11223 - The Key to Understanding RR Lyr Stars: WFPC2 Observations of a Unique LMC EB with a RR Lyr Component

Cycle: 16, 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	(1) OGLE052218.07-692827.4	WFPC2	3	25-Jun-2007 21:16:07.0	yes

3 Total Orbits Used

ABSTRACT

We are proposing HST/WFPC2 2550-10420A multi-band photometry of an important "unique" LMC eclipsing binary with an RR Lyr component. This binary is the only bona fide eclipsing binary (EB) with an RR Lyr component. Because of their constant mean luminosities (L ~ 45 Lsun; <Mv>

~ +0.5 mag) and easily recognizable light curves, RR Lyr variables have long served as the "cornerstone" of the Pop II distance scale in our galaxy and for Local Group galaxies. However, in spite of their critical importance to astronomy, there is a paucity of fundamental data available for RR Lyr stars. In fact, there are no direct measures of their most fundamental properties - such as Mass, Radius and Luminosity. The astrophysical and cosmological consequences of finding an RR Lyr star in an EB are considerable, because the masses and absolute radii of the stars of eclipsing binaries can be determined to within a few percent from time-tested analyses of their light and radial velocity curves. With accurate temperatures and ISM absorption values, determined from the proposed WFPC2 observations, it is possible to determine reliable stellar luminosities and distances. It is for these reasons that we propose WFPC2 observations of the recently discovered detached LMC eclipsing binary OGLE J052218.07-692827.4 (<V> ~18.6-mag; <B-V>0 ~+0.27; Porb = 8.9231-d); the RR Lyr primary component has a pulsation period of P(RR) = 0.564876-d. This important binary star is an integral part of our on-going multi-wavelength study of selected eclipsing binaries in nearby galaxies. Three HST/WFPC2 orbits are requested to determine complementary accurate Teff, log g and ISM absorption (A-lambda) for the component stars. These quantities will be combined with the fundamental stellar data being determined from our ground-based radial velocity and photometric observations. The combined observations will yield accurate stellar masses, radii, temperatures and luminosities, as well as a direct distance to the binary and LMC-Bar. This RR Lyr/EB thus offers the unprecedented opportunity to: (1) determine directly (and for the first time) the fundamental physical properties (M, R, L) of an RR Lyr star, (2) directly calibrate "in situ" the zero-point of the LMC RR Lyr - P - Mv - Z relation and (3) to derive an additional accurate distance to the Bar region of the LMC.

OBSERVING DESCRIPTION

In this study we are requesting WFPC2 multi-wavelength observations of the LMC RR Lyr/EB target. This object has existing light curves and is the focus of an ongoing radial velocity program with the Magellan 6.5-m telescope at Las Campanas, as well as continuing (and improved) OGLE II/III photometry. For this proposal, 3 HST orbits are requested (the same number of orbits originally proposed for with the ACS). We have used the APT (v16.0.2) in its Phase II mode to perform detailed simulations of the exposure times and orbit planning to optimize the resulting datasets. According to the HST orbital constraints and the declination of our target, typical maximum visibilities are 3300-s per orbit. However, there are several dates where the target is within the CVZ and has ~5700-s of visibility per orbit. It would be ideal to schedule the observations during one of these times to reduce the proposal to just 2 HST orbits. Our simulations indicate that only 3 HST orbits will be sufficient to achieve full spectral coverage (UV to near-IR) with the necessary S/N to fulfill the program?s scientific goals. Also, having these images at different wavelengths will be useful for

exploring the region close to the target for fainter companions that can not be resolved from the ground.

Our modeling simulations indicate that the use of multi-band photometry, as proposed here (rather than spectrophotometry) only slightly degrades the determinability of temperatures, log g and A? values. This is because the proposed photometry provides a dense sampling of the spectral energy distributions. We will not be able to accurately determine metal abundances ([Fe/H]) from the proposed photometry. However, metal abundance determinations will be made from the analysis of the groundbased spectroscopy secured with the Magellan telescope for radial velocity studies.

