User Guide for the Goodman Acquisition Camera (GACAM)
Version 2.0. César Briceño, Dec 15, 2015
Updated Jan 18, 2024, César Briceño

The need for faster target acquisition for relatively bright targets (**V≤19**) in the Goodman High Throughput Spectrograph (HTS) led to the development at CTIO of a slit-viewing acquisition camera, hereafter GACAM (Tokovinin 2015: *Goodman Acquisition Camera Instructions*, July 14, 2015). GACAM is located inside the spectrograph. Its deployable arm places a diagonal mirror between the slit and the collimator. The image is captured by a Prosilica GigE camera of 659x493 (Horizontal xVertical) pixel format, with a scale 0.165"/pixel and **field of view of 1.82' x 1.36'**. The software was developed by R. Cantarruti. GACAM was designed to be simple to use and unobtrusive to the spectrograph. An added advantage of the GACAM is that all settings in the Goodman GUI can now stay fixed. In particular, there is no need to switch form imaging to spectroscopic mode (i.e., grating and camera stay at fixed position), change the Region of Interest (ROI), readout mode, nor any other option in the spectrograph GUI other than exposure time, file name, and of course, withdrawing/replacing the slit mask during target acquisition.

 However, if you find you cannot use GACAM to center your target efficiently, maybe its just too faint, and /or the sky too bright, in which case you should be using the standard pre-imaging acquisition mode with Goodman. Just move the camera arm out of the way (see II.1), put Goodman in imaging mode and you are set.

I) Start the camera and Goodman HTS electronics:

1. During the afternoon, the day crew or Telescope Operator will turn ON the Goodman GACAM power in the Remote Power Control Iboot web application.
2. Log in into Goodman, Home Systems (see the Goodman User Startup Guide at: http://www.ctio.noao.edu/soar/content/goodman-user-startupshutdown-guide)
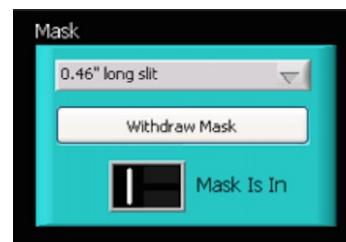3. Select the slit you will work with.

Figure 1: Goodman Slit Mask selection window

II) Access the GACAM GUI (Observer AND Telescope Operator)

1. To access the GACAM GUI (Fig.2), vnc to: 1**39.229.15.168:1** and type the password provided by your Goodman Support Scientist or the Telescope Operator. Double-click on the icon on the left as shown in Figure 2. The white window will show the camera ID 02-2110A-07072 if GACAM is powered and the connection to the Prosilica camera is established (Fig. 3, left).
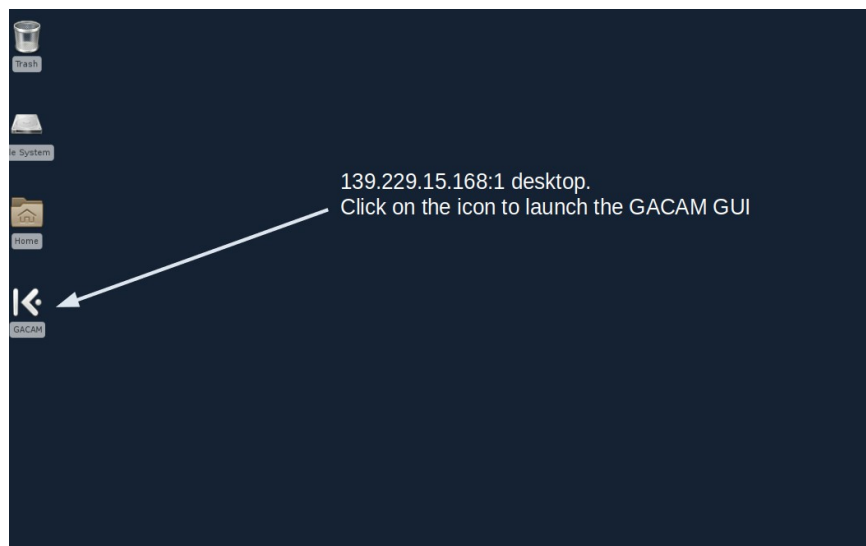

Figure 2: The GACAM computer desktop after launching the VNC connection. Click on the GACAM icon to start the camera software.

