

Lecture 11

November 15, 2018

Lab 6

News

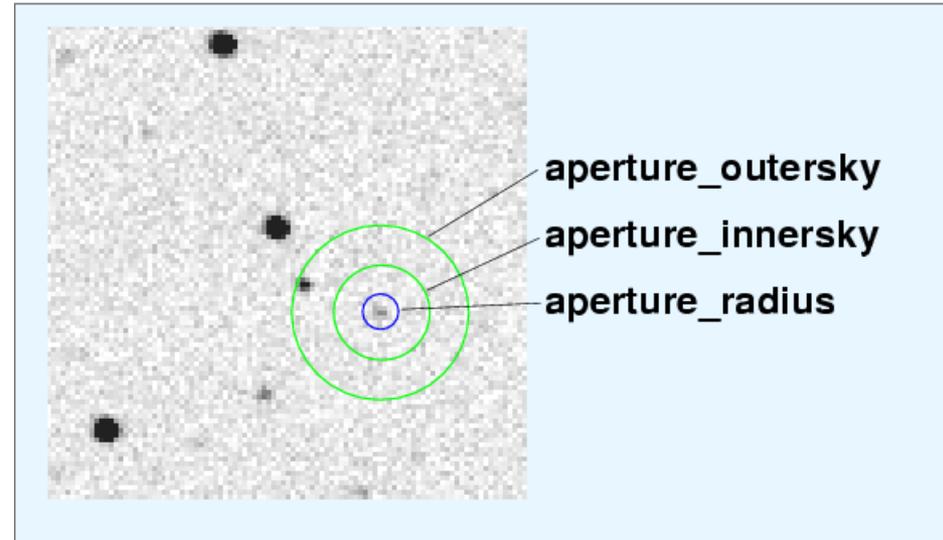
- Lecture is on Tuesday next week.
- Labs 3 and 4
 - Handed back next week (I hope).
- Lab 6 (Color-Magnitude Diagram)
 - Observing on this Friday; then ends.
 - I will email the Monday, Tuesday, and Wednesday groups telling them which data to use.
 - Email me your instrumental color-magnitude diagram by Wednesday, November 21
 - Entire lab due: November 29

Color-Magnitude Diagram of an Open Cluster

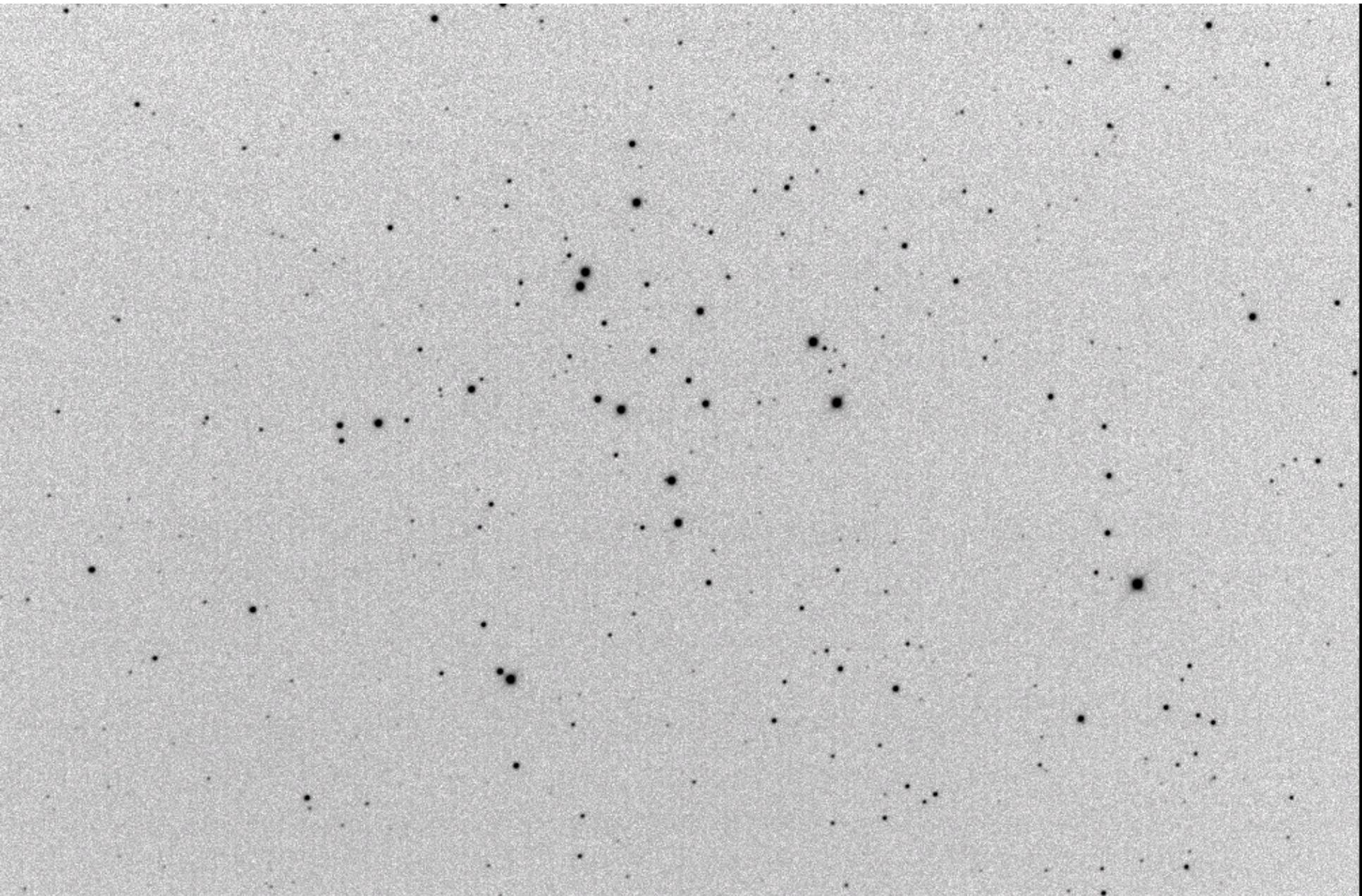
- Plot stellar color versus brightness for stars in a cluster (a gravitationally bound group of stars that formed at the same time and are at the same distance).
- Determine cluster properties
 - Distance
 - Age
 - Open star cluster (and globular star clusters) have been our principal tools to understand stellar structure and evolution.

