# 17609 - A UV spectroscopic View of the 2024 outburst of AT2020afhd: A Unique Opportunity to Test the Reprocessing model of Tidal Disruption Event

Cycle: 31, Proposal Category: GO/DD

(Availability Mode: SUPPORTED)

**INVESTIGATORS**



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|---|---|
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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) AT2020AFHD | STIS/CCD<br>STIS/NUV-MAMA | 1 | 16-Feb-2024 08:00:16.0 | yes |
| 02 | (1) AT2020AFHD | STIS/CCD<br>STIS/FUV-MAMA | 1 | 16-Feb-2024 08:00:17.0 | yes |

2 Total Orbits Used

**ABSTRACT**

The 2024 optical outburst of AT2020afhd is a newly identified TDE at a redshift of 0.024 and is currently approaching its peak. In addition to an obvious bump in the optical rising light curves, AT2020afhd exhibits an unusually bright soft X-ray emission (~10^43 erg/s), which has decreased by a factor of ~10 within only one week, making it the second TDE with similar behaviors after AT2022dsb. This behavior can be ideally explained in the reprocessing model, in which the high-speed outflow launched at the high accretion rate stage serves as the obscuring material. Therefore,

AT2020afhd offers an extremely rare opportunity to explore TDE physics in real time. This target is UV bright and is currently in the HST visibility window (ends on March 4) and the next window does not begin until December 2024. We propose to conduct timely STIS UV spectroscopic observations on the intriguing system with a small amount of time (2 orbits). Our immediate objectives are twofold: 1) to detect broad blueshifted UV absorption lines with which we can check whether the rapid X-ray fading is caused by the obscuration of the high-speed outflow (reprocessing layer); 2) to detect potential characteristic UV emission lines of TDEs to further confirm the TDE nature given the existence of AGN activity (eROSITA DR1 detection) prior to the outburst. We anticipate that the proposed observation can significantly contribute to understanding the optical emission origin of TDEs in combination with other follow-up observations.

**OBSERVING DESCRIPTION**

We request a single epoch (that could be split into two visits, if necessary) of UV spectroscopy of a TDE, the 2024 outburst of AT2020afhd, over the wavelength range from 1200-3000A. HST, with its sensitive UV spectrographs and exquisite angular resolution, is the only facility that can conduct such observations. A slit width of 0.2" is preferred to cover the galaxy's nucleus and minimize the starlight contamination. The magnitudes in UVW1 (central wavelength 2688.46A) and UVW2 (2140.26A) bands measured from the latest Swift/UVOT observations on Feb 13 are 16.16+/-0.04 and 16.23+/-0.03, respectively, which should be almost their peak magnitudes based on its optical light curves. We expect that the TDE is going to decline soon and could be 0.5-1 mag fainter after a couple of weeks when the observations are conducted. Thus we try to estimate the resulted signal to noise ratio (SNR) assuming an AB magnitude of 17. The calculations were performed with the Exposure Time Calculator (ETC) of HST/STIS. We assume a blackbody spectrum with temperature of 20,000K, which is a typical value for TDE, and an AB magnitude of 17 in the UVW1 band. To reliably detect a possible C IV absorption line, a continuum signal-to-noise ratio (SNR) of 10 at 1586A is needed. We assume that our targets are visible for 55 minutes each orbit. After including overheads for guide-star acquisition (6 min), target acquisition (~8 min for an extended source, no peak-up required for 0.2" slit width), and wavelength calibration (4 min per orbit), we find that we can obtain 37 min of effective exposure. We request to allocate one-orbit time for G230L and G140L, respectively. That will result in 2100 second exposure time for each grism and meet with our scientific goal. According to the exposure time calculator by inputting our assumed SED, we would expect a SNR per resolution element >=10 for the range from 1650-3100 A. To summarize, we request a single epoch of STIS spectroscopy of AT2020afhd, for a total of 2 orbits (1 FUV + 1 NUV).

## Visit

**Proposal 17609, Visit 01, implementation** Fri Feb 16 13:00:17 GMT 2024

**Diagnostic Status: No Diagnostics**

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

Special Requirements: BEFORE 04-MAR-2024:00:00:00

## Patterns

| # | Primary Pattern | | Secondary Pattern | Exposures |
|---|---|---|---|---|
| (1) | Pattern Type=STIS-ALONG-SLIT | Coordinate Frame=POS-TARG | | (2) |
| | Purpose=DITHER | Pattern Orientation=90.0 | | |
| | Number Of Points=3 | Angle Between Sides= | | |
| | Point Spacing=0.4165 | Center Pattern=false | | |
| | Line Spacing= | | | |

