

# CCD Imaging and Processing

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CFAS Star Party 2002

# CCD Imaging and Processing

- ▶ The camera
- ▶ Matching scope with camera
- ▶ Taking the image
- ▶ Processing the image
- ▶ Final results

# The Camera

- **Choosing the camera**
  - ▶ **Many different options to start imaging with**
    - ◀ **Digital camera - easiest way to start**
      - Nikon CP995
      - Olympus C-series
      - Full digital SLR
    - ◀ **Webcam - excellent for planets (check QCUIAG)**
      - True CCD version (not CMOS based)
        - » Philips Toucam Pro, Vesta Pro
        - » Older Logitech/Connectix B&W Quickcam
    - ◀ **Video camera - I.e. StellaCam - semi-deepsky capable**
    - ◀ **True CCD camera for astro-imaging**

# The Camera

- True CCD camera
  - ▶ Several major CCD camera vendors
    - ◀ SBIG - probably the largest and most recognizable
    - ◀ Apogee - high end cameras
    - ◀ FLI - high end cameras
    - ◀ Starlight Express - great values
    - ◀ SAC - very inexpensive to start with - lacking software support
  - ▶ All are good choices

# The Camera

- **Starlight Express**

- ▶ **MX7C - why is this a good choice?**

- ◀ **An excellent first camera**

- Good for starters and advanced imagers

- Relatively simple to operate, especially for color images

- ◀ **Affordable by CCD standards**

- 750x582 resolution tops in its price range

- ◀ **Small and compact - 2" dia**

- ◀ **Light weight**

- Balance kit not necessary for the LX200

- Approximately the weight of a good 2" eyepiece

- ◀ **Primary SBIG equivalent considered - ST-7E**

# The Camera

- **Starlight Express**

- ▶ **MX7C (cont.)**

- ◀ **One shot camera - color matrix filters - CMY**

- Synthesizes RGB from the filtered signals

- Much less overall imaging time involved for color

- » Color filter wheel not required

- Probably not as accurate a color balance as RGB imaging

- ◀ **Self-guiding capability with Star2000 interface**

- Uses the same chip for imaging and guiding

- Sensitivity reduced by 50% as a result

- Simple software interface to self-guide

# Matching Scope and Camera

- General guidelines

- ▶ Sampling

- ◀ Depends on seeing

- Good seeing (i.e. 1 arc-sec) can tolerate higher resolution sampling rates

- Sampling rate (arc-sec/pixel) =  $206 \times (\text{pixel size}) / (\text{focal length})$

- » Pixel size is dependent on the camera

- » FL can be varied by focal reducers and barlow lenses

- Scope and camera should provide a typical sampling rate of approximately 2 arc-sec/pixel

- » 12" LX200 @ f/3.3 = 1.7 arc-sec/pixel (good match!)

- » Rates > 2 is undersampling and rates < 2 is oversampling

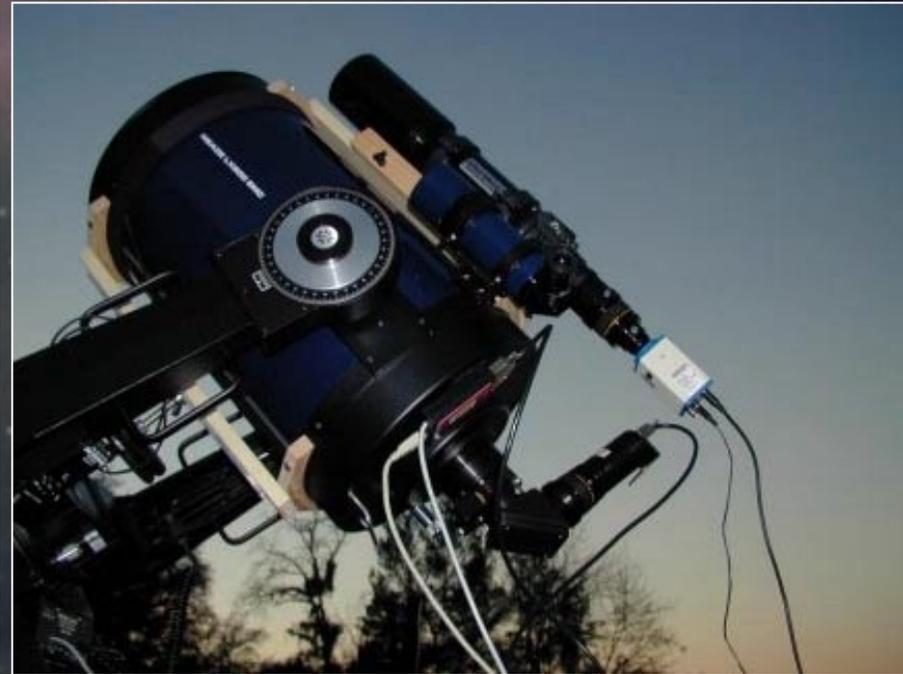
# Taking the Image

- Imaging process
  - ▶ Setup the optics/camera



# Taking the Image

- Imaging process
  - ▶ Setup scope, camera, laptop and align
    - ◀ No hot plugging - turn everything on after setup



# Taking the Image

- Imaging process
  - ▶ Choose first object
  - ▶ Slew to it using HPP
    - ◀ HPP targets a nearby bright star to center
    - ◀ Use this opportunity to focus CCD camera on star
    - ◀ Slew to object

**Note: Astroart is referenced in this presentation**

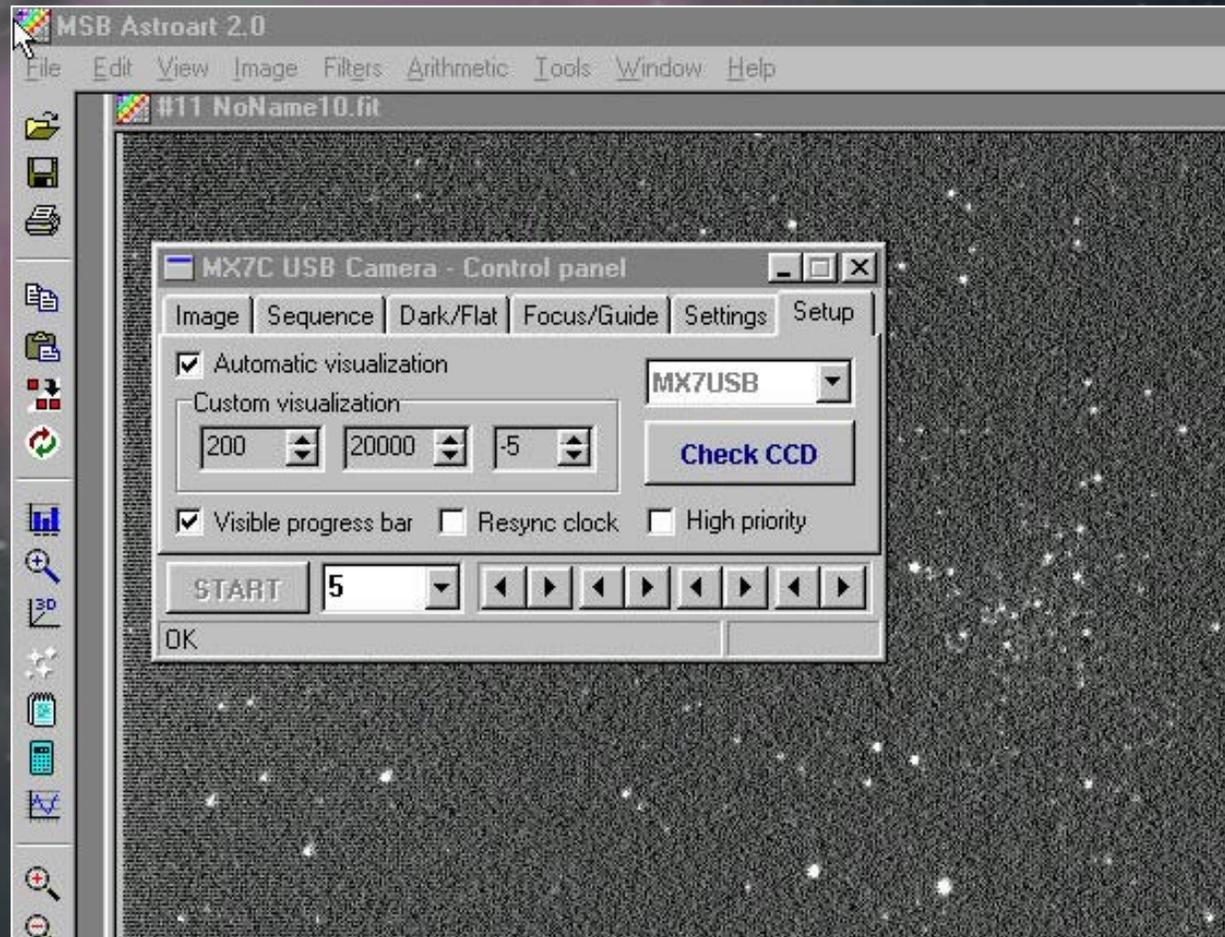
Great support for Starlight cameras

Relatively inexpensive (~\$150)

