10773 - Calibrating the Mass-Luminosity Relation at the End of the Main Sequence

Cycle: 13, Proposal Category: GO

(Availability Mode: SUPPORTED)

INVESTIGATORS

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VISITS

Visit	*Targets*	*Configurations*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
01	(11) GL22-024-REF (12) GL22-049-REF (13) GL22-087-REF (10) GL22	FGS	1	15-Nov-2005 21:27:05.0	yes

1 Total Orbits Used

ABSTRACT

We propose to use HST-FGS1R to calibrate the mass-luminosity relation (MLR) for stars less massive than 0.2 Msun, with special emphasis on objects near the stellar/brown dwarf border. Our goals are to determine M_V values to 0.05 magnitude, masses to 5\ than double the number of objects with masses determined to be less than 0.20 Msun. This program uses the combination of HST-FGS3/FGS1R at optical wavelengths and ground-based infrared interferometry to examine nearby, subarcsecond binary systems. The high precision measurements with HST-FGS3/FGS1R (to 1 mas in the separations) for these faint targets (V = 10--15) simply cannot be equaled by any ground based technique. As a result of these measurements, we are deriving high quality luminosities and masses for the components in the observed systems, and characterizing their spectral energy distributions from 0.5 to 2.2 Mum. Several of the objects included have M < 0.1 Msun, placing them at the very end of the stellar main sequence. Three of the targets are brown dwarf candidates, including the current low mass record holder, GJ 1245C, with a mass of 0.062 +/- 0.004 Msun. The payoff of this proposal is high because all 10 of the systems selected have already been resolved with HST- FGS3/FGS1R during Cycles 5--10 and contain most of the reddest objects for which masses can be determined.

OBSERVING DESCRIPTION

Cycle 5--13 Update: FGS-TRANS observations of the systems were (generally) made at the beginning and end of Cycle 5 and once each in Cycles 6/7/8/9/10/11/12/13, resulting in about six observations so far for each system (except Gl 54 and GJ 2005, which were added more recently). Additional Cycle 10
measurements have not yet been carried out for eight of the systems. The TRANS mode observations are used to map the binary orbits via determination of the separations and position angles, and to measure the magnitude difference of the
components so that luminosities can be derived. In Cycles 8-13 FGS-POS measurements have been made to locate the position of the center of mass of each system with respect to background stars. This allows us to determine the fractional masses of the components so that individual masses can be
derived. Because of the long orbital periods of these systems, radial velocity techniques are not typically useful in getting fractional masses because the velocity differences are small, in addition to the complicating factor that the systems are generally faint and the velocities are of poor precision. The timing of observations has been carefully planned to provide points on the orbits every 20--30^degrees, and a similar strategy will be used in Cycles 11/12/13. Experience from Gl 748 (17 observations) and Gl 791.2 (14 observations)
indicates that a set of roughly 12 measurements spread around the orbit is sufficient to achieve orbital parameter errors smaller than 1\ error in the semimajor axis triples in Kepler's Third Law, which is why we need orbital elements with minimal error, and the consequent orbital coverage. Cycle

11--13 Plan: We propose to continue this effort to (1) increase the orbital coverage from six to nine years, thereby passing the critical half-orbit point on all of the systems, (2) determine the first masses for six systems, (3) revise masses for four systems, (4) refine the brightness ratios, and (5) employ the low-cost (in the sense of number of orbits) technique to measure the fractional masses in nine systems. In essence, via this program HST-FGS will be the instrument responsible for defining the MLR for the most populous stars in the Galaxy --- not a bad legacy for the sometimes forgotten HST instrument. Each of the 10 systems will be observed once each Cycle in FGS-TRANS mode through filter F583W to determine the separation, position angle, and brightness difference between the components. For the TRANS mode observations, 20--60 scans 0.8--3.0" in length are typically made across the binary. The F583Waperture has been selected because it is the best calibrated of the filters available in FGS. The transmission of the telescope through F583W is already calibrated to the Johnson
V band (Henry et al 1999), and will allow the magnitude difference at visible wavelengths to be attained with high accuracy. During the same orbit, nine of the systems will be observed in FGS-POS mode to relate the binary to a background grid of stars in order to find the center of mass (Gl 473 is
the lone exception because it lacks reference stars). POS mode observations will include multiple runs through the field. The POS mode observations allow to get fractional masses for each system. Over time, the vector connecting the
two components rotates about the center of mass as they orbit one another. By overlapping the yearly vectors, we pinpoint the center of mass and derive the fractional masses, provided that the movement of the system due to its proper motion and parallax can be removed using accurate ground-based data.
Errors in the location of vector overlap due to parallax uncertainties are minimized by observing the systems at nearly the same time every year. GJ 1215 and GJ 2005 are the most difficult targets due to faintness, but they are arguably the most important targets --- their secondaries have masses in the brown dwarf regime.