2. Then click on the "eye" icon to open the **View** window (Fig.3, left). Three menus on top of the View window provide: 1) control of the camera arm and bring up the offsets window (`Control`), 2) Camera Exposure window (`Exposure`), and 3) display scaling parameters window (`Scale`). The arm status is shown in the lower right corner (Fig. 3, right). A magnified image of the region inside the cyan Slit-Box is shown in the upper left corner of the View window (Fig. 4).
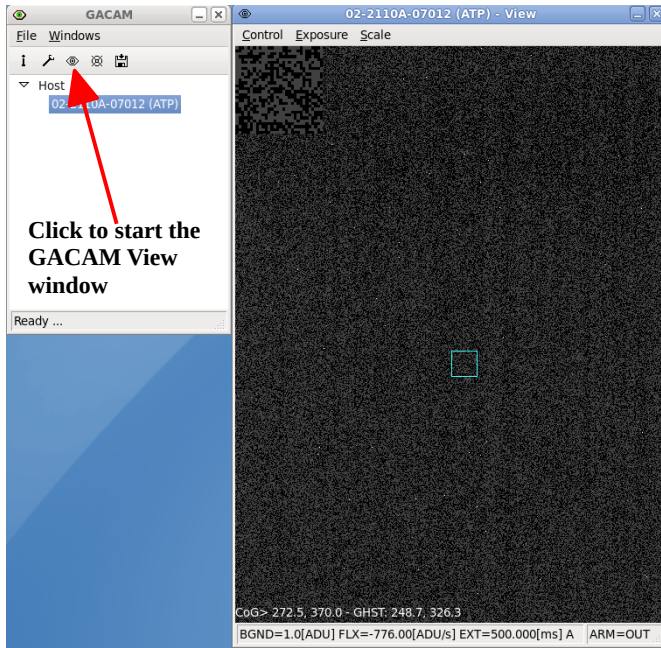

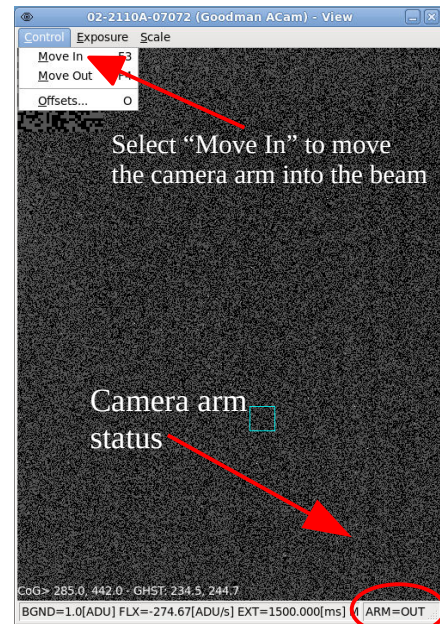*Figure 3.* **Left:** *ACAM GUI with camera live display window open*

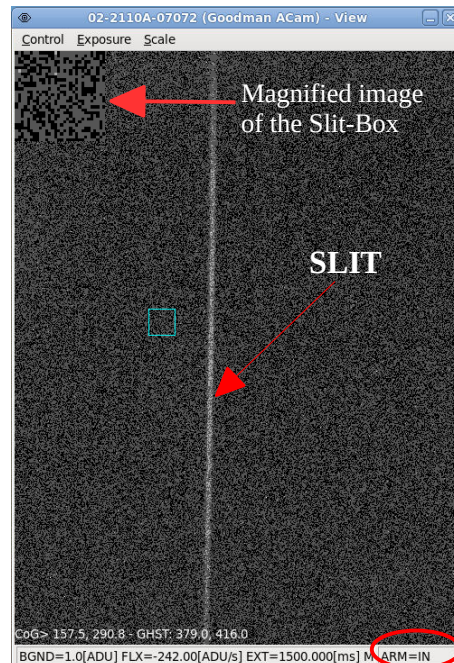*Figure 3.* **Right:** *The Control menu for moving the camera ARM IN/OUT of the beam.*

Figure 4: ACAM image of the slit on a bright Moon night.