» Handles both camera control and image processing

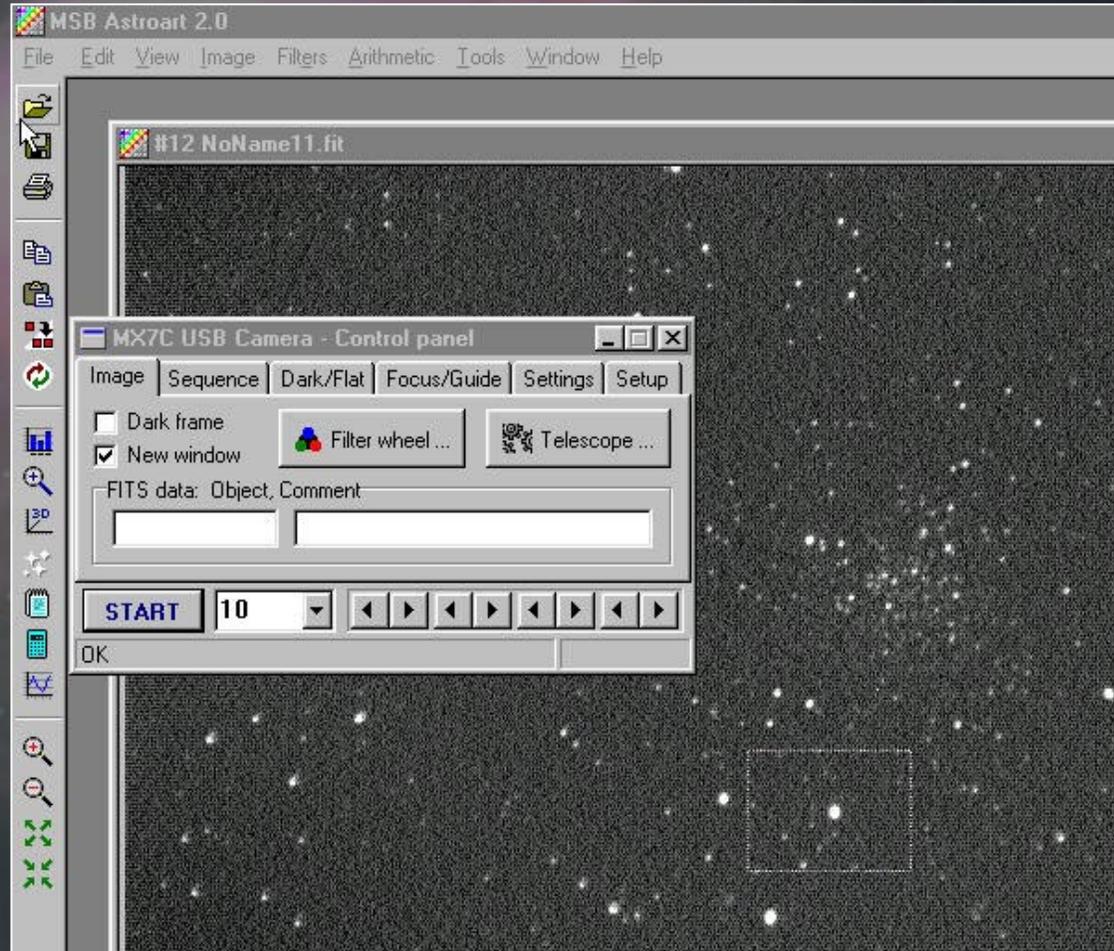
# Taking the Image

- ▶ Take a quick 5 to 30 second image of the object



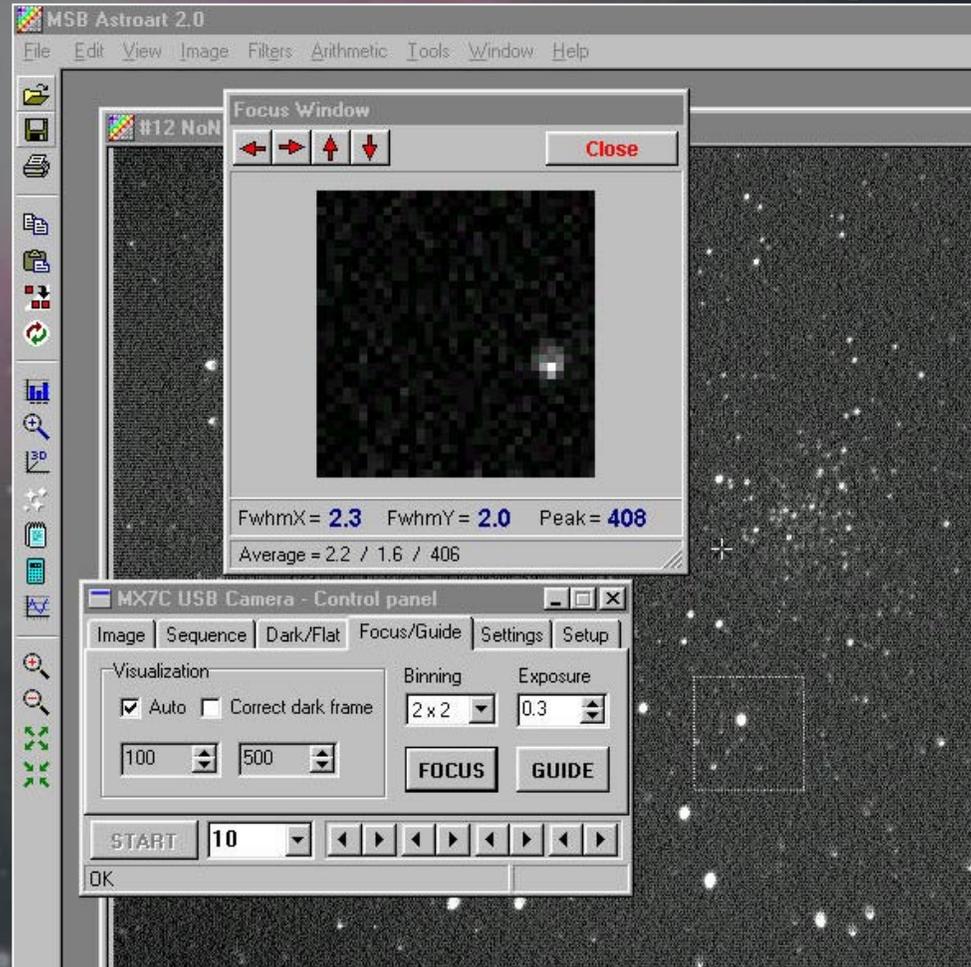
# Taking the Image

- ▶ Select a star anywhere on the image to fine focus



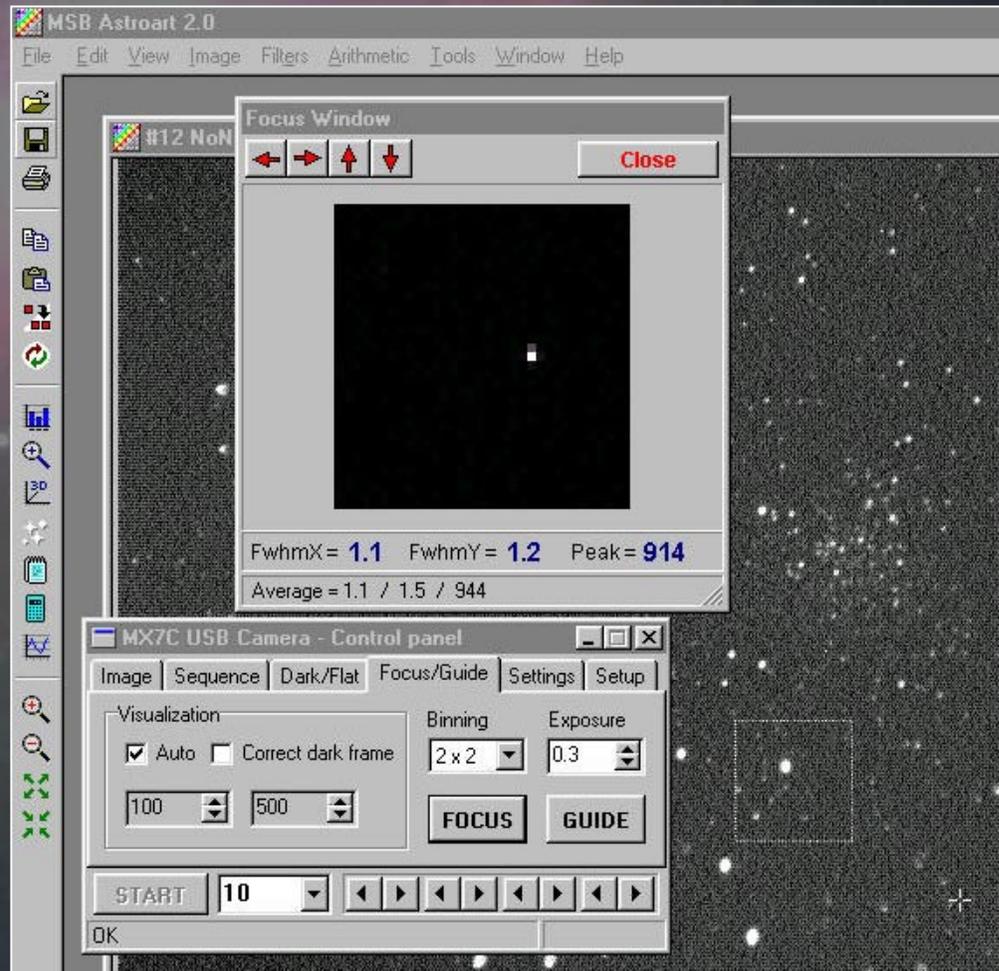
# Taking the Image

- Select the focus box - star is rough focused



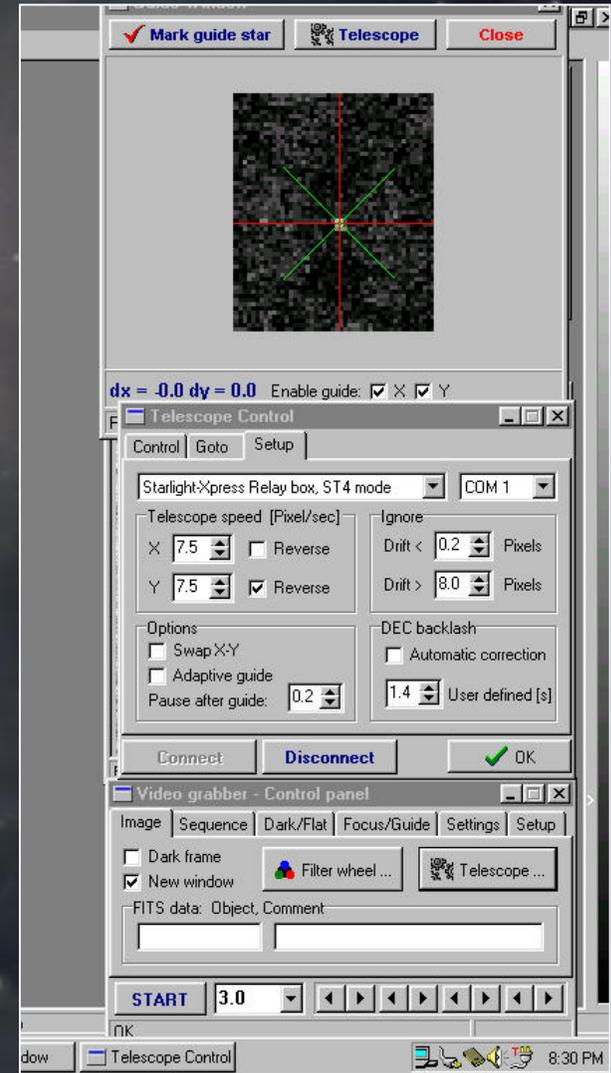
# Taking the Image

- Good focus has been achieved



# Taking the Image

- Autoguider setup
  - ▶ Example uses a video camera as the guider
    - ◀ Mintron 12V1 (0.0001 lux)
  - ▶ Star2000 equally effective
  - ▶ Scope setup
    - ◀ Correction speed
    - ◀ Correction range
    - ◀ Backlash



# Taking the Image

- Taking the image

The screenshot displays the MSB Astroart 2.0 software interface. The main window shows a star field image with a red crosshair and green lines indicating a guide star position. The status bar at the bottom indicates the current coordinates: X = 323, Y = 302, Value = 5724.