Visit

Proposal 10773, Visit 01 Wed Nov 16 02:27:09 GMT 2005

Diagnostic Status: No Diagnostics

Scientific Instruments: FGS

Special Requirements: SCHED 70%; ORIENT 73.0D TO 90.0 D; BETWEEN 12-DEC-2005:00:00:00 AND 29-DEC-2005:00:00:00

Comments: scanlength 1.5"

Fixed Targets

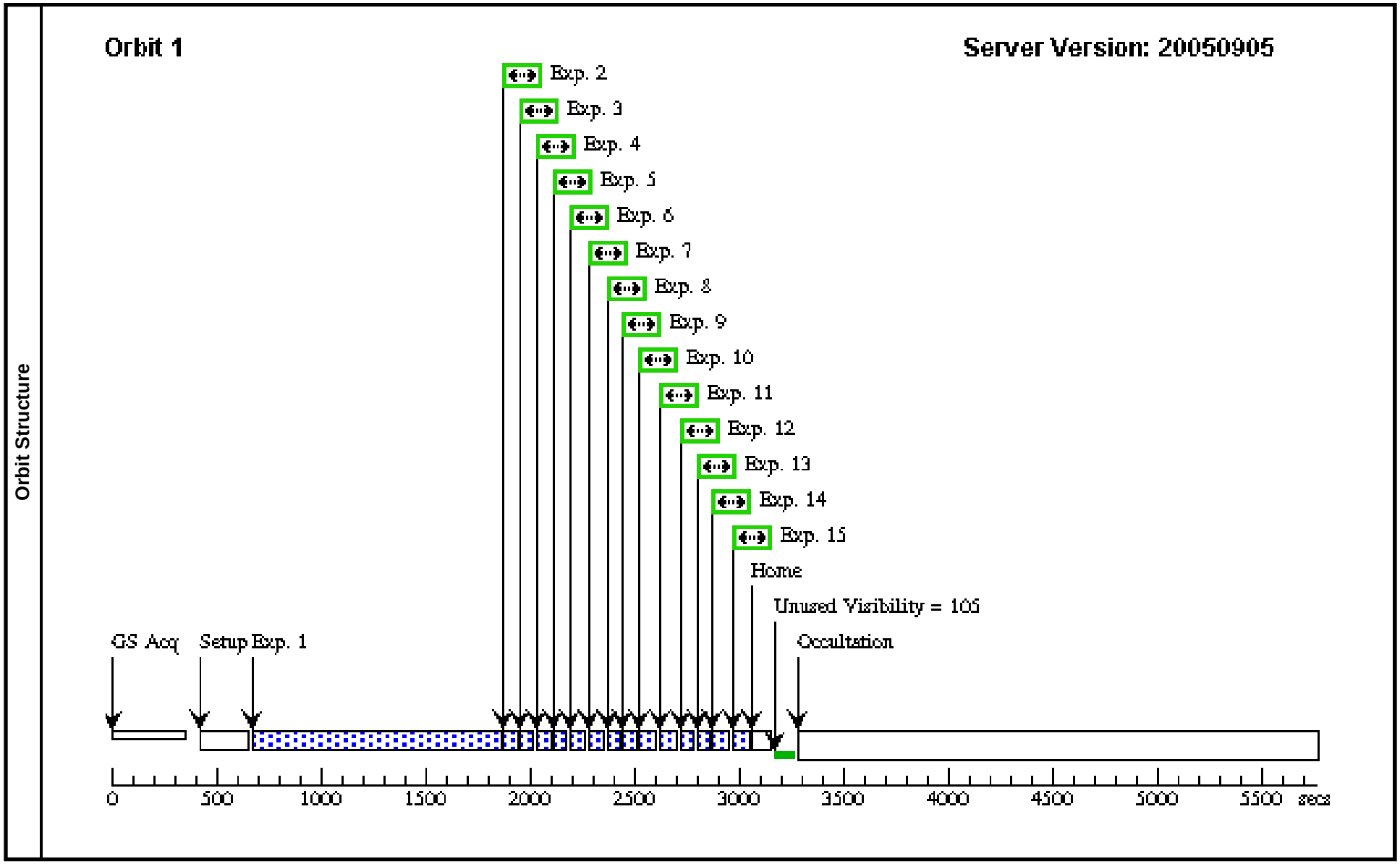
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(10)	GL22	RA: 00 32 24.7000 (8.1029167d)	Proper Motion RA: 0.29504s/yr	V=10.38+/-0.05	Coordinate Source: GUIDE_STAR_CATALOG
	Alt Name1: BD+66D34	Dec: +67 14 11.90 (67.23664d)	Proper Motion Dec: -0.2372"/yr		
	Alt Name2: LHS114	Equinox: J2000	Parallax: 0.09809"		
		Plate Id: (?)	Epoch of Position: 1983.84		
Comments: B-V = 1.54+/-0.05 TYPE=M2V BEWARE: second component at 4" with V = 12.4					
(11)	GL22-024-REF	RA: 00 32 18.3840 (8.0766000d)	Proper Motion RA: 0.0s/yr	V=12.6+/-0.2	Coordinate Source: GUIDE_STAR_CATALOG
		Dec: +67 13 7.03 (67.21862d)	Proper Motion Dec: 0.0"/yr		
		Equinox: J2000	Parallax: 0.0"		
		Plate Id: (?)	Epoch of Position:		
(12)	GL22-049-REF	RA: 00 32 22.1780 (8.0924083d)	Proper Motion RA: 0.0s/yr	V=13.3+/-0.2	Coordinate Source: GUIDE_STAR_CATALOG
		Dec: +67 11 55.21 (67.19867d)	Proper Motion Dec: 0.0"/yr		
		Equinox: J2000	Parallax: 0.0"		
		Plate Id: (?)	Epoch of Position:		
(13)	GL22-087-REF	RA: 00 32 12.7900 (8.0532917d)	Proper Motion RA: 0.0s/yr	V=13.4+/-0.2	Coordinate Source: GUIDE_STAR_CATALOG
		Dec: +67 13 19.92 (67.22220d)	Proper Motion Dec: 0.0"/yr		
		Equinox: J2000	Parallax: 0.0"		
		Plate Id: (?)	Epoch of Position:		