3. Once you click on the **Move IN** option of the `Control` menu, the camera arm will move into the spectrograph beam and you will see the slit as shown in Figure 4. This movement is fast (~4s). On a Moonless night it migh be difficult to see the slit with the default 500ms exposure. Increase the exposure to something like 5s (5000 ms).

III) **Center the ACAM crosshair on the slit.** This is a task that is best done in the afternoon, maybe after completing calibrations. Otherwise, just use the sky background and skip step 1.

1. Start by asking the Telescope Operator to put the comparison mirror IN, and turn on the Quartz lamp (30% is ok). Otherwise, just use the sky background.

2. Make sure the slit is IN (Fig.1) and move the camera arm to the IN position (Fig.3 right and 4).

3. Right click on anywhere on the display window to bring up the pop-up menu. Select the "Show Cross-Hair" option (Fig. 5). Now unselect the "Lock Cross-Hair" option and left click with the mouse in the exact position you want your object to fall on the slit. The crosshair will show up on that position (Fig. 5, right). The crosshair coordinates are shown in the upper left corner of the GACAM display window (Fig. 6, left), first in GACAM pixels (0.165 arcsec/pixel), and in Goodman (GHTS) pixels (0.15 arcsec/pixel). If you are happy with that position, right click again and select the "Lock Cross-Hair" option in the pop-up menu. *The crosshair will now stay at your selected location and will define the slit position.* You can verify this by moving the slit mask out of the beam (you could now take a moment to look at your target field and check that it is correct, see IV below), and then back in, using the Slit Mask control box in the Goodman GUI (Fig.1). Sometimes the slit will not position exactly in the same place the first time it comes back in. Adjust the crosshair position (unlock/lock) and repeat the slit in/out movement if necessary. Moving the slit mask in or out takes ~15s.
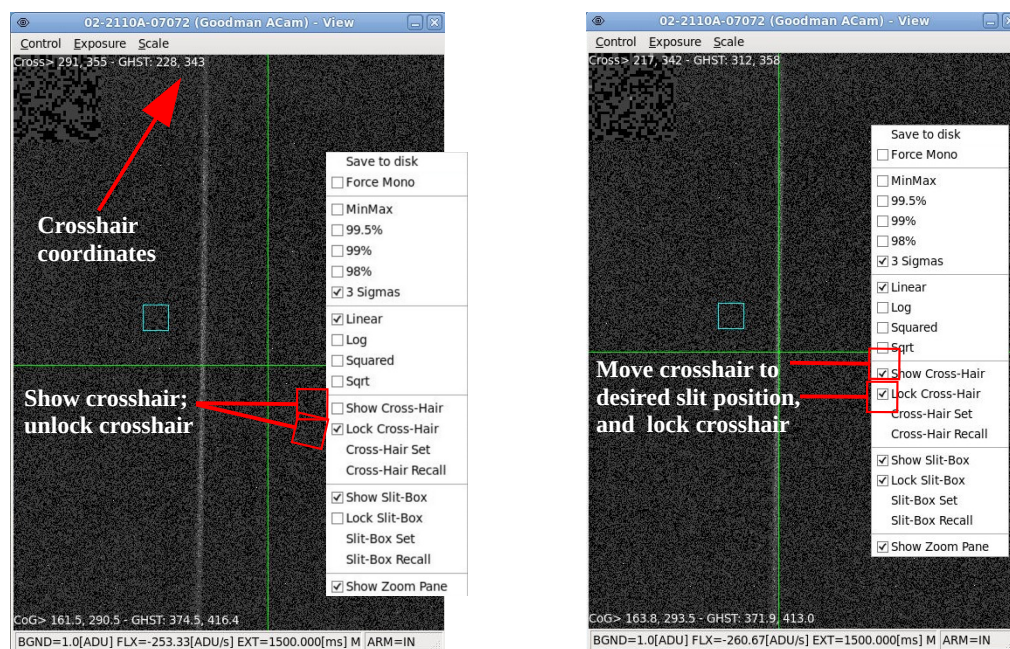

