15284 - Constraining the binary properties of 2M1938+4603 with irradiated stellar atmospheres

Cycle: 25, Proposal Category: GO

(UV Initiative)

(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) TYC-3556-3568-1 WAVE	STIS/CCD STIS/FUV-MAMA	1	16-Aug-2017 17:07:59.0	yes
02	(1) TYC-3556-3568-1 WAVE	STIS/CCD STIS/FUV-MAMA	1	16-Aug-2017 17:08:01.0	yes
03	(1) TYC-3556-3568-1 WAVE	STIS/CCD STIS/FUV-MAMA	1	16-Aug-2017 17:08:02.0	yes

3 Total Orbits Used

ABSTRACT

Hot subdwarf stars are the stripped cores of evolved 0.8-2 Msun stars with a mass of 0.5 Msun, likely formed in common-envelope evolution. About a dozen such stars are known to be orbited by faint low mass stars or brown dwarfs on periods of few hours. Their light curves are characterized by

eclipses and strong reflection effects due to the heated hemisphere of the cool companion. Hot subdwarfs are promising targets for asteroseismology, because some show multi-periodic oscillations, allowing to determine the stellar mass and internal structure. An ideal laboratory to determine the fundamental parameters would be a pulsating subdwarf in an eclipsing binary as it allows to combine the tools of binary and seismic analyses and provide a benchmark for both fields. Such a system has recently been found by the Kepler space mission: 2M1938+4603 hosts a pulsating hot subdwarf primary and a dM companion in a 181 min. orbit. The radial velocity curve of the primary has been measured, but no spectral features of the companion are accessible in the optical. By modelling the irridiated atmosphere we show that plenty of emission lines from the companion are detectable in the FUV. We expect this spectrum to be superimposed on the absorption line spectrum of the hot subdwarf. With phase resolved spectroscopy we shall identify FUV emission lines and measure the RV amplitude of the companion (~240km/s), the last piece missing in the puzzle. Our models of the companion's irradiated atmosphere will greatly improve the analysis of the accurate Kepler light curve. Our investigations have a high potential as 2M1938 is a benchmark object in the validation of binary evolution and seismic models.

OBSERVING DESCRIPTION

2M1938 is a short period eclipsing binary star with a pulsating hot subdwarf B type primary and a late type companion. The hot subdwarf irradiates the cool companion giving rise to the reflection effect in the light curve, as the hot irradiated hemisphere turns in and out of view due to the binary orbit. The irradiation cause temperature inversion in the upper atmosphere of the cool companion, which produce emission lines in our models and FUV synthetic spectra. We aim at detecting these emission features near the strongest metal resonance lines of the hot subdwarf, where the contrast is the most favorable to find the spectral contribution of the reflection effect.

The binary orbit is assumed to be circular and the rotation of the binary members is synchronized with the orbit. The projected rotation velocity of the sdB star is ~80 km/s, therefore the expected sharp emission lines superimposed on the rotationally broadened lines of the subdwarf primary shall be detectable by a differential analysis. During the planned, approximately 40 minutes observations before the maximum of the reflection effect, we expect the companion to show a ~240 km/s radial velocity variation, and a maximum radial velocity difference between the subdwarf and the companion to be around ~300 km/s. Near orbital phase 0.25 the radial velocity variation, hence the orbital smearing of the emission lines are the lowest, which further helps identifying emission lines from the companion.

The reflection effect is strongest near the secondary eclipse (orbital phase 0.5) and the radial velocity difference between the two components is maximum at orbital phase 0.25. Therefore our science observations need to be scheduled between orbital phase 0.24 and 0.46. We provide the binary ephemeris with zero-point (orbital phase = 0) HJD = 2455369.4217000927 and orbital peridod P = 0.125765251 days to schedule the observations. We made available a real-time binary ephemeris tool as well: http://stelweb.asu.cas.cz/~nemeth/cgi-bin/ephem_2M1938p.py

We propose the three orbit observing time to be conducted in three visits, each visit extends to one HST orbit. With this schedule we can cover the same binary orbital phase range multiple times and maximize the signal-to-noise ratio. We need TIME-TAG observations to be able to extract different binary orbital phase bins of the spectroscopic data and combine the data from the three visits. To account for a variable air glow and to maximize the length of science exposures we chose a buffer time of 135 seconds to avoid buffer overflow due to increased background levels towards Earth occultation. In order to further increase the length of science exposures we removed the auto WAVECAL observations from the beginning of the visits and added manual WAVECAL observations to the end of the visits, during occultation.
We chose to work with the 0.2x0.2 arcsec slit to maximize the signal-to-noise ratio and maximize the length of science observations by avoiding ACQ/PEAK slit positioning exposures.