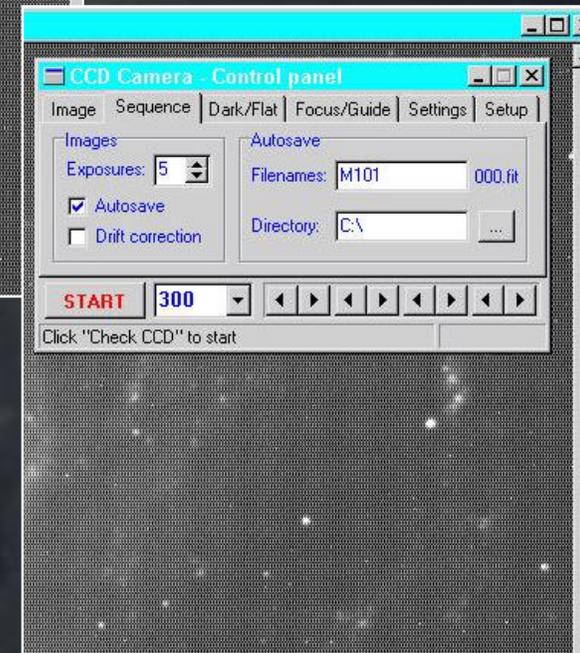
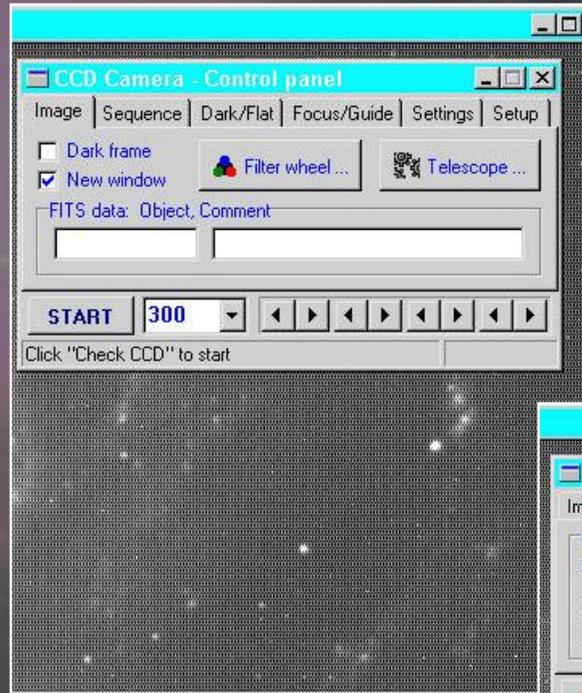
Key components of the interface include:

- MSB Astroart 2.0 Main Window:** Contains a menu bar (File, Edit, View, Image, Filters, Arithmetic, Tools, Window, Help) and a toolbar with various icons for file operations and image processing. The main image area shows a star field with a red crosshair and green lines.
- Telescope Control Panel:** Located on the right, it includes a "Mark guide star" checkbox, a "Telescope" icon, and a "Close" button. Below the image, it shows the guide star coordinates:  $dx = -0.1$   $dy = 0.2$ . It also has checkboxes for "Enable guide" (checked), "X" (checked), and "Y" (checked).
- Telescope Control Setup Panel:** Below the Telescope Control panel, it has tabs for "Control", "Goto", and "Setup". It includes a dropdown menu for "Starlight-Xpress Relay box, ST4 mode" and "CDM 1". It also has sliders for "Telescope speed [Pixel/sec]" (X: 7.5, Y: 7.5) and "Drift" (Drift <: 0.2, Drift >: 8.0). There are checkboxes for "Reverse" and "Adaptive guide".
- MX7C USB Camera - Control panel:** Located at the bottom left, it has tabs for "Image", "Sequence", "Dark/Flat", "Focus/Guide", "Settings", and "Setup". It includes checkboxes for "Dark frame" (unchecked) and "New window" (checked). It also has a "Filter wheel ..." button and a "Telescope ..." button. The "FITS data" field is set to "Object, Comment". It has a "STOP" button and a "240" value field.
- Video grabber - Control panel:** Located at the bottom right, it has tabs for "Image", "Sequence", "Dark/Flat", "Focus/Guide", "Settings", and "Setup". It includes checkboxes for "Dark frame" (unchecked) and "New window" (checked). It also has a "Filter wheel ..." button and a "Telescope ..." button. The "FITS data" field is set to "Object, Comment". It has a "START" button and a "3.0" value field.

The taskbar at the bottom shows the Start button and several open windows: Astroart, MX7C USB Cam..., Astroart, Video grabber..., Guide Window, and Telescope Control. The system tray on the right shows the time as 8:35 PM.

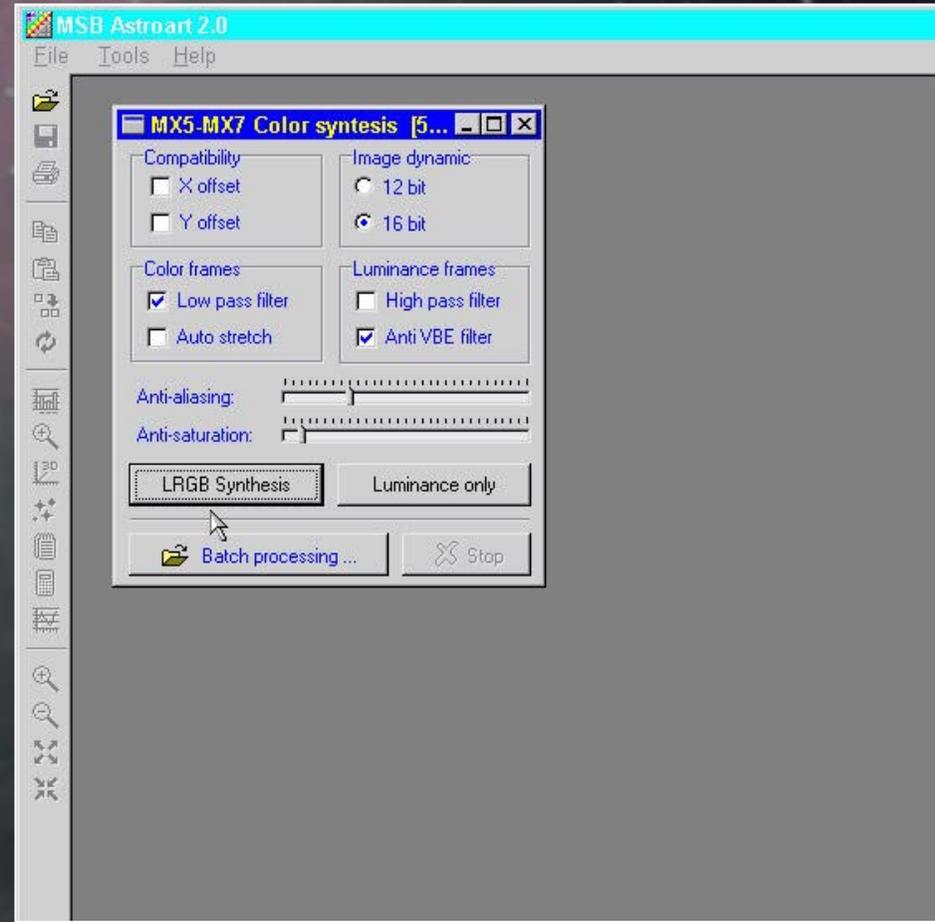
# Taking the Image

- To take the image, select image or sequence
  - ▶ Image generates a single image
  - ▶ Sequence allows multiple images to be taken and saved



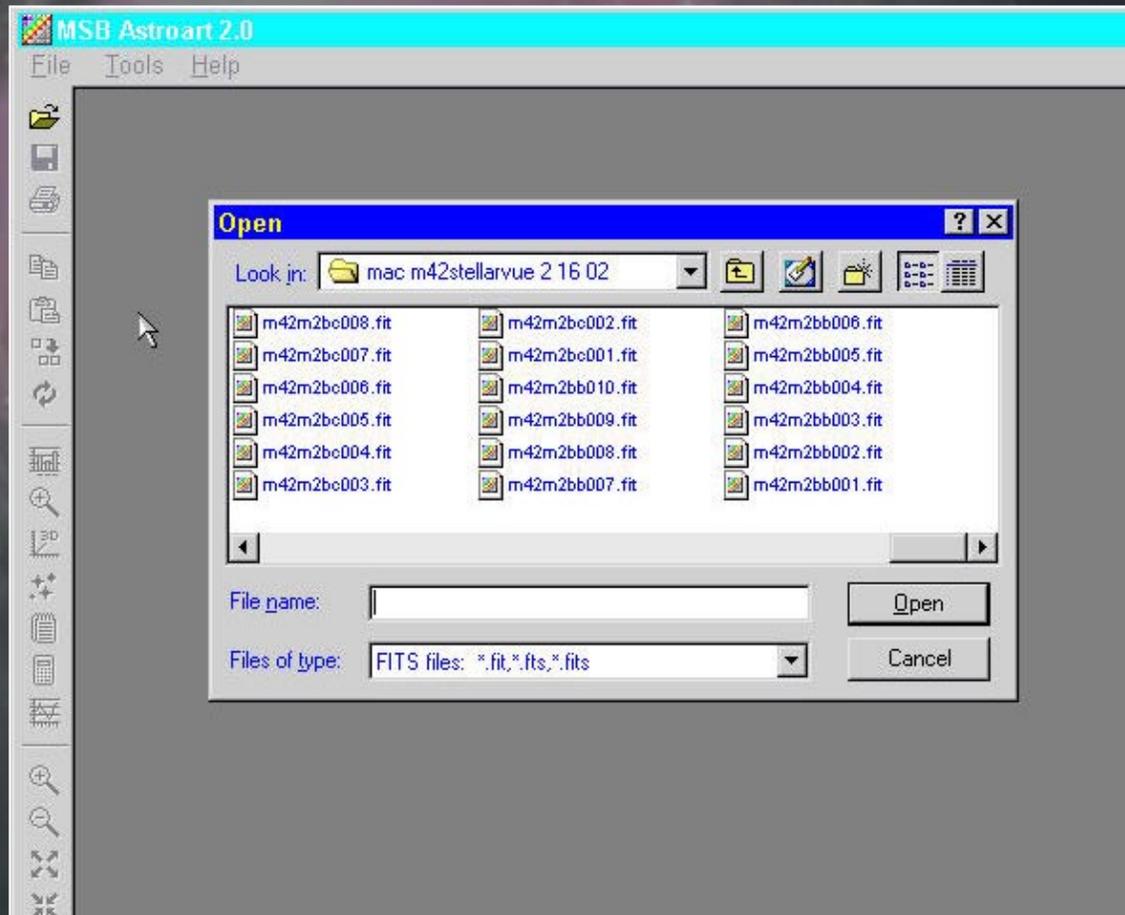
# Processing the image

- Astroart: batch processing menu
  - For the MX7C camera, the Anti-aliasing setting can be increased to minimize the point source issue for one-shot cameras, eliminating the occasional wild star color



# Processing the image

- Batch processing: selecting the images



# Processing the image

- Batch processing: results in LRGB separation

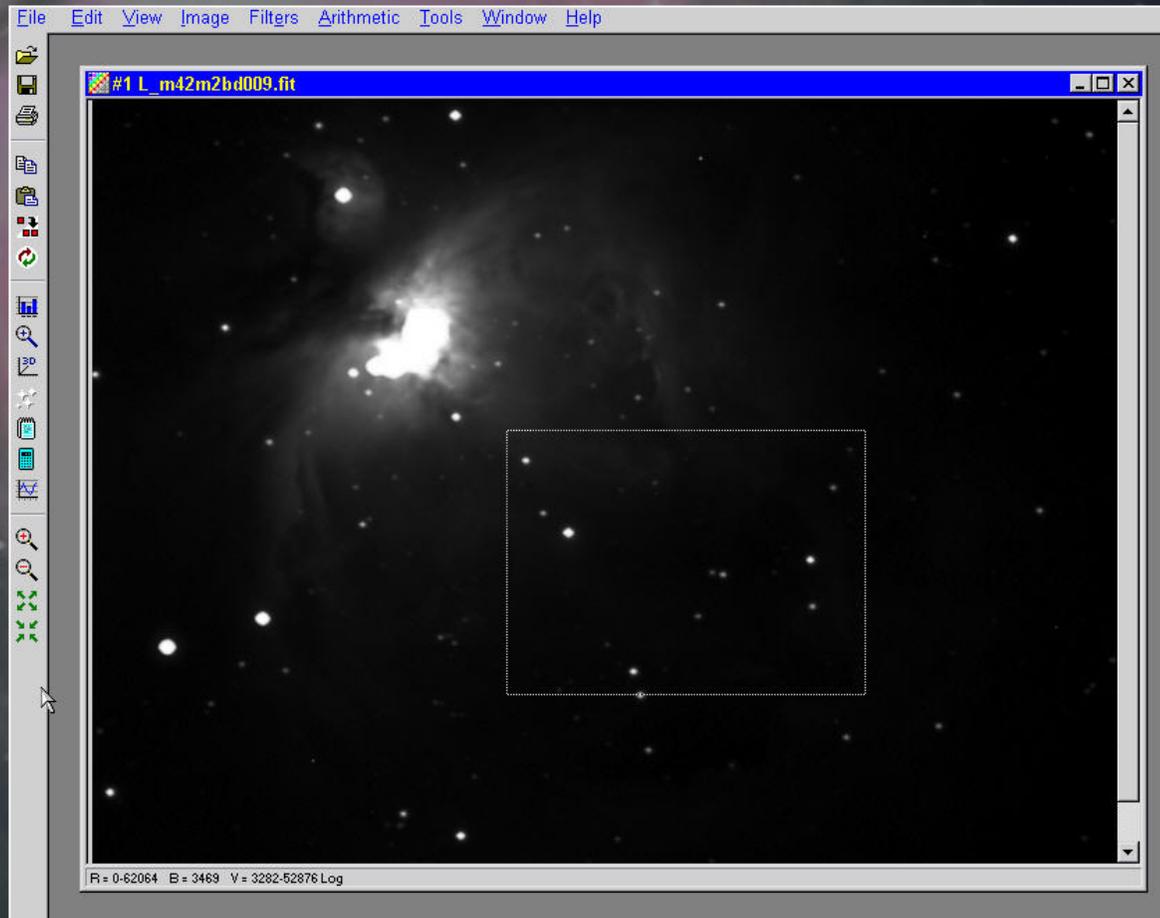
The screenshot shows a Windows Explorer window with the following details:

- Left Pane (All Folders):** Shows a tree view of folders. The 'Data files' folder is expanded, showing sub-folders like 'avisfits', 'darkfiles', 'jupiter 12 15 01', 'jupiter 12 21 01', 'jupiter 2 01 02', 'presentation', 'saturn 12 15 01', 'saturn 2 01 02', 'scope mods', and 'stellarvue'. The 'stellarvue' folder is further expanded to show 'flame stellarvue 1 1', 'HH stellarvue 1 15', 'HH stellarvue 1 19', 'm42 tests', and 'm42stellarvue 1 10'.
- Right Pane (File List):** Shows a list of files with columns for Name, Size, and Type. All files are 855KB FIT Files. The files are:
 

Name	Size	Type
R_m42m2bc003.fit	855KB	FIT File
B_m42m2bc004.fit	855KB	FIT File
G_m42m2bc004.fit	855KB	FIT File
R_m42m2bc004.fit	855KB	FIT File
L_m42m2bc005.fit	855KB	FIT File
B_m42m2bc005.fit	855KB	FIT File
G_m42m2bc005.fit	855KB	FIT File
R_m42m2bc005.fit	855KB	FIT File
B_m42m2bc006.fit	855KB	FIT File
L_m42m2bc006.fit	855KB	FIT File
G_m42m2bc006.fit	855KB	FIT File
R_m42m2bc006.fit	855KB	FIT File
B_m42m2bc007.fit	855KB	FIT File
G_m42m2bc007.fit	855KB	FIT File
L_m42m2bc007.fit	855KB	FIT File
R_m42m2bc007.fit	855KB	FIT File
B_m42m2bc008.fit	855KB	FIT File
G_m42m2bc008.fit	855KB	FIT File
L_m42m2bc008.fit	855KB	FIT File
R_m42m2bc008.fit	855KB	FIT File
L_m42m2bc009.fit	855KB	FIT File
B_m42m2bc009.fit	855KB	FIT File