The target is relatively faint (mv ~ +18.6-mag) and has several faint stars nearby. However, we plan to use the HST/WFPC2 images to correct the ground-based photometry for possible contaminations from these fainter stars before modeling the light curves using a variant of the Wilson-Devinney Code. From previous observations, the coordinates of the
proposed target are known to a precision better than + 0.2 arcsec and no problems with target acquisition are expected. It should be noted that the use of WFPC2 instead of the originally proposed ACS filter photometry does not have any significant negative impact on the proposed science. In fact, WFPC2?s long history and use in the Hubble Deep Fields have made it a well-calibrated and well-understood instrument for photometry.

Visit

Proposal 11223, Visit 01, implementation Tue Jun 26 01:16:11 GMT 2007

Diagnostic Status: Warning

Scientific Instruments: WFPC2

Special Requirements: (none)

Diagnostics

(Visit 01) Warning: EXPOSURE TIME DECREASED FOR WFPC

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(Visit 01) Warning: EXPOSURE TIME DECREASED FOR WFPC

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	OGLE052218.07-692827.4	RA: 05 22 18.0700 (80.5752917d) Dec: -69 28 27.40 (-69.47428d) Equinox: J2000		V=18.5	Reference Frame: ICRS

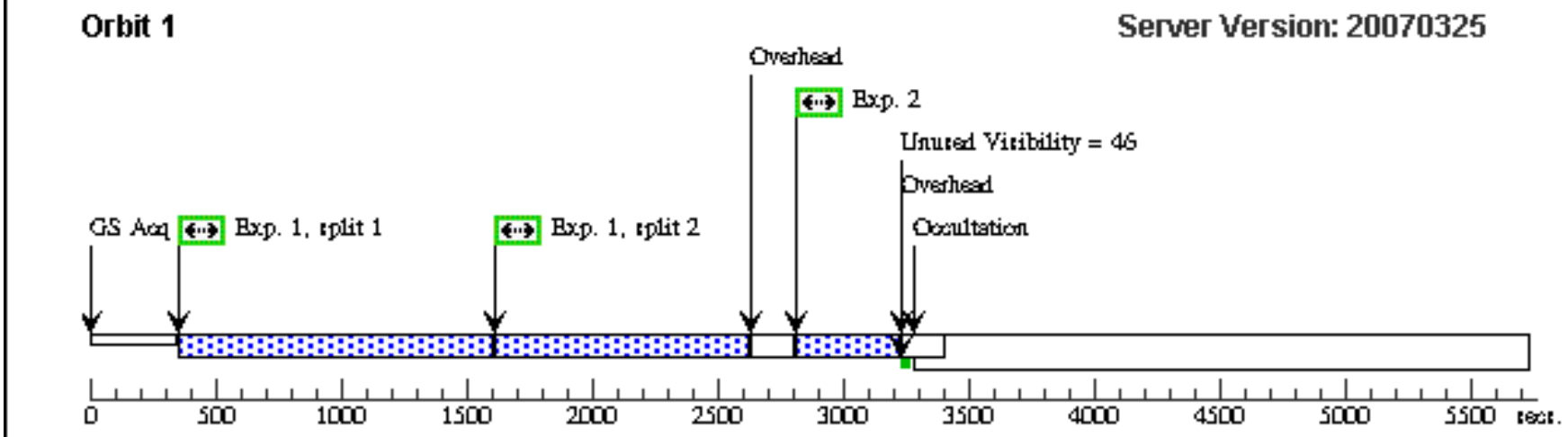
Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
1		(1) OGLE052218.07-692827.4	WFPC2, IMAGE, PC1	F255W	CR-SPLIT=DEF			2100.0 Secs *[==>(Split 1)]* *[==>(Split 2)]*	***[1]***
2		(1) OGLE052218.07-692827.4	WFPC2, IMAGE, PC1	F555W	CR-SPLIT=DEF			250.0 Secs *[==>]*	***[1]***
3		(1) OGLE052218.07-692827.4	WFPC2, IMAGE, PC1	F300W	CR-SPLIT=DEF			700.0 Secs *[==>(Split 1)]* *[==>(Split 2)]*	***[2]***
4		(1) OGLE052218.07-692827.4	WFPC2, IMAGE, PC1	F336W	CR-SPLIT=DEF			550.0 Secs *[==>]*	***[2]***
5		(1) OGLE052218.07-692827.4	WFPC2, IMAGE, PC1	F555W	CR-SPLIT=DEF			160.0 Secs *[==>]*	***[2]***
6		(1) OGLE052218.07-692827.4	WFPC2, IMAGE, PC1	F380W	CR-SPLIT=DEF			300.0 Secs *[==>]*	***[2]***
7		(1) OGLE052218.07-692827.4	WFPC2, IMAGE, PC1	F439W	CR-SPLIT=DEF			350.0 Secs *[==>]*	***[3]***
8		(1) OGLE052218.07-692827.4	WFPC2, IMAGE, PC1	F555W	CR-SPLIT=DEF			160.0 Secs *[==>]*	***[3]***
9		(1) OGLE052218.07-692827.4	WFPC2, IMAGE, PC1	F675W	CR-SPLIT=DEF			100.0 Secs *[==>]*	***[3]***