*Figure 5. **Left:** GACAM Crosshair. **Right:** Make a right click anywhere in the image to bring the pop-up menu. Unlocking and then left-clicking will place the crosshair at the mouse position.*

<u>IMPORTANT NOTE:</u> The slit position on the GACAM detector depends on the rotator angle, because there is some flexure in the GACAM arm. So, it cannot be set once and for all, but should be verified each time at a new target position. The full peak-to-peak flexure is ~10 pixels, large enough to spoil acquisition if not accounted for.

IV) **Acquire Target.**

1. Now that you have the slit position defined with the crosshair, bring up the pop-up menu in GACAM and unselect the "Lock Slit-box" option (Fig. 6, left). Move the slit mask out of the beam in the Goodman Slit Mask control box (Fig. 1). You will now see your target field as shown in Figure 6, center. Remember that the GACAM FOV is 1.4 arcmin wide x 1.8 arcmin high. For a position angle (PA) = 0 deg, the orientation is North up and East to the left, other orientations are as shown here:

PA=0º   N

E

E   PA=90º

N

E   PA=180º

N

N   PA=270º

E
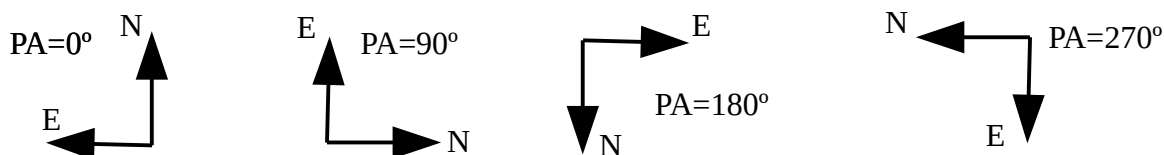
Clicking on your target will place the blue box on it as shown in Figure 7, right; as opposed to the crosshair, which will be at the exact mouse position, the cyan Slit-Box uses a centroiding algorithm to determine the position of the target. The center coordinates are shown in the lower left corner of the GACAM viewing window (Fig. 8), first in GACAM coordinates, then in Goodman coordinates.
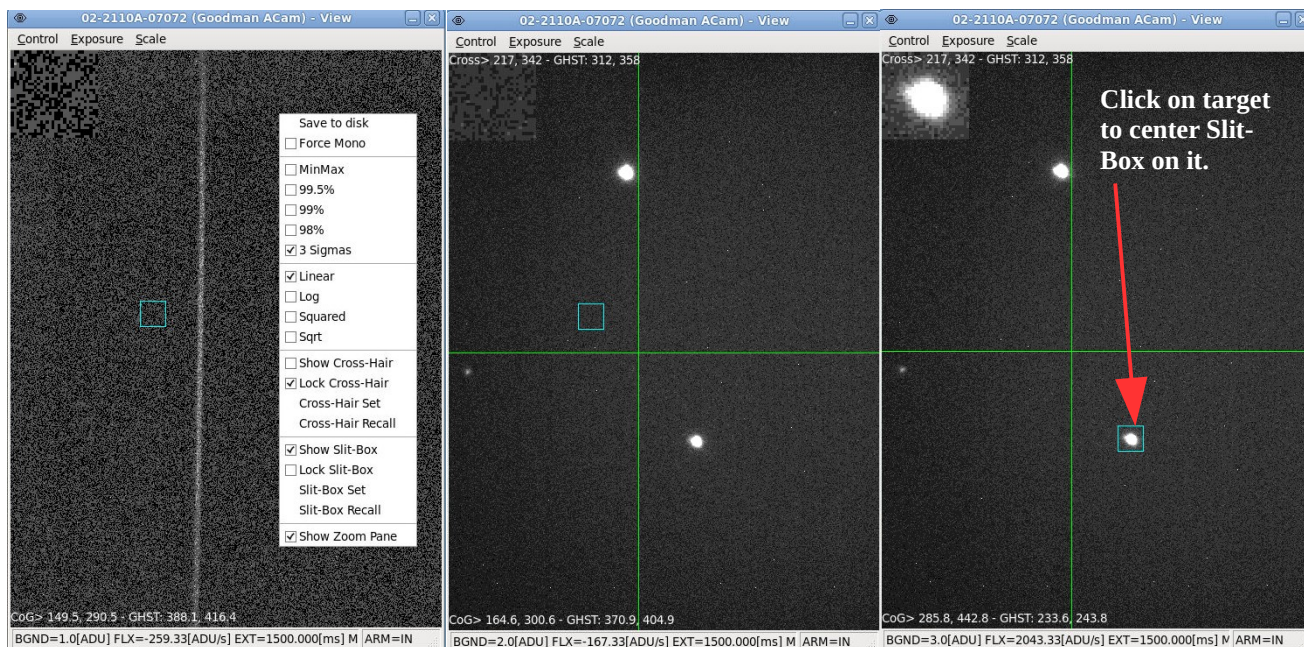