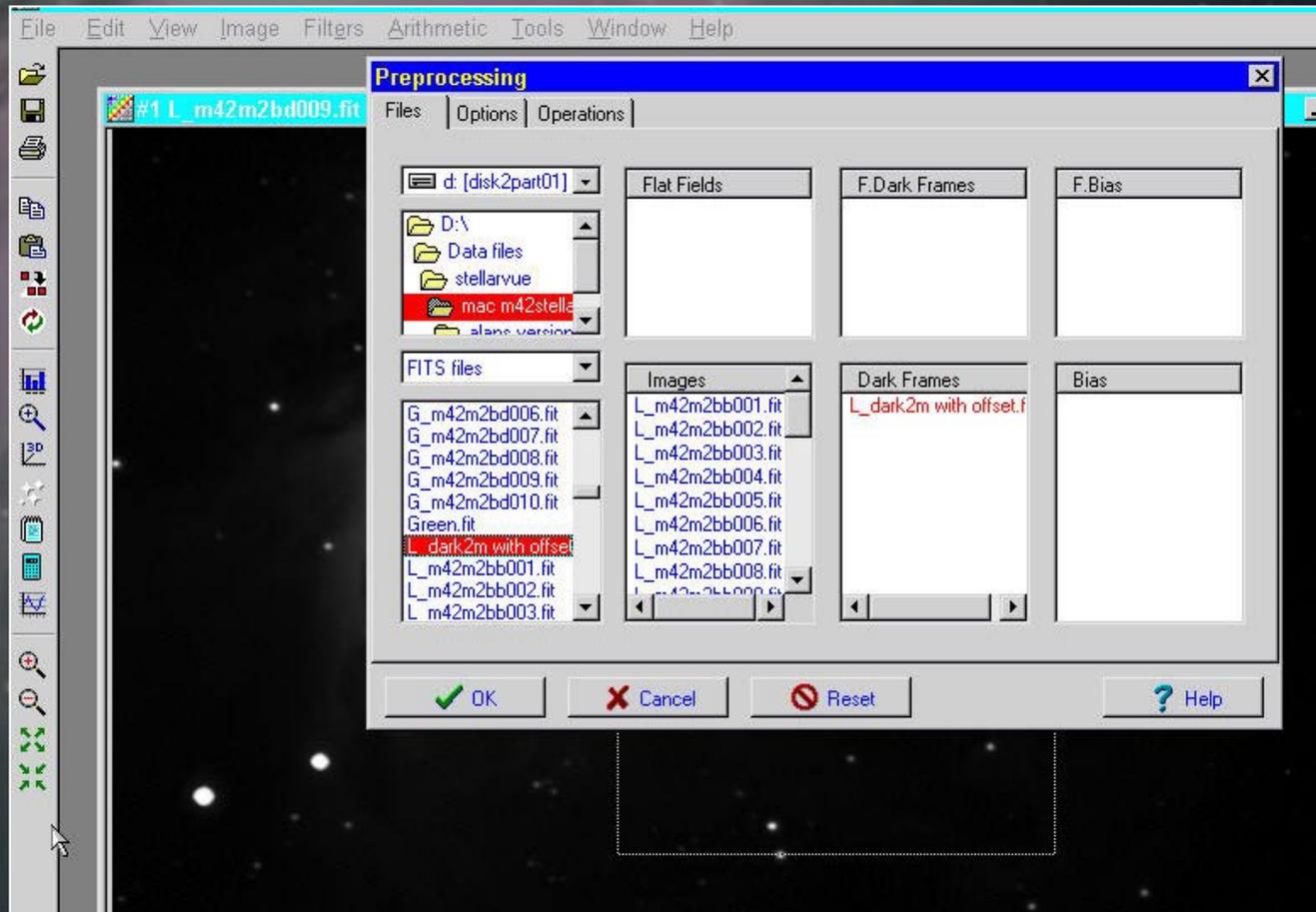
# Processing the image

- Pre-processing: selecting stars to autoalign



# Processing the image

- Pre-processing: select files to combine



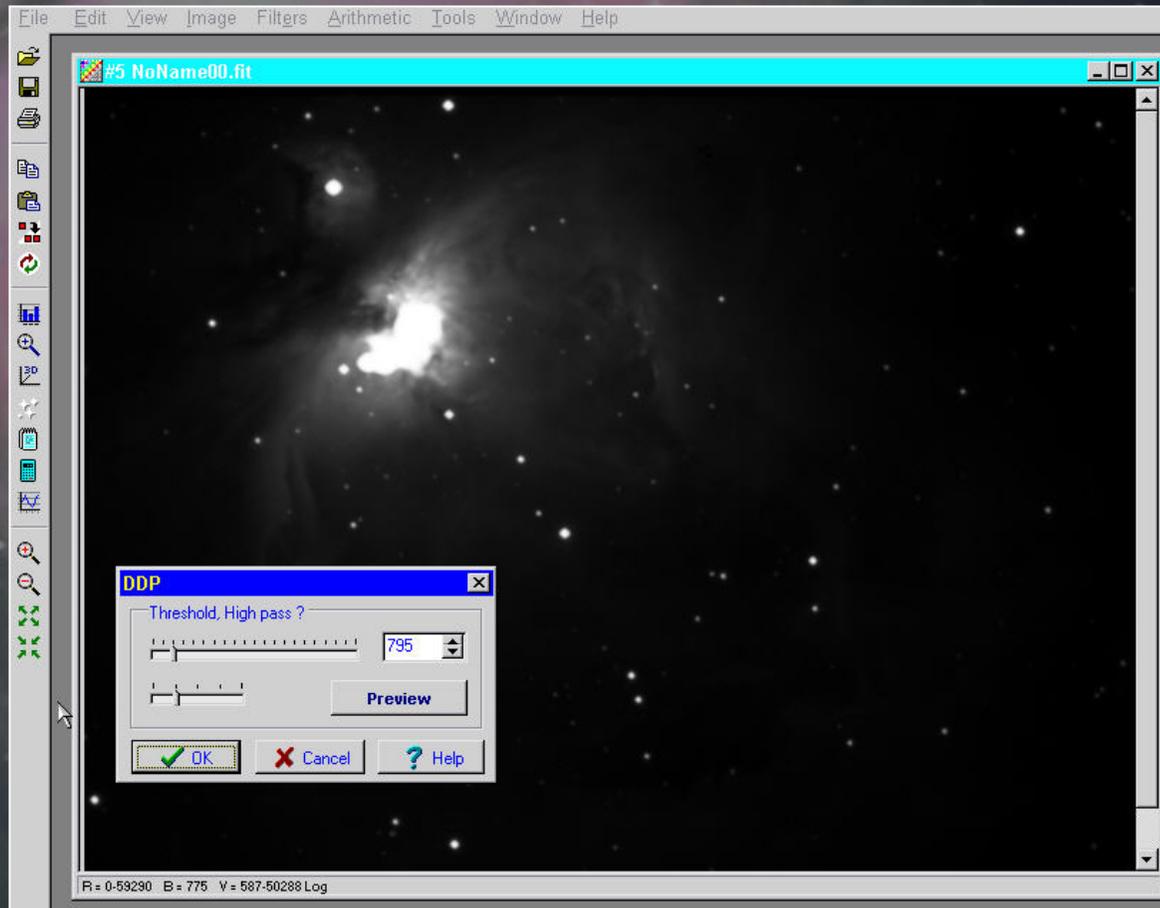
# Processing the image

- Pre-processing: 30x2min. images combined



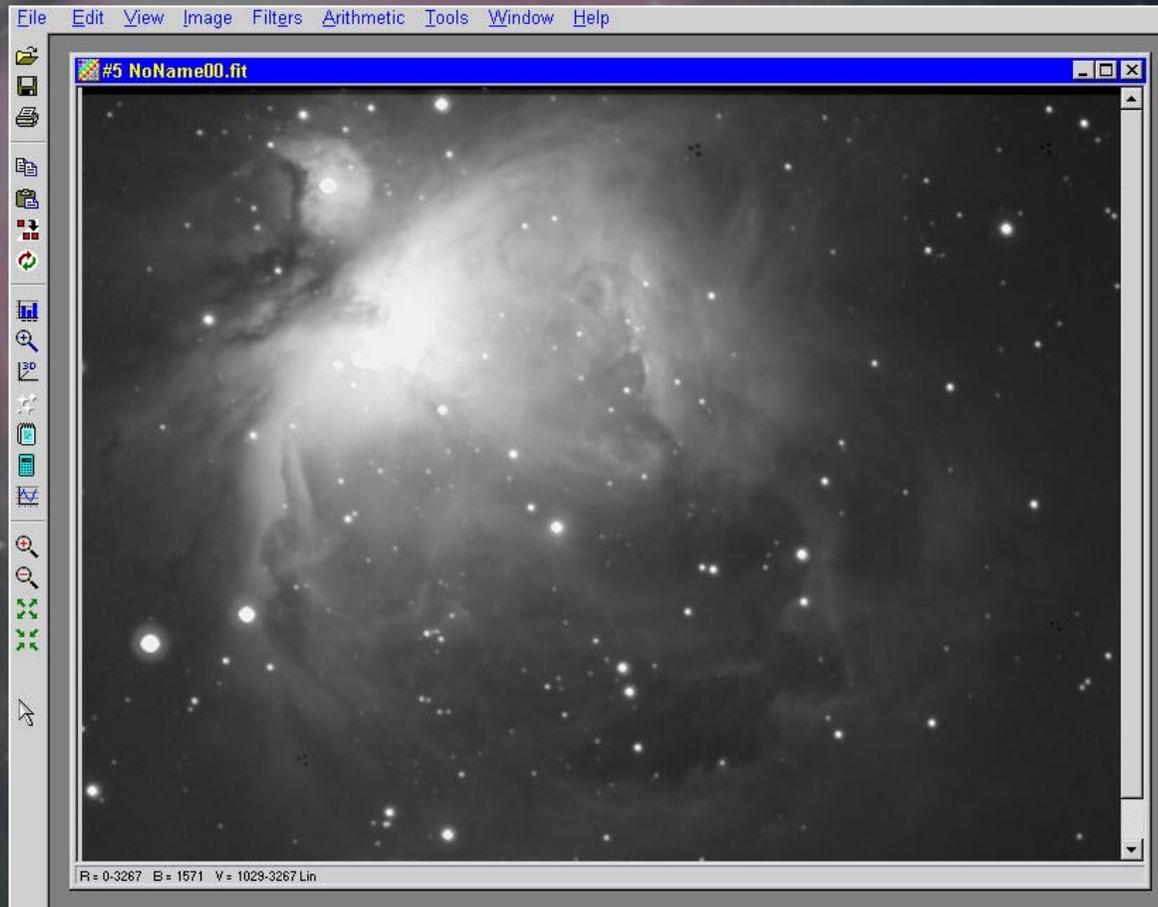
# Processing the image

- DDP processing - compresses signal range



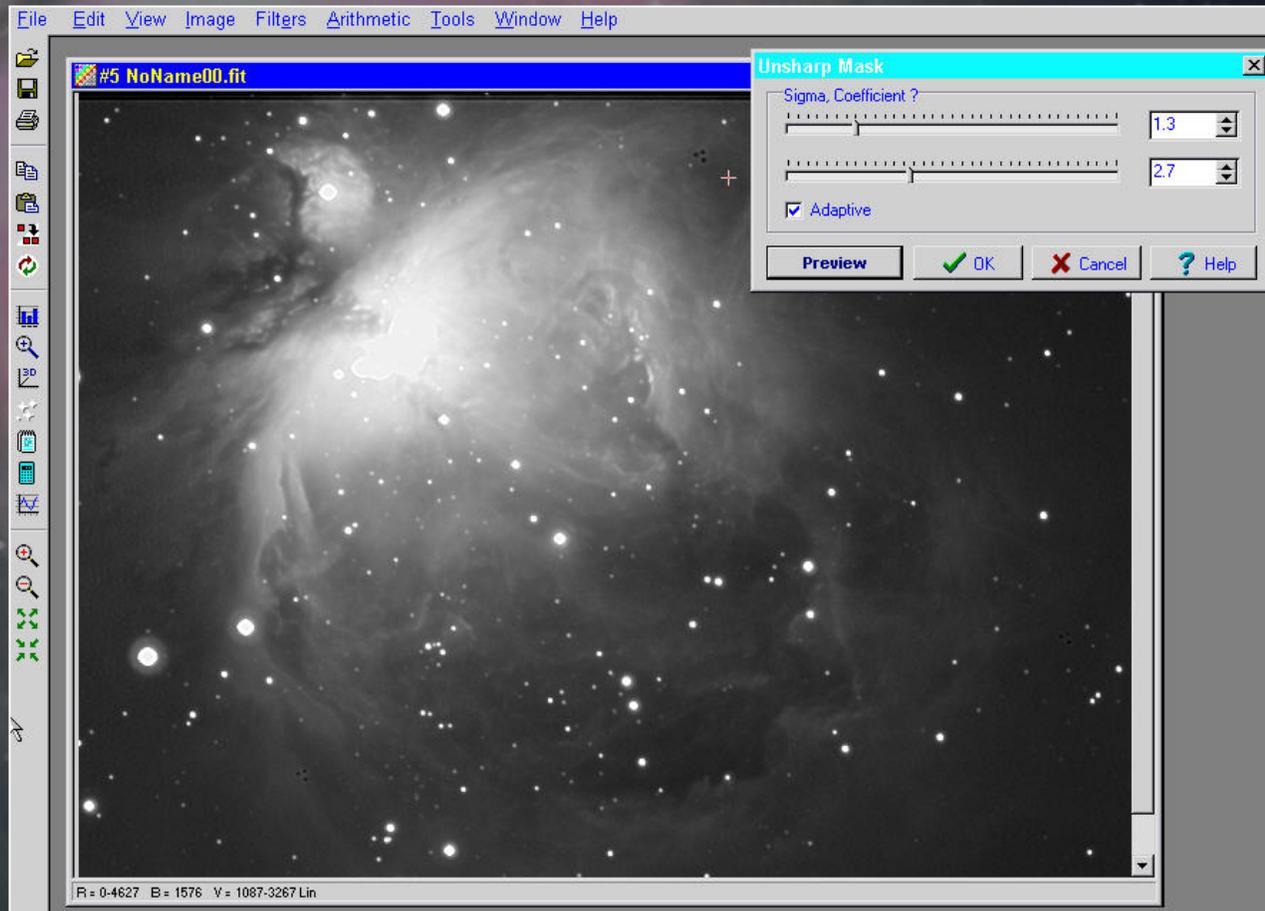
# Processing the image

- DDP processing - result of ddp filter



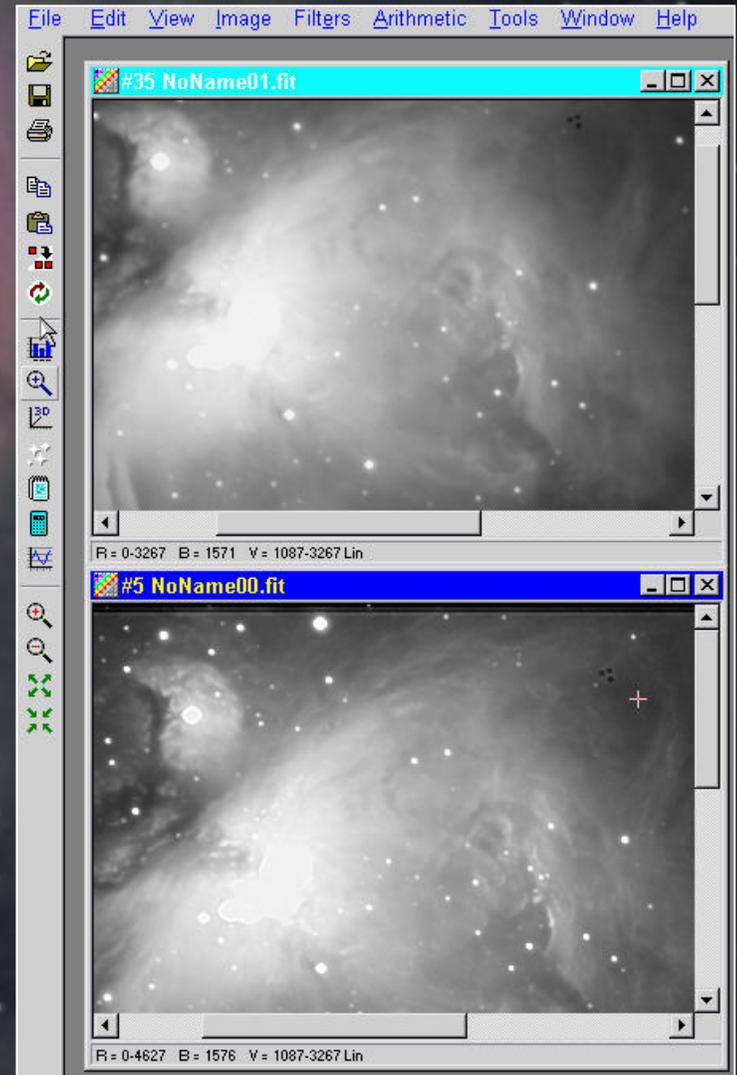
# Processing the image

- Unsharp Mask filtering



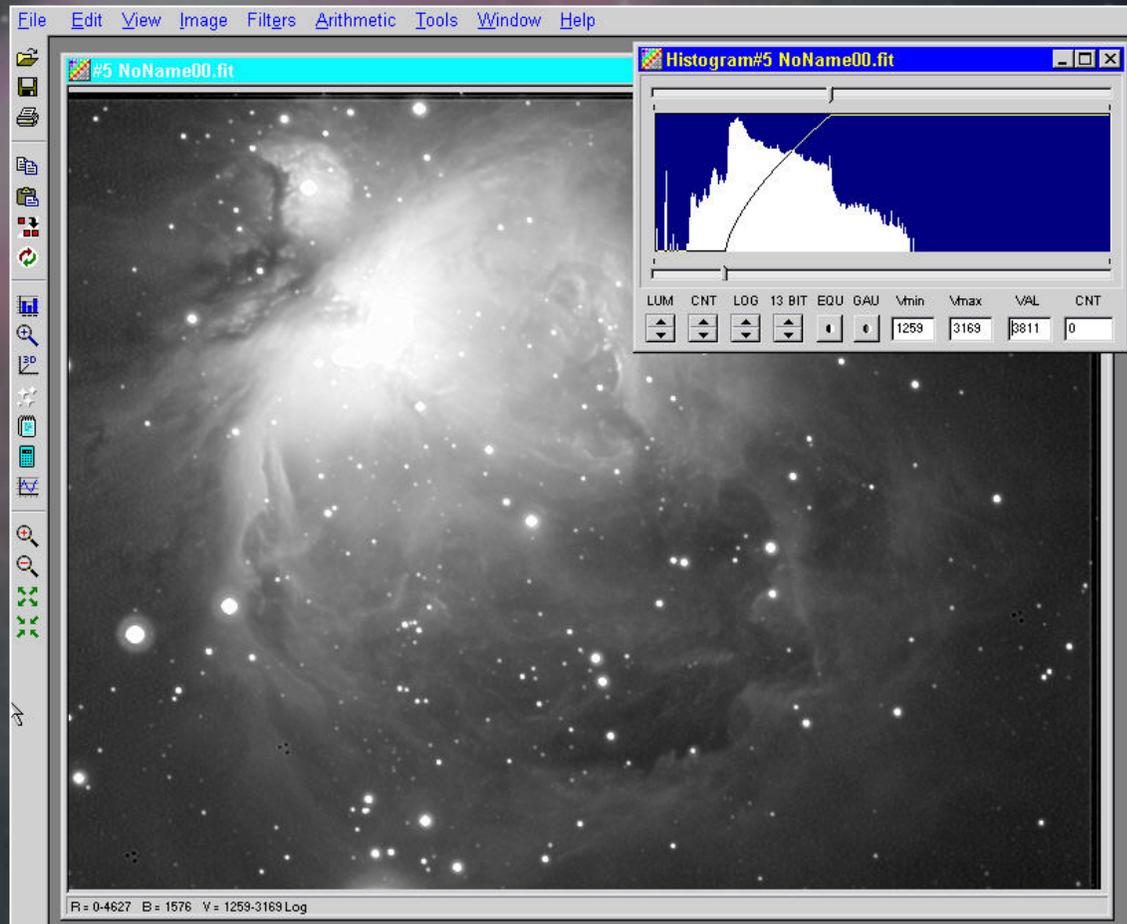
# Processing the image

- Unsharp Mask filtering
  - ▶ Sharpens the fine nebulosity and tightens the star images