Each of the three visits starts with a standard guide star acquisition. We inserted a CCD observation for target acquisition. According to the online STIC ETC the CCD detector and the F25ND3 filter provides a signal-to-noise >40 in 15 seconds for our target, including the E(B-V)=0.14 mag reddening (upper limit) towards J1938. Following acquisition and instrument configurations we need a continuous TIME-TAG STIS/MAMA-FUV observation with the E140M grating until the end of the visibility period. At the end of the visit we inserted a manual WAVECAL observation during occultation.

Visit

Proposal 15284, Visit 01, implementation Wed Aug 16 21:08:03 GMT 2017

Diagnostic Status: No Diagnostics

Scientific Instruments: STIS/CCD, STIS/FUV-MAMA

Special Requirements: SCHED 30%; Period 0.125765251 D AND ZERO-PHASE HJD2455369.4217000927

Fixed Targets

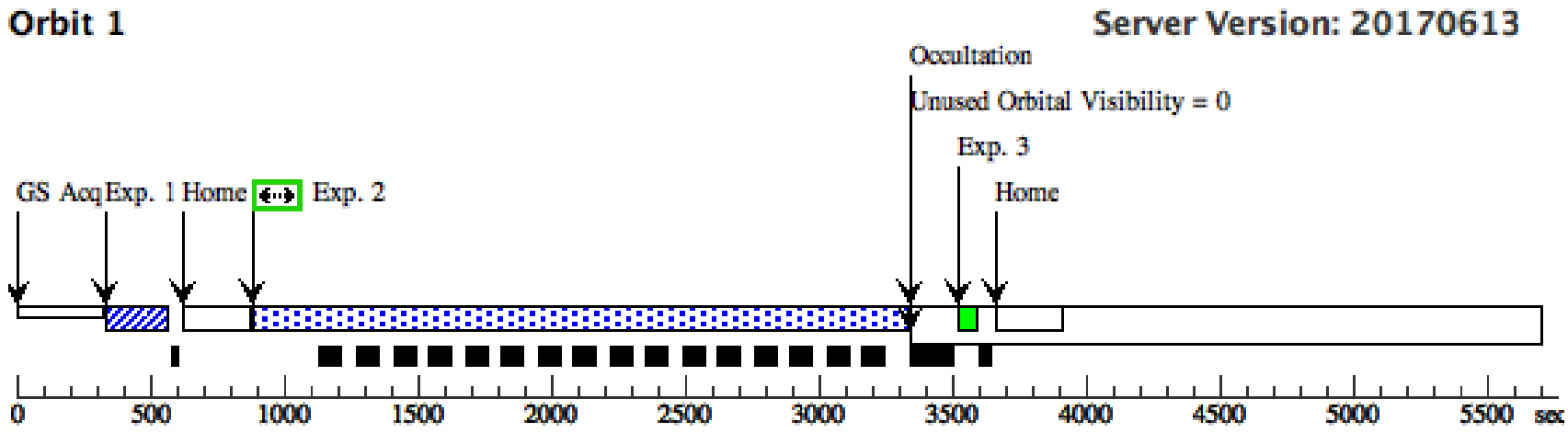
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	TYC-3556-3568-1	RA: 19 38 32.6120 (294.6358833d) Dec: +46 03 59.15 (46.06643d) Equinox: J2000	Proper Motion RA: 2.8 mas/yr Proper Motion Dec: -2.7 mas/yr Epoch of Position: 2000	V=12.69+/-0.05	Reference Frame: ICRS

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Extended=NO

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	Acq (STIS.ta.1018144)	(1) TYC-3556-3568-1	STIS/CCD, ACQ, F28X50LP	MIRROR	ACQTYPE=POINT			2 Secs (2 Secs) *[==>]*	*[1]*
2	Sci (STIS.sp.1011540)	(1) TYC-3556-3568-1	STIS/FUV-MAMA, TIME-TAG, 0.2X0.2	E140M 1425 A	BUFFER-TIME=135; WAVECAL=NO	PHASE 0.24 TO 0.46		2320 Secs (2310 Secs) *[==>2310.0 Secs]*	*[1]*
3	Wav	WAVE	STIS/FUV-MAMA, ACCUM, 0.2X0.2	E140M 1425 A				*[==>]*	*[1]*

Orbit Structure



Visit

Proposal 15284, Visit 02, implementation Wed Aug 16 21:08:03 GMT 2017

Diagnostic Status: No Diagnostics

Scientific Instruments: STIS/CCD, STIS/FUV-MAMA

Special Requirements: SCHED 30%; Period 0.125765251 D AND ZERO-PHASE HJD2455369.4217000927

Fixed Targets

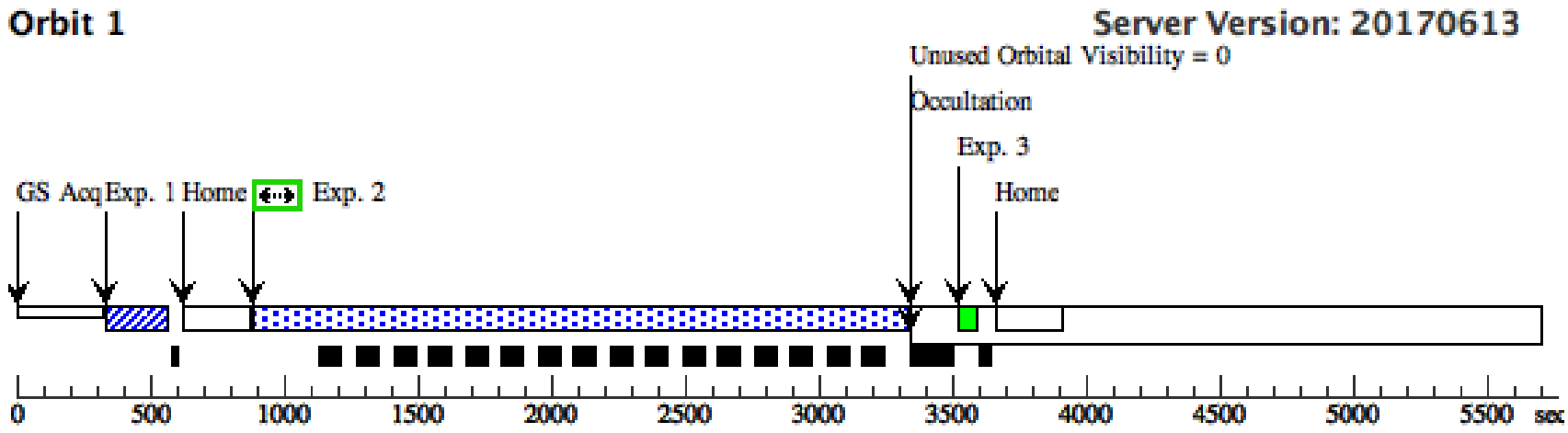
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	TYC-3556-3568-1	RA: 19 38 32.6120 (294.6358833d) Dec: +46 03 59.15 (46.06643d) Equinox: J2000	Proper Motion RA: 2.8 mas/yr Proper Motion Dec: -2.7 mas/yr Epoch of Position: 2000	V=12.69+/-0.05	Reference Frame: ICRS

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Extended=NO

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	Acq (STIS.ta.1018144)	(1) TYC-3556-3568-1	STIS/CCD, ACQ, F28X50LP	MIRROR	ACQTYPE=POINT			2 Secs (2 Secs) *[==>]*	*[1]*
2	Sci (STIS.sp.1011540)	(1) TYC-3556-3568-1	STIS/FUV-MAMA, TIME-TAG, 0.2X0.2	E140M 1425 A	BUFFER-TIME=135; WAVECAL=NO	PHASE 0.24 TO 0.46		2320 Secs (2310 Secs) *[==>2310.0 Secs]*	*[1]*
3	Wav	WAVE	STIS/FUV-MAMA, ACCUM, 0.2X0.2	E140M 1425 A				*[==>]*	*[1]*

Orbit Structure



Visit

Proposal 15284, Visit 03, implementation Wed Aug 16 21:08:03 GMT 2017

Diagnostic Status: No Diagnostics

Scientific Instruments: STIS/CCD, STIS/FUV-MAMA

Special Requirements: SCHED 30%; Period 0.125765251 D AND ZERO-PHASE HJD2455369.4217000927

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	TYC-3556-3568-1	RA: 19 38 32.6120 (294.6358833d) Dec: +46 03 59.15 (46.06643d) Equinox: J2000	Proper Motion RA: 2.8 mas/yr Proper Motion Dec: -2.7 mas/yr Epoch of Position: 2000	V=12.69+/-0.05	Reference Frame: ICRS

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Extended=NO

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	Acq (STIS.ta.1018144)	(1) TYC-3556-3568-1	STIS/CCD, ACQ, F28X50LP	MIRROR	ACQTYPE=POINT			2 Secs (2 Secs) *[==>]*	*[1]*
2	Sci (STIS.sp.1011540)	(1) TYC-3556-3568-1	STIS/FUV-MAMA, TIME-TAG, 0.2X0.2	E140M 1425 A	BUFFER-TIME=135; WAVECAL=NO	PHASE 0.24 TO 0.46		2320 Secs (2310 Secs) *[==>2310.0 Secs]*	*[1]*
3	Wav	WAVE	STIS/FUV-MAMA, ACCUM, 0.2X0.2	E140M 1425 A				*[==>]*	*[1]*

Orbit Structure