Figure 6: ***Left:*** *Bring up pop-up menu and select unlock Slit-Box.* ***Center:*** *remove slit mask to reveal target field.* ***Right:*** *click on target to center the cyan box on it. The box will center on the target using a centroiding algorithm.*
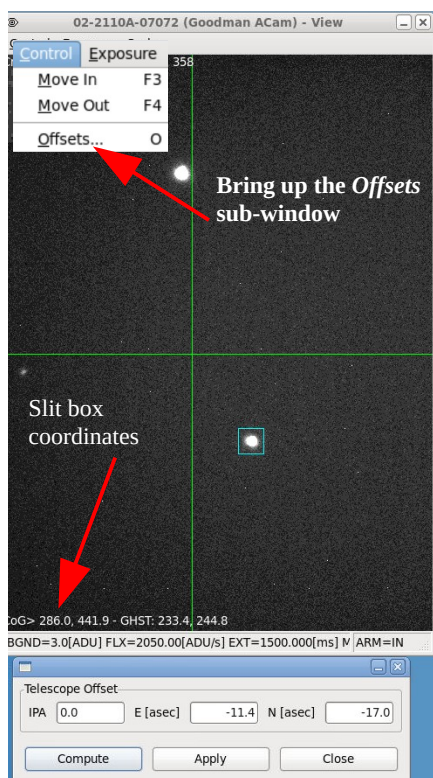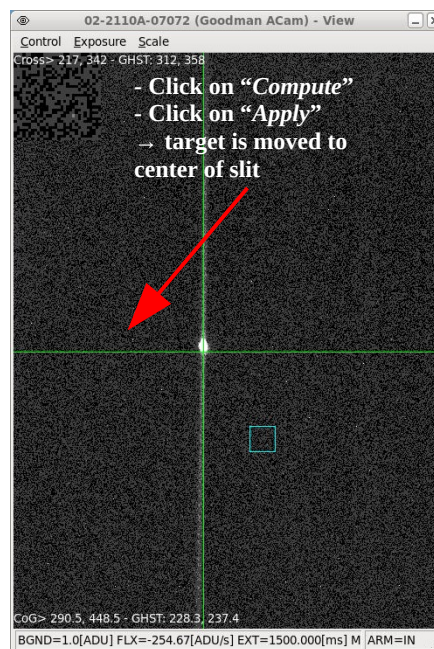
Figure 7. **Left:** *Offsets window*

Figure 7. **Right:** *Target on slit*

2. Now bring up the `Control` menu, and select the **Offsets** option (Fig. 7, left). You will see the `Offsets` sub-window as shown. Click on the `Compute` button. The fields will display the Instrument Position Angle (IPA), and the calculated offsets (in arcsec) in the E-W and N-S directions, between the current (locked) position of the crosshair (which is the reference) and the center of the cyan Slit-box. Click on the `Apply` button to send these offsets to the telescope Control System (TCS). Advise the Telescope Operator so he keeps track of the guide star when the offset is applied. You will see the target move and end up centered on the crosshair, as shown in Figure 7, right. You can more easily double check your object is correctly centered on the slit by removing the crosshair, as shown in Figure 8 (unselect the `Show Cross-Hair` option in the pop-up menu).

NOTE FOR TELESCOPE OPERATORS: if the `GFollow` switch has been activated in the TCS GUI, the guide star will follow the offset applied from GACAM.

You can fine tune the centering of your target on the slit by applying directly small offsets in the `Offsets` window (Figure 7, left). E.g., apply a negative offset to move West or South if PA=0. Another option is using the Goodman GUI offset box. With GACAM you will see the target move in real time.

The centering procedure described here is best suited for point sources, which may not be your case. **If you have an extended/fuzzy target, you can simply swap and use the Slit-Box to define the slit position, and lock it in place**. Then unlock and use the crosshair to define your desired target position (no centroiding algorithm). Then click on `Compute` in the **Offsets** window to calculate the offset. Now, **change the signs of the offset in both E and N boxes,** then click on the `Apply` button to execute the offset. Your target should move to the center of the Slit-Box, i.e., in the slit.

Finally, if needed you can save a GACAM image as a FITS file. Just select the **"Save to disk"** option in the pop-up menu (Fig.9).
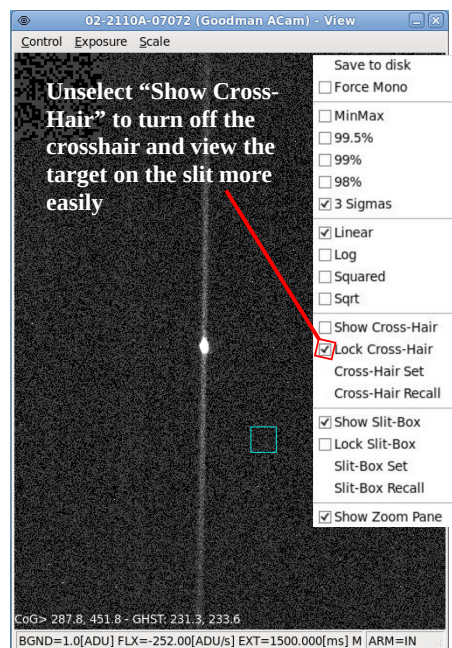

Figure 8: Target centered on the slit.

V) Adjusting the Exposure time and the display scale.

Depending on the target and sky brightness you will probably need to adjust the exposure time and display scale. To that effect, select among the various display scale options in the second and third blocks of the pop-up menu (Fig.9) to experiment what choice is best for your particular conditions. Additionally, you can manually set the minimum and maximum display values, by using the **Scale** window in the `Scale` menu (Fig.10).

You can also change the exposure time of GACAM using the `Exposure` sub-window shown in Figure 11. The default exposure is 500 milliseconds. To change it, select **Manual**, and type the desired exposure time. Note that this will also be your refresh time in the real-time display. Other options are **Auto** or **Force AutoMax**.
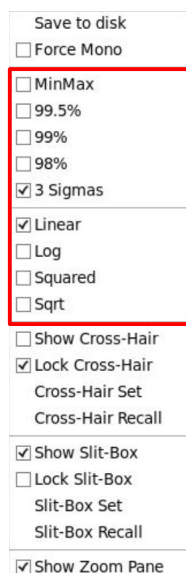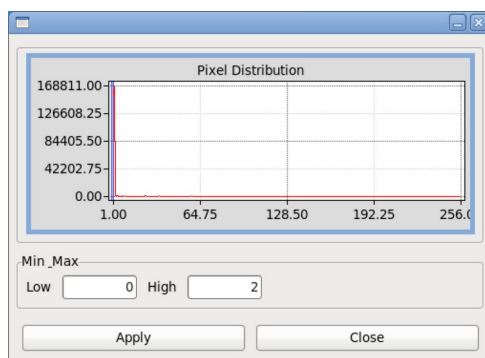