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
1		(10) GL22	FGS, TRANS, 1	F583W	STEP-SIZE=1; SCANS=12	POS TARG 0,35	Sequence 1-15 Non-Int	950.0 Secs	
								[==>]	***[1]***
2		(10) GL22	FGS, POS, 1	F583W		SAME POS AS 1	Sequence 1-15 Non-Int	20.0 Secs	
								[==>]	***[1]***
3		(11) GL22-024-REF	FGS, POS, 1	F583W		SAME POS AS 1	Sequence 1-15 Non-Int	20.0 Secs	
								[==>]	***[1]***
4		(13) GL22-087-REF	FGS, POS, 1	F583W		SAME POS AS 1	Sequence 1-15 Non-Int	20.0 Secs	
								[==>]	***[1]***
5		(11) GL22-024-REF	FGS, POS, 1	F583W		SAME POS AS 1	Sequence 1-15 Non-Int	20.0 Secs	
								[==>]	***[1]***
6		(12) GL22-049-REF	FGS, POS, 1	F583W		SAME POS AS 1	Sequence 1-15 Non-Int	20.0 Secs	
								[==>]	***[1]***

Exposures (continued)

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
7		(10) GL22	FGS, POS, 1	F583W		SAME POS AS 1	Sequence 1-15 Non-Int	20.0 Secs	
								[==>]	***[1]***
8		(11) GL22-024-REF	FGS, POS, 1	F583W		SAME POS AS 1	Sequence 1-15 Non-Int	20.0 Secs	
								[==>]	***[1]***
9		(13) GL22-087-REF	FGS, POS, 1	F583W		SAME POS AS 1	Sequence 1-15 Non-Int	20.0 Secs	
								[==>]	***[1]***
10		(12) GL22-049-REF	FGS, POS, 1	F583W		SAME POS AS 1	Sequence 1-15 Non-Int	20.0 Secs	
								[==>]	***[1]***
11		(13) GL22-087-REF	FGS, POS, 1	F583W		SAME POS AS 1	Sequence 1-15 Non-Int	20.0 Secs	
								[==>]	***[1]***
12		(11) GL22-024-REF	FGS, POS, 1	F583W		SAME POS AS 1	Sequence 1-15 Non-Int	20.0 Secs	
								[==>]	***[1]***
13		(10) GL22	FGS, POS, 1	F583W		SAME POS AS 1	Sequence 1-15 Non-Int	20.0 Secs	
								[==>]	***[1]***
14		(12) GL22-049-REF	FGS, POS, 1	F583W		SAME POS AS 1	Sequence 1-15 Non-Int	20.0 Secs	
								[==>]	***[1]***
15		(13) GL22-087-REF	FGS, POS, 1	F583W		SAME POS AS 1	Sequence 1-15 Non-Int	20.0 Secs	
								[==>]	***[1]***


Orbit 1
Server Version: 20050905
Orbit Structure
Exp. 2
Exp. 3
Exp. 4
Exp. 5
Exp. 6
Exp. 7
Exp. 8
Exp. 9
Exp. 10
Exp. 11
Exp. 12
Exp. 13
Exp. 14
Exp. 15
Home
Unused Visibility = 105
GS Acq
Setup
Exp. 1
Occultation
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
secs