# Processing the image

- Stretching the image with a histogram

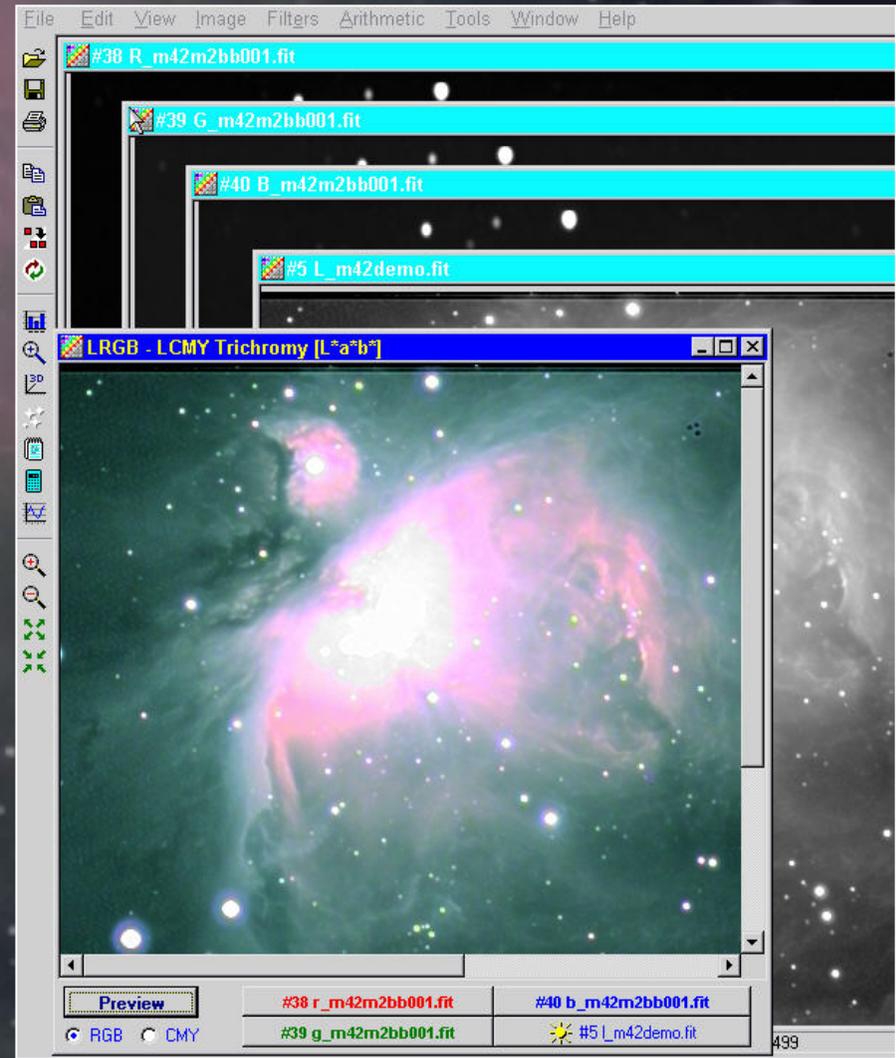


# Processing the image

- Color processing
  - ▶ Repeat the procedure as in slide 22 to combine all of the R-frames together, then the G-frames and finally the B-frames
  - ▶ Upon completion, there should be one L, R, G and B frame (4 total frames)

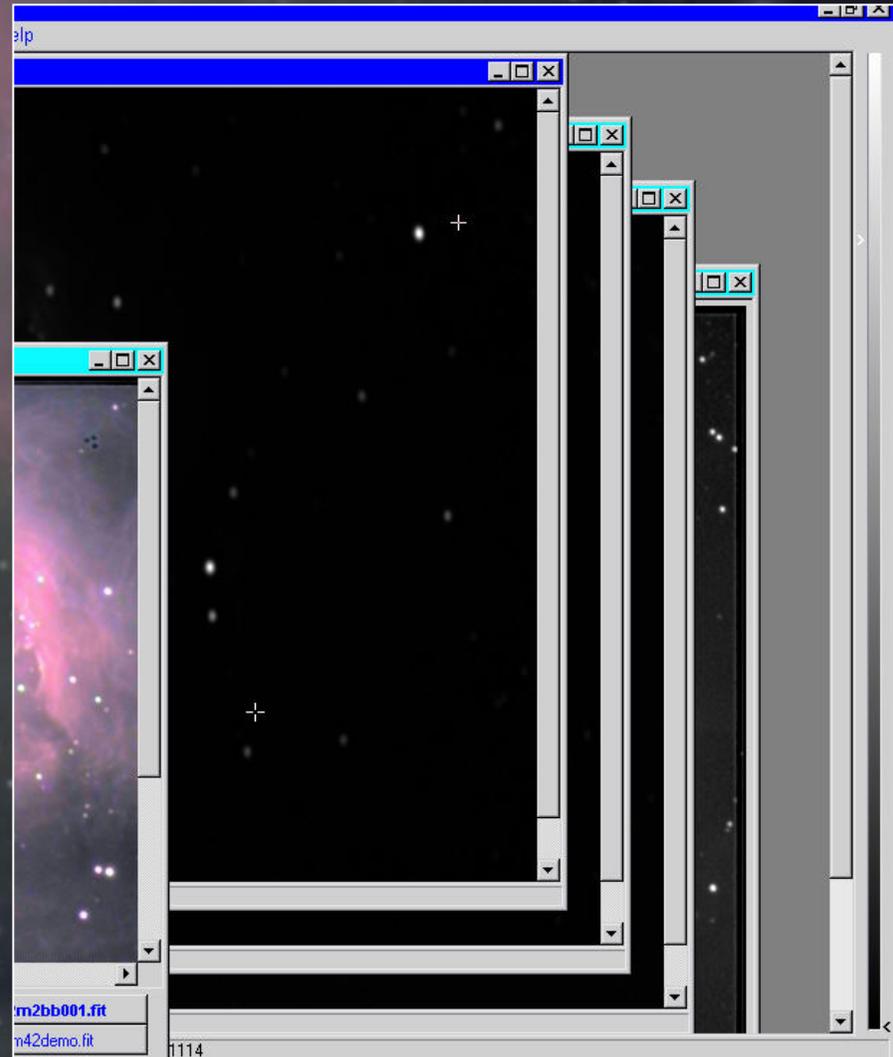
# Processing the image

- Color processing
  - ▶ Trichromy command
  - ▶ We have color!



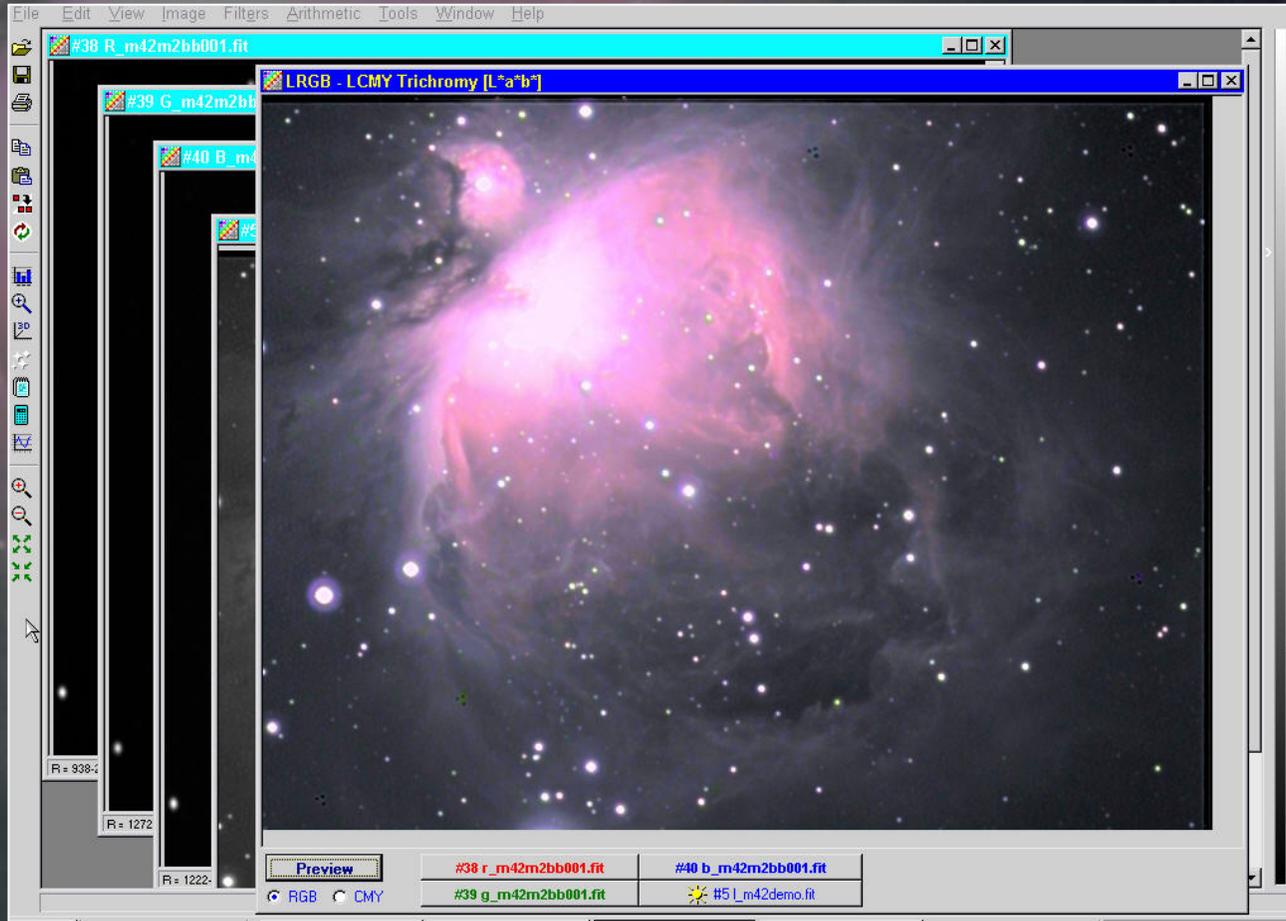
# Processing the image

- Color processing
  - ▶ Tweaking colors
  - ▶ Sliders at the far right to adjust color intensity and balance
    - ◀ Histograms can also be employed for better control
    - ◀ Linear stretch preferred for color frames



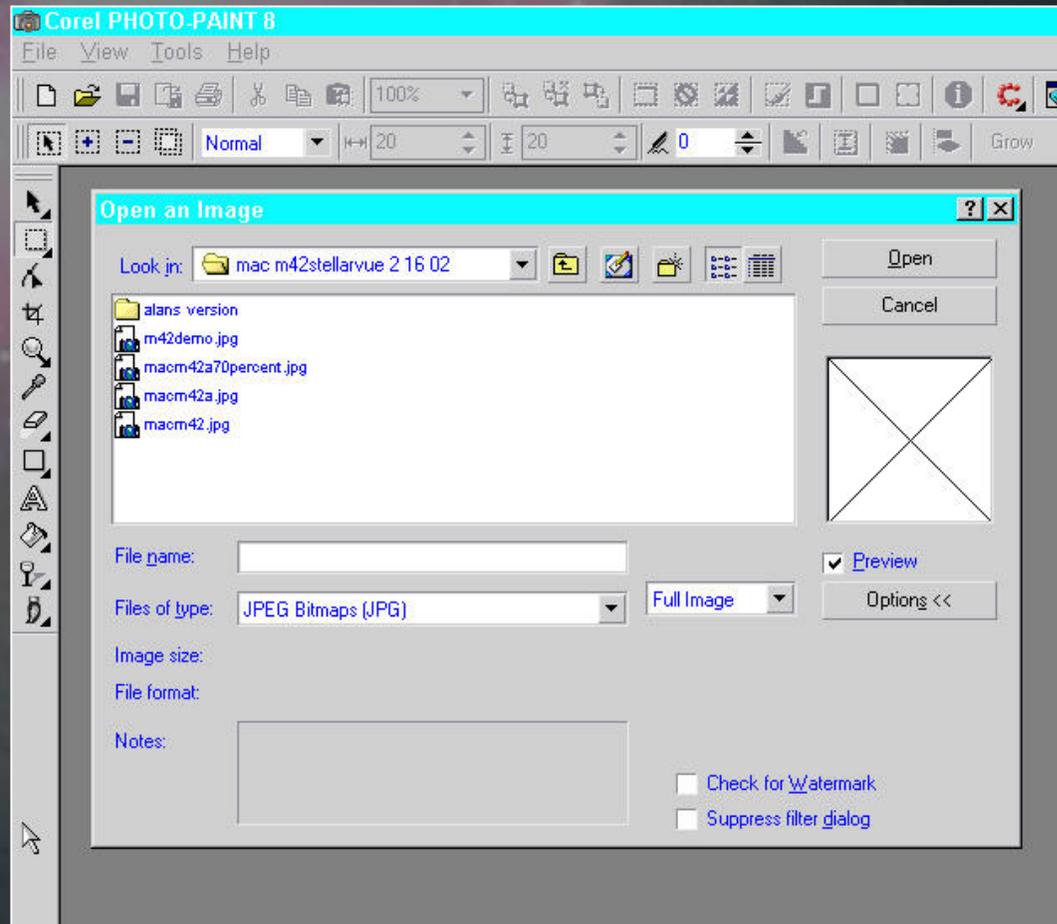
# Processing the image

- Color processing - final result: saved as a jpg



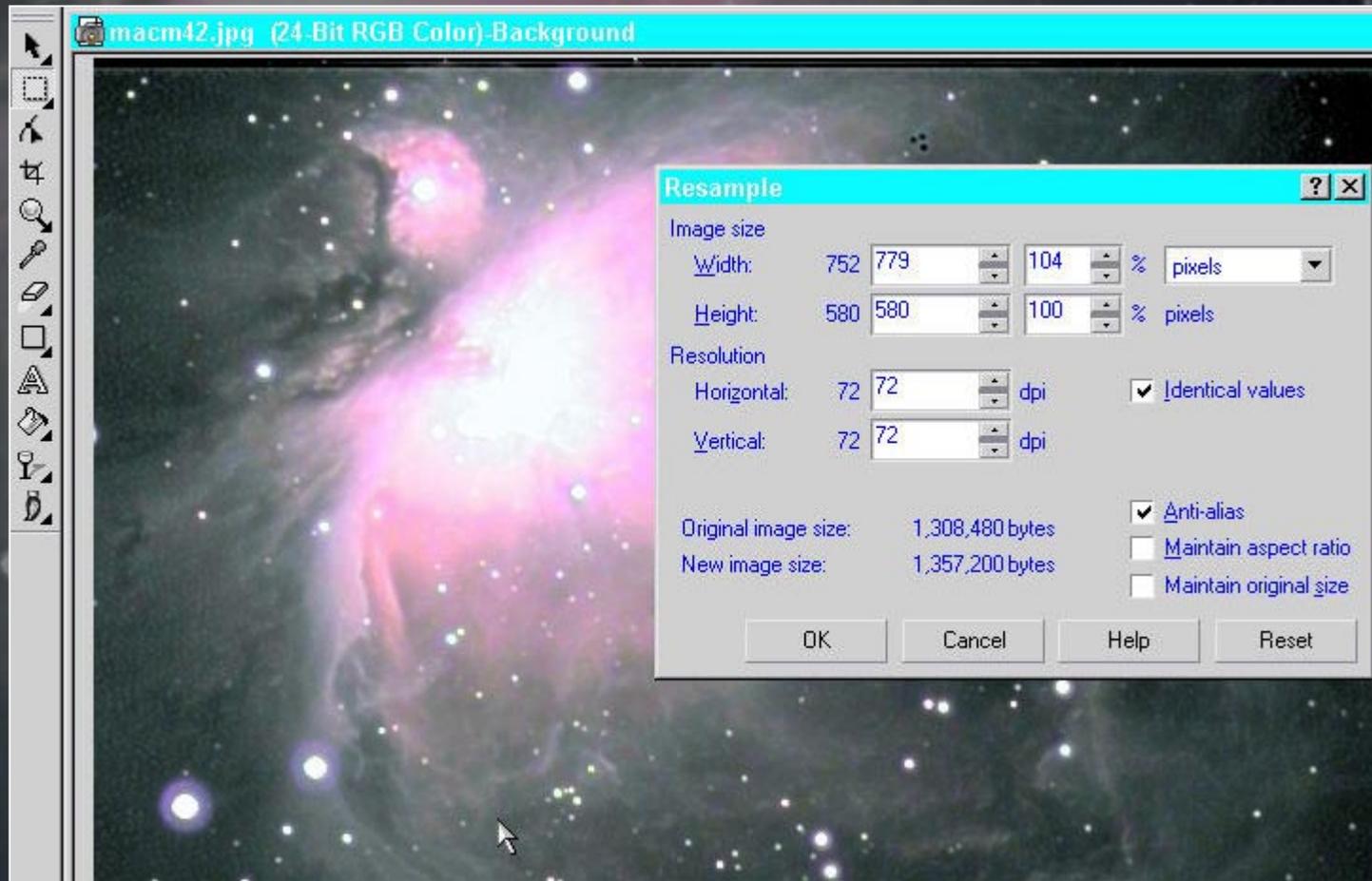
# Processing the image

- Color processing - tweaking in Corel Photopaint



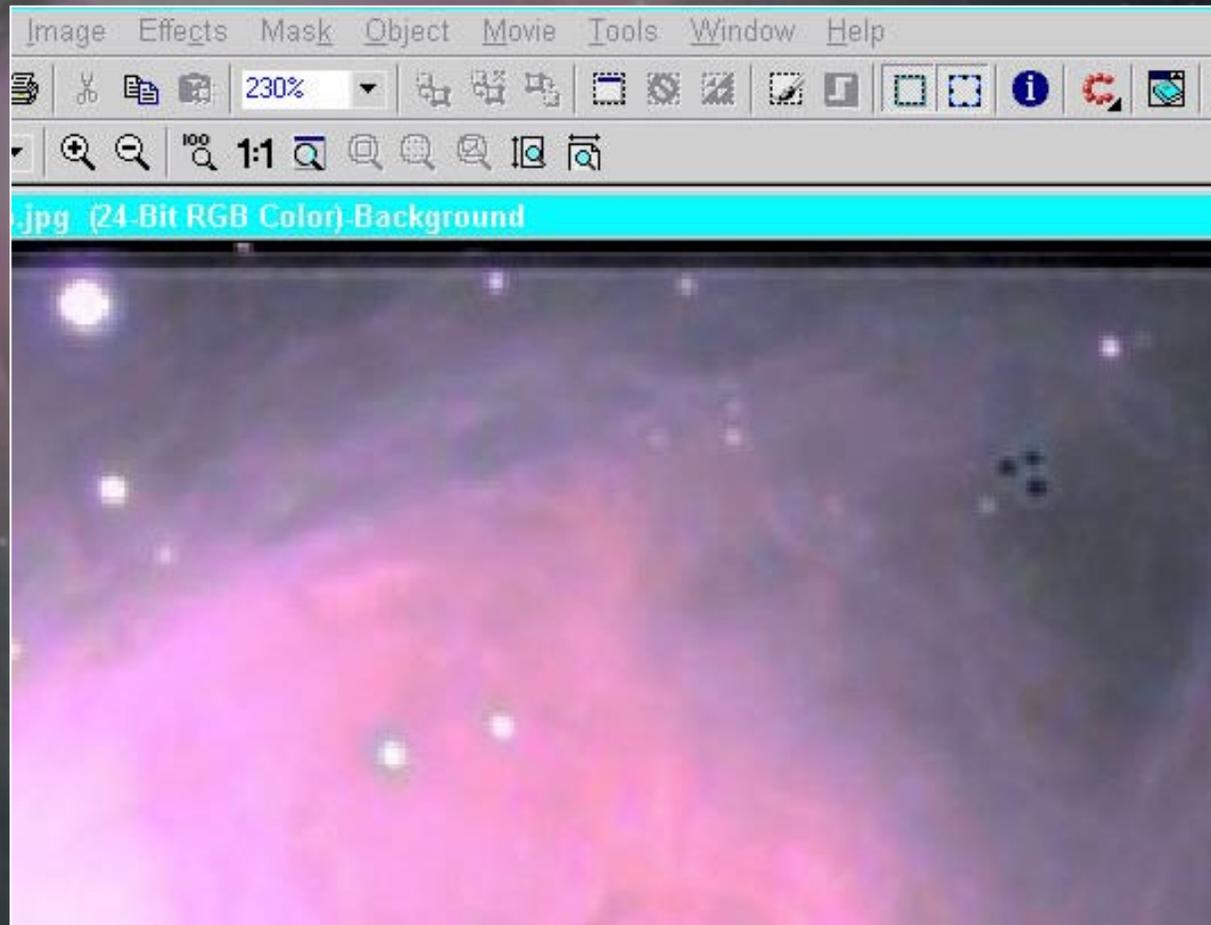
# Processing the image

- Corel Photo - resampling to square the pixels



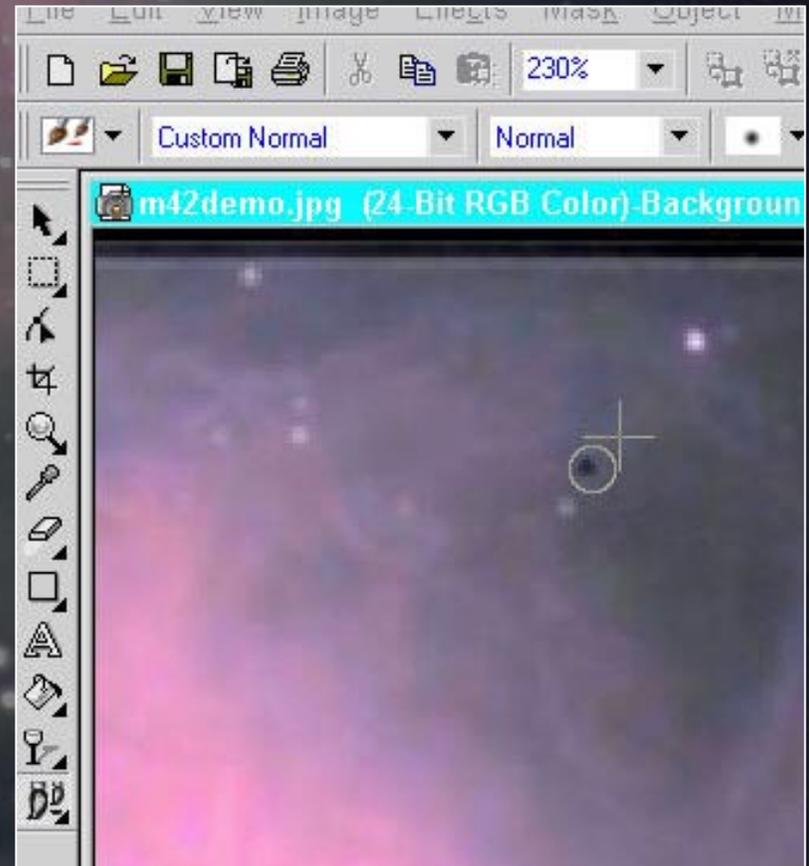