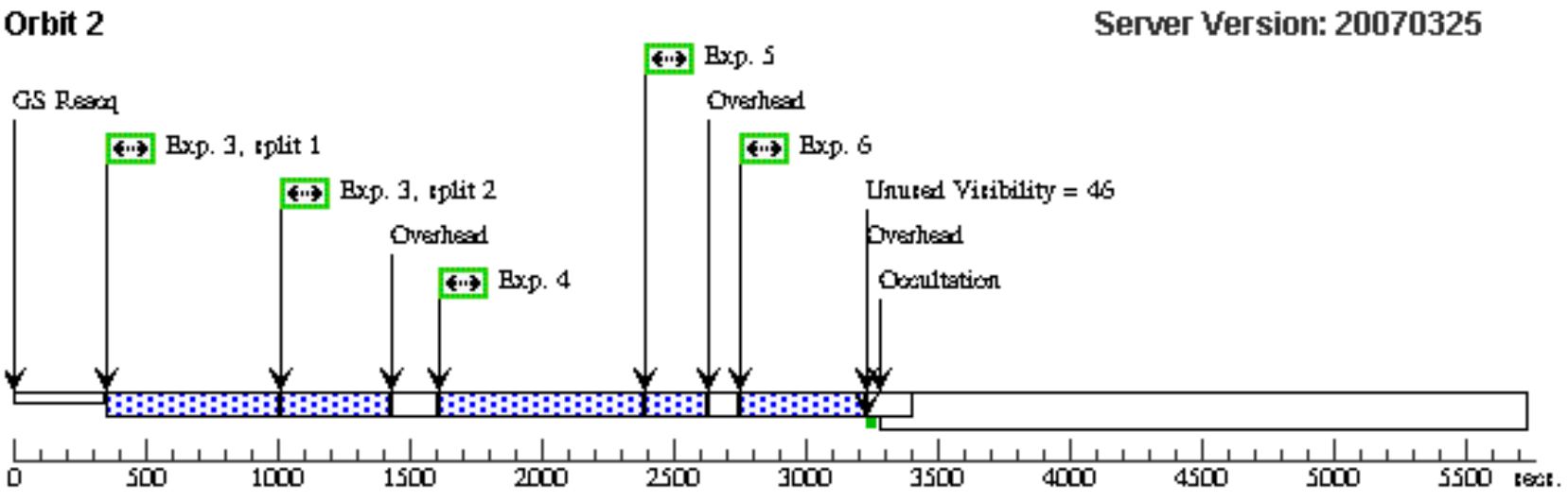
Exposures (continued)