## Fixed Targets

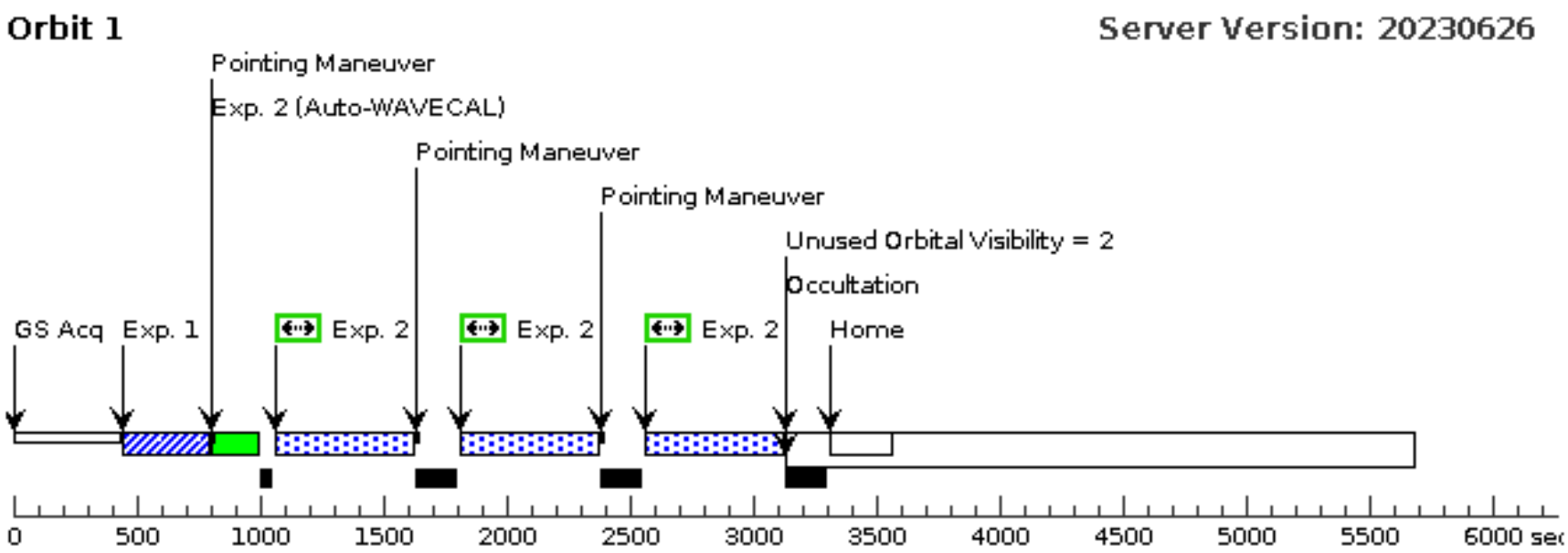
| # | Name | Target Coordinates | Targ. Coord. Corrections | Fluxes | Miscellaneous |
|---|---|---|---|---|---|
| (1) | AT2020AFHD | RA: 03 13 35.6670 (48.3986125d)<br>Dec: -02 09 6.21 (-2.15172d)<br>Equinox: J2000 | | V=16.8+/-0.2 | Reference Frame: ICRS |

*Comments:*
*Category=GALAXY*
*Description=[ACCRETION DISK, NUCLEUS, SEYFERT]*

## Exposures

| # | Label (ETC Run) | Target | Config,Mode,Aperture | Spectral Els. | Opt. Params. | Special Reqs. | Groups | Exp. Time (Total)/[Actual Dur.] | Orbit |
|---|---|---|---|---|---|---|---|---|---|
| 1 | (1902351) | (1) AT2020AFHD | STIS/CCD, ACQ, F28X50LP | MIRROR | | | | 30 Secs (30 Secs) | |
| | | | | | | | | *[==>]* | ***[1]*** |
| 2 | (1902345) | (1) AT2020AFHD | STIS/NUV-MAMA, TIME-TAG, 52X0.2 | G230L 2376 A | BUFFER-TIME=676 | | Pattern 1, Exps 2-2 in Visit 01 (1) | 544 Secs (1632 Secs) | |
| | | | | | | | | *[==>(Pattern 1)]* | ***[1]*** |
| | | | | | | | | *[==>(Pattern 2)]* | |
| | | | | | | | | *[==>(Pattern 3)]* | |

Orbit Structure



## Visit

**Proposal 17609, Visit 02, implementation** Fri Feb 16 13:00:18 GMT 2024

**Diagnostic Status: No Diagnostics**

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

Special Requirements: BEFORE 04-MAR-2024:00:00:00

## Patterns

| # | Primary Pattern | | Secondary Pattern | Exposures |
|---|---|---|---|---|
| (1) | Pattern Type=STIS-ALONG-SLIT | Coordinate Frame=POS-TARG | | (2) |
| | Purpose=DITHER | Pattern Orientation=90.0 | | |
| | Number Of Points=3 | Angle Between Sides= | | |
| | Point Spacing=0.4165 | Center Pattern=false | | |
| | Line Spacing= | | | |

## Fixed Targets

| # | Name | Target Coordinates | Targ. Coord. Corrections | Fluxes | Miscellaneous |
|---|---|---|---|---|---|
| (1) | AT2020AFHD | RA: 03 13 35.6670 (48.3986125d)<br>Dec: -02 09 6.21 (-2.15172d)<br>Equinox: J2000 | | V=16.8+/-0.2 | Reference Frame: ICRS |

*Comments:*
*Category=GALAXY*
*Description=[ACCRETION DISK, NUCLEUS, SEYFERT]*

## Exposures

| # | Label (ETC Run) | Target | Config,Mode,Aperture | Spectral Els. | Opt. Params. | Special Reqs. | Groups | Exp. Time (Total)/[Actual Dur.] | Orbit |
|---|---|---|---|---|---|---|---|---|---|
| 1 | (1902351) | (1) AT2020AFHD | STIS/CCD, ACQ, F28X50LP | MIRROR | | | | 30 Secs (30 Secs) | |
| | | | | | | | | *[==>]* | ***[1]*** |
| 2 | (1902348) | (1) AT2020AFHD | STIS/FUV-MAMA, TIME-TAG, 52X0.2 | G140L 1425 A | BUFFER-TIME=676 | | Pattern 1, Exps 2-2 in Visit 02 (1) | 540 Secs (1620 Secs) | |
| | | | | | | | | *[==>(Pattern 1)]* | ***[1]*** |
| | | | | | | | | *[==>(Pattern 2)]* | |
| | | | | | | | | *[==>(Pattern 3)]* | |

Orbit Structure