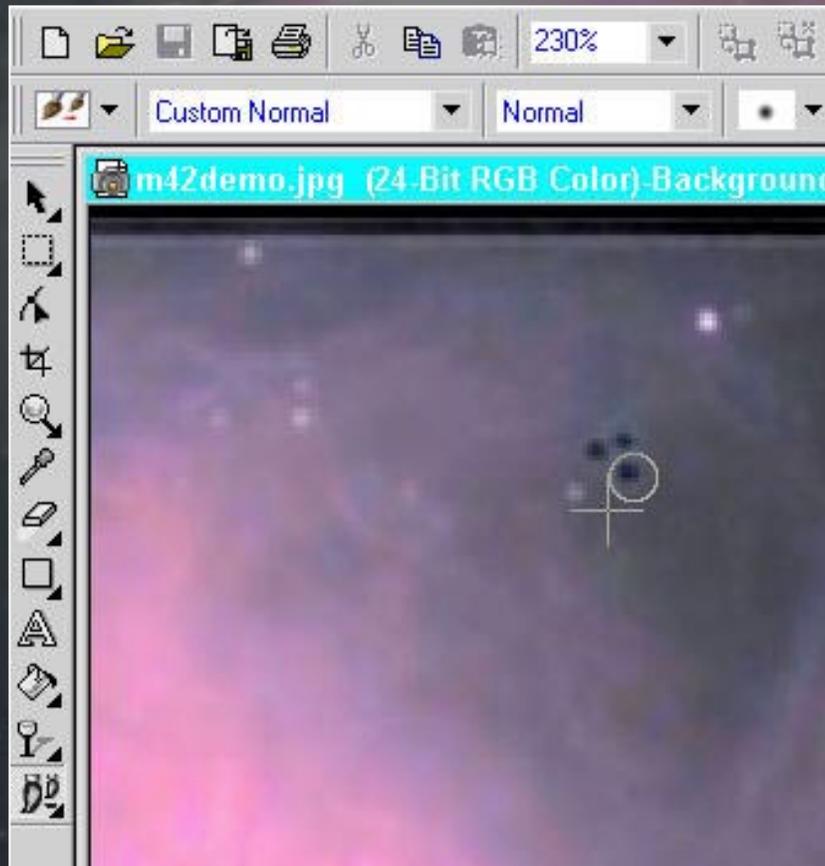
# Processing the image

- Corel Photo - Eliminating image defects



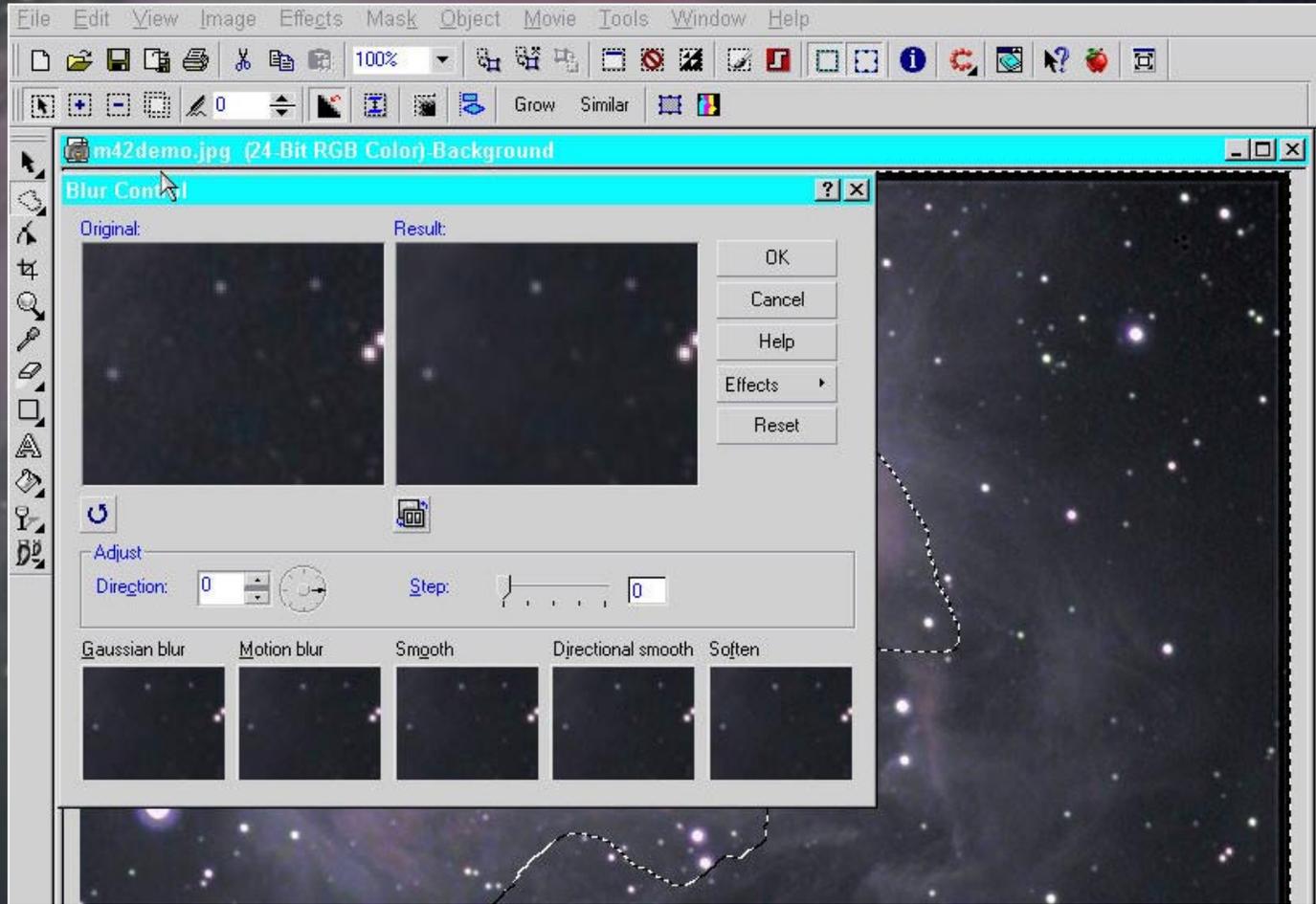
# Processing the image

- Corel Photo - Using the clone tool



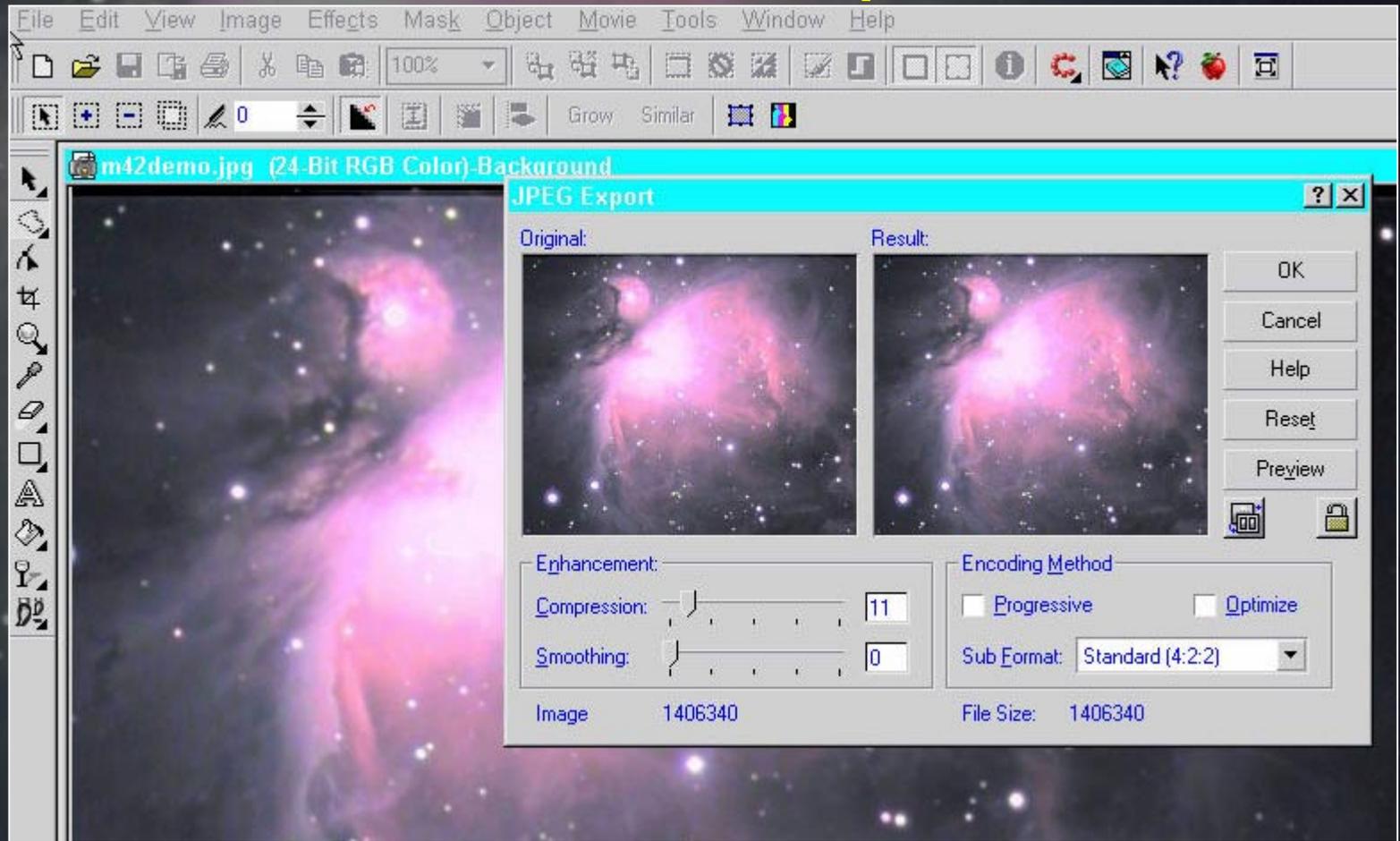
# Processing the image

- Corel Photo - Gaussian blur



# Processing the image

- Corel Photo - save with compression - Done!



# M42: 80mm Stellarvue