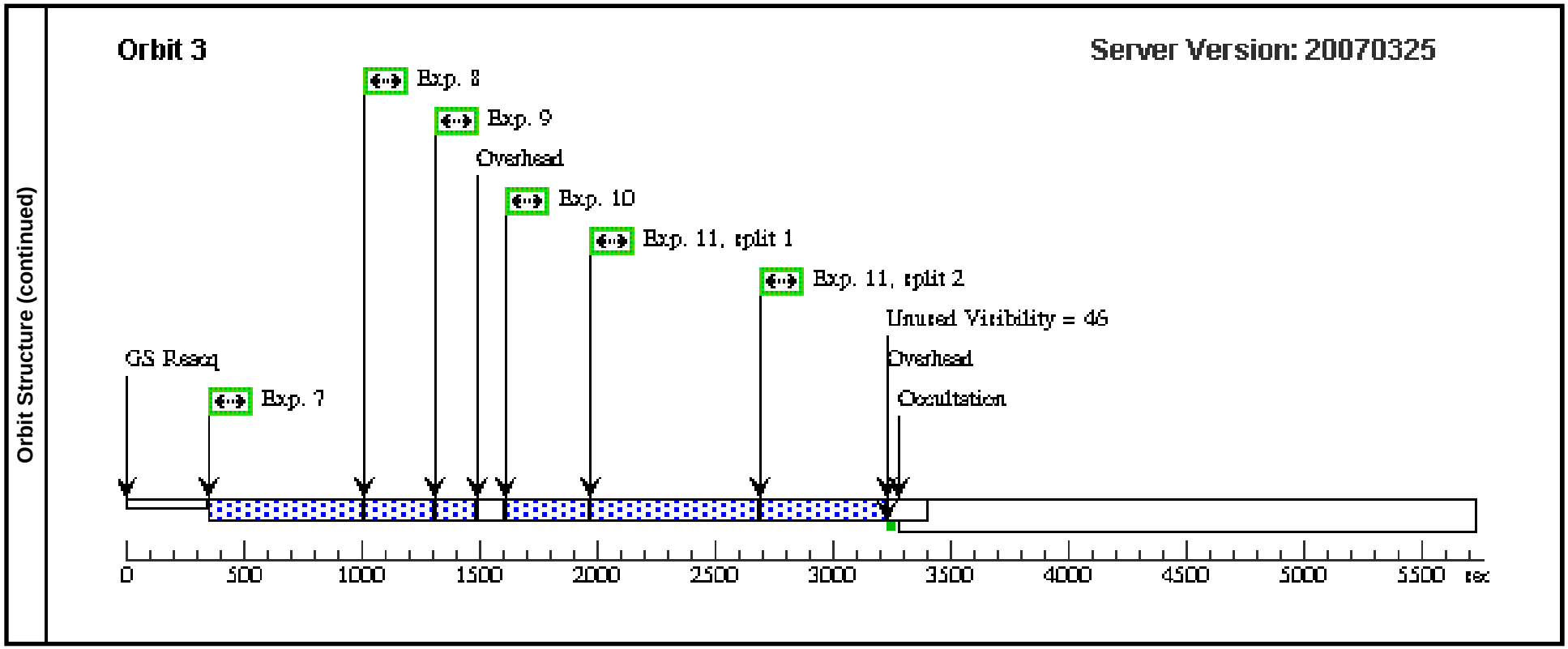
#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
10		(1) OGLE052218.07 -692827.4	WFPC2, IMAGE, PC1	F814W	CR-SPLIT=DEF			160.0 Secs	
								[==>]	***[3]***
11		(1) OGLE052218.07 -692827.4	WFPC2, IMAGE, PC1	F953N	CR-SPLIT=DEF			1100.0 Secs	
								[==>(Split 1)] *[==>(Split 2)]*	***[3]***

Orbit Structure



Orbit Structure (continued)




Orbit Structure (continued)
Orbit 3
Server Version: 20070325
Exp. 8
Exp. 9
Overhead
Exp. 10
Exp. 11, split 1
Exp. 11, split 2
Unused Visibility = 46
Overhead
Occultation
GS Reacq
Exp. 7
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec