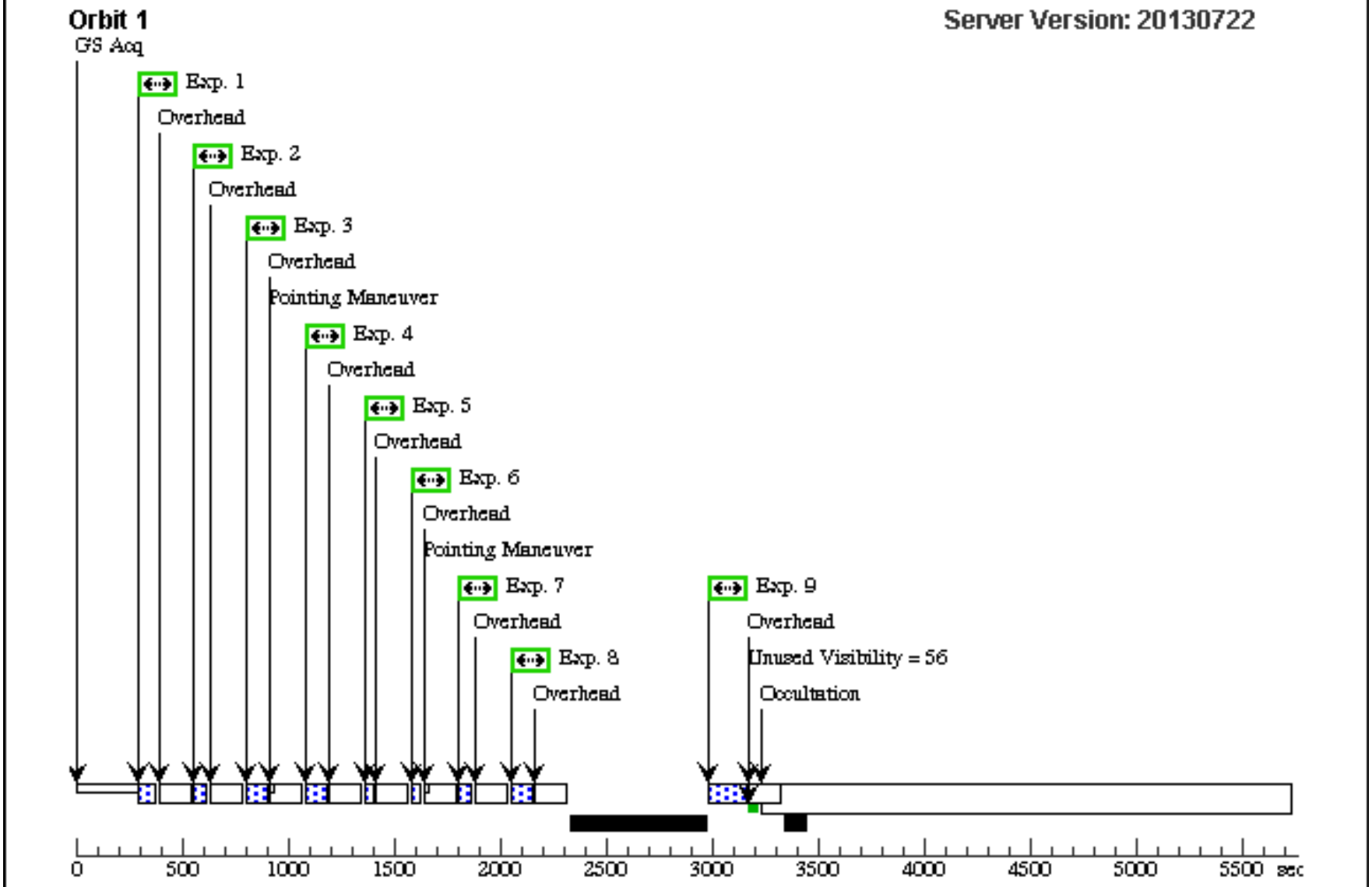
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(3)	G105-30-SOURCE	RA: 06 20 48.2000 (95.2008333d) Dec: +06 45 17.10 (6.75475d) Equinox: J2000		V=16.37	Reference Frame: ICRS

Comments: The coordinates were calculated using POSS2 red image. The coordinates are that of the source that will be lensed by the WD.