Figure 9: Display options in the pop-up menu

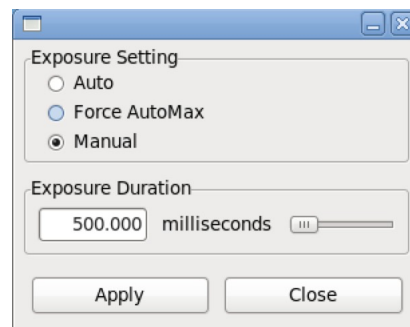*Figure 10: Minimum and maximum display values scaling sub-window (in **Scale** menu).*

*Figure 11: GACAM Exposure sub-window (in **Exposure** Menu)*

Appendix: Direct and through-slit images obtained with GACAM of various stars under clear skies with Full Moon, showing the approximate range of object brightness that can be acquired, for the default 500ms (0.5s) exposure. We have used exposure times of up to 30s for really faint targets (V~19). Results will, of course, vary for non-point sources like galaxies and nebula, and with different sky conditions. In all cases the 1.0" longslit was used.
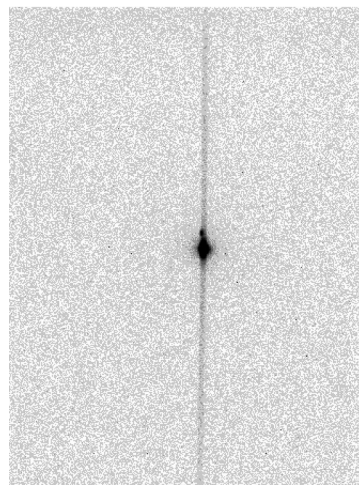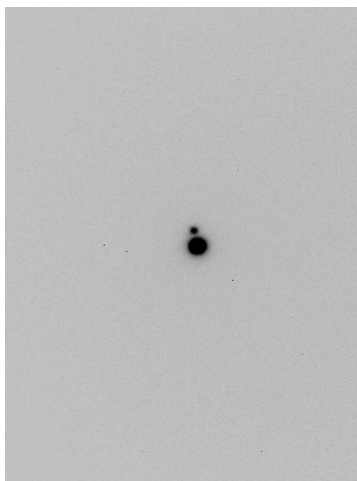
Figure A-1.

V=10.32 star CD-40 14389
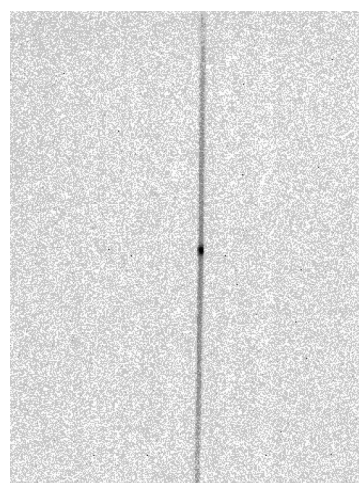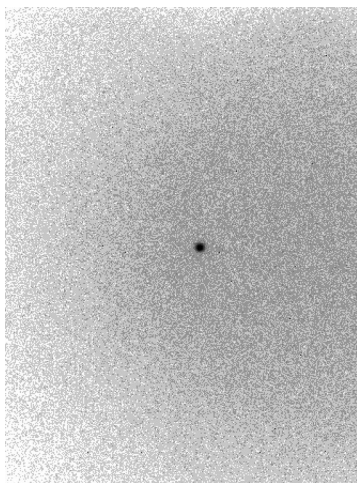
Figure A-2.

V=15.93 star
2MASS J21280452-4012597

Figure A-3.

V=17.7 star (white dwarf)
WDJ2234-408