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(3) G105-30-SOURCE	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F606W		POS TARG 9.36,8.22		50 Secs (50 Secs) *[==>]*	 ***[1]***
2		(3) G105-30-SOURCE	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F814W		SAME POS AS 1		40 Secs (40 Secs) *[==>]*	 ***[1]***
3		(3) G105-30-SOURCE	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F814W		SAME POS AS 1		100 Secs (100 Secs) *[==>]*	 ***[1]***
4		(3) G105-30-SOURCE	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F814W		POS TARG 19.62,2.29		100 Secs (100 Secs) *[==>]*	 ***[1]***
5		(3) G105-30-SOURCE	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F814W		SAME POS AS 4		40 Secs (40 Secs) *[==>]*	 ***[1]***
6		(3) G105-30-SOURCE	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F606W		SAME POS AS 5		20 Secs (20 Secs) *[==>]*	 ***[1]***
7		(3) G105-30-SOURCE	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F814W		POS TARG 3.44,18.48		40 Secs (40 Secs) *[==>]*	 ***[1]***
8		(3) G105-30-SOURCE	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F814W		SAME POS AS 7		100 Secs (100 Secs) *[==>]*	 ***[1]***
9		(3) G105-30-SOURCE	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F850LP		SAME POS AS 7		160 Secs (160 Secs) *[==>]*	 ***[1]***

Orbit Structure



Visit

Proposal 12588, Visit 02, completed Thu Sep 19 01:01:50 GMT 2013

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/UVIS

Special Requirements: BEFORE 07-SEP-2011

Fixed Targets

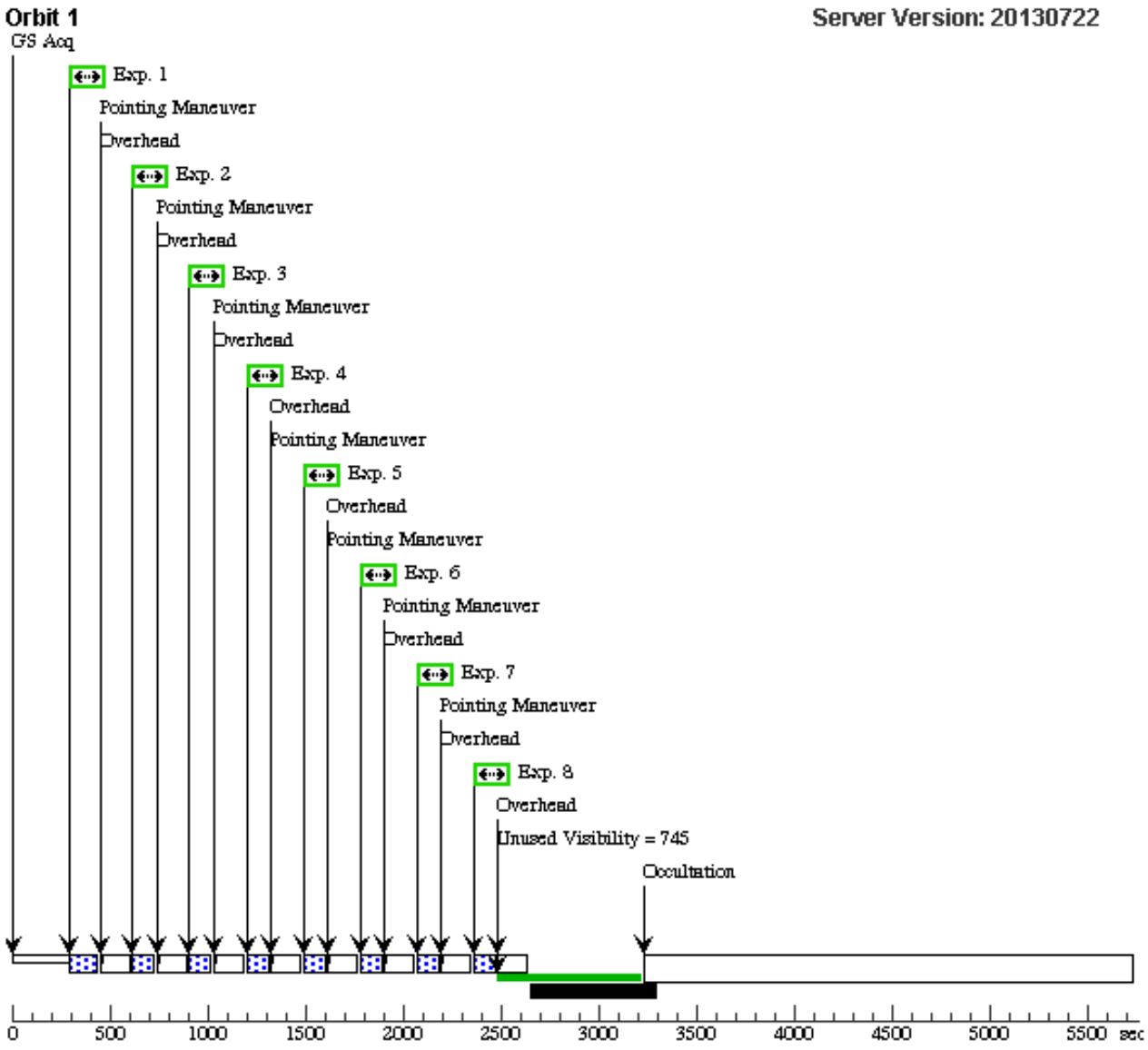
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(3)	G105-30-SOURCE	RA: 06 20 48.2000 (95.2008333d) Dec: +06 45 17.10 (6.75475d) Equinox: J2000		V=16.37	Reference Frame: ICRS

Comments: The coordinates were calculated using POSS2 red image. The coordinates are that of the source that will be lensed by the WD.

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(3) G105-30-SOURCE	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F814W		POS TARG 17.192,9.849		110 Secs (110 Secs) *[==>]*	 ***[1]***
2		(3) G105-30-SOURCE	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F814W		POS TARG 13.746,14.91		110 Secs (110 Secs) *[==>]*	 ***[1]***
3		(3) G105-30-SOURCE	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F814W		POS TARG 7.731,16.052		110 Secs (110 Secs) *[==>]*	 ***[1]***
4		(3) G105-30-SOURCE	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F814W		POS TARG 2.67,12.606		110 Secs (110 Secs) *[==>]*	 ***[1]***
5		(3) G105-30-SOURCE	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F814W		POS TARG 1.528,6.591		110 Secs (110 Secs) *[==>]*	 ***[1]***
6		(3) G105-30-SOURCE	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F814W		POS TARG 4.974,1.53		110 Secs (110 Secs) *[==>]*	 ***[1]***
7		(3) G105-30-SOURCE	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F814W		POS TARG 10.989,0.388		110 Secs (110 Secs) *[==>]*	 ***[1]***
8		(3) G105-30-SOURCE	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F814W		POS TARG 16.05 ,3.834		110 Secs (110 Secs) *[==>]*	 ***[1]***

Orbit Structure



Visit

Proposal 12588, Visit 04, pi Thu Sep 19 01:01:51 GMT 2013

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/UVIS

Special Requirements: ORIENT 275D TO 281 D; BETWEEN 30-SEP-2013 AND 18-OCT-2013

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(3)	G105-30-SOURCE	RA: 06 20 48.2000 (95.2008333d) Dec: +06 45 17.10 (6.75475d) Equinox: J2000		V=16.37	Reference Frame: ICRS

Comments: The coordinates were calculated using POSS2 red image. The coordinates are that of the source that will be lensed by the WD.

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(3) G105-30-SOURCE	WFC3/UVIS, ACCUM, UVIS2	F606W	FLASH=10	POS TARG 0,0		40 Secs (40 Secs) *[==>]*	*[1]*
2		(3) G105-30-SOURCE	WFC3/UVIS, ACCUM, UVIS2	F606W		POS TARG 0,0; SPATIAL SCAN 0.040,1.8612 Degrees, Forward		500 Secs (500 Secs) *[==>]*	*[1]*
3		(3) G105-30-SOURCE	WFC3/UVIS, ACCUM, UVIS2	F606W		POS TARG 2,0; SPATIAL SCAN 0.040,1.8612 Degrees, Forward		500 Secs (500 Secs) *[==>]*	*[1]*
4		(3) G105-30-SOURCE	WFC3/UVIS, ACCUM, UVIS2	F606W		POS TARG 0,0; SPATIAL SCAN 0.040,88.091 Degrees, Forward		500 Secs (500 Secs) *[==>]*	*[1]*
5		(3) G105-30-SOURCE	WFC3/UVIS, ACCUM, UVIS2	F606W		POS TARG 0,2; SPATIAL SCAN 0.040,88.091 Degrees, Forward		500 Secs (500 Secs) *[==>]*	*[1]*
6		(3) G105-30-SOURCE	WFC3/UVIS, ACCUM, UVIS2	F606W	FLASH=10	POS TARG 2,5		40 Secs (40 Secs) *[==>]*	*[1]*

Orbit Structure