Measuring Stellar Brightness

- One Method: Aperture Photometry
 - Add up signal in pixels within a circular aperture centered on the star.
 - Subtract the contribution from the sky, estimated from pixels in a surrounding annulus.
 - Need a “robust” average sky value that removes the effect of any stars present.
 - (Relatively) simple.
 - How big to make the aperture?

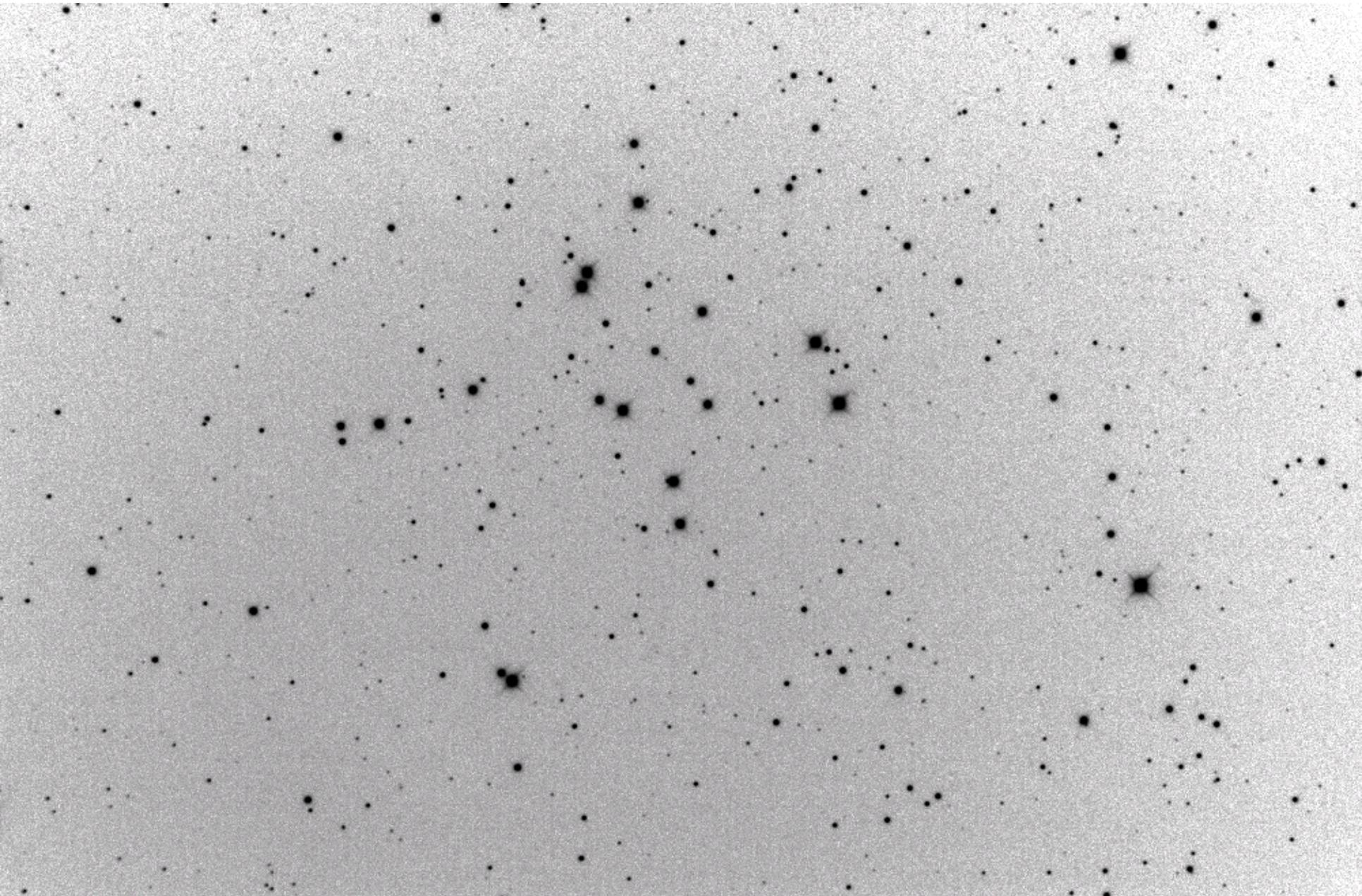


M34 V 7 sec unflattened



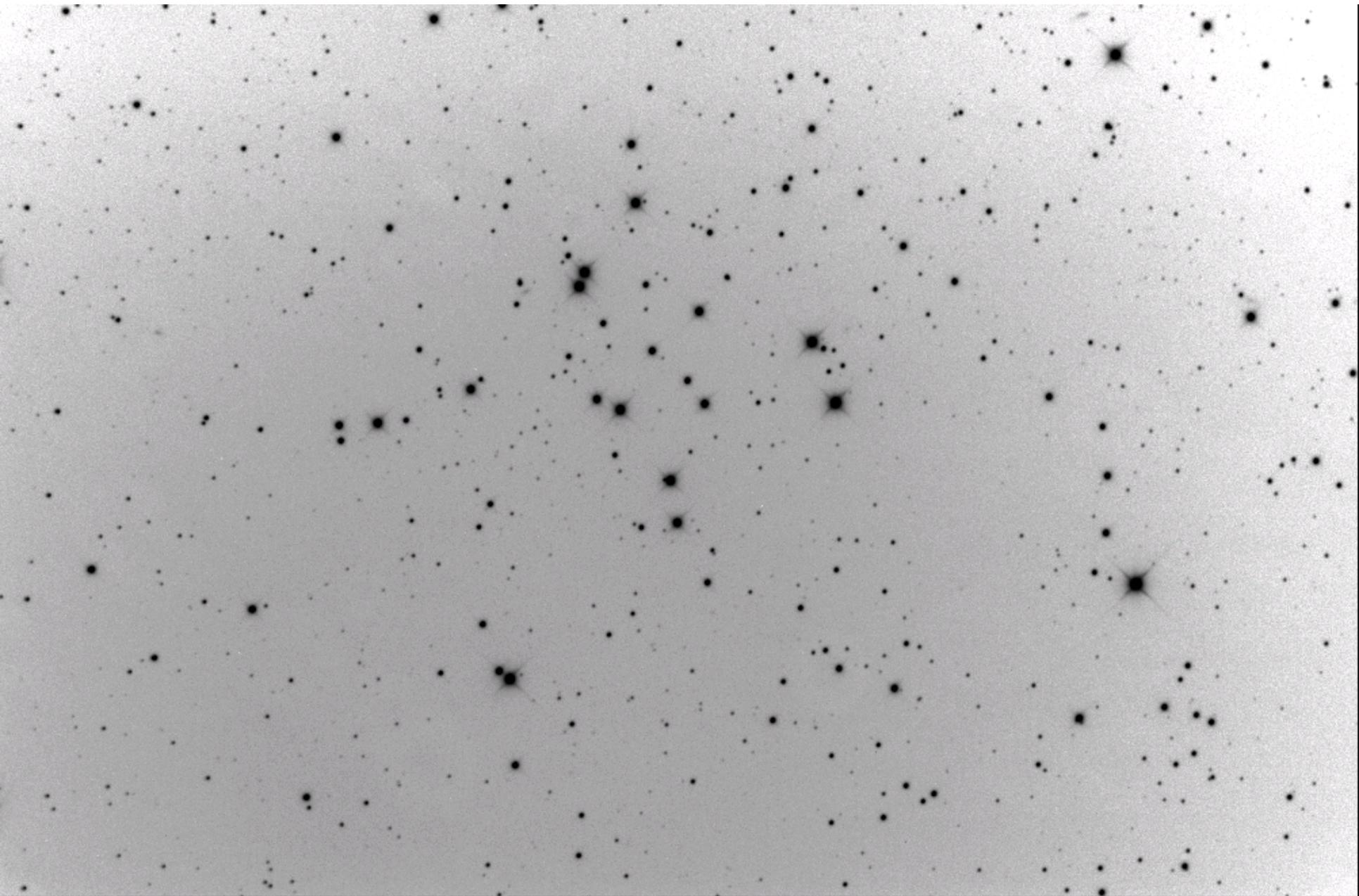
One field approximately centered on M34.

M34 V 45 sec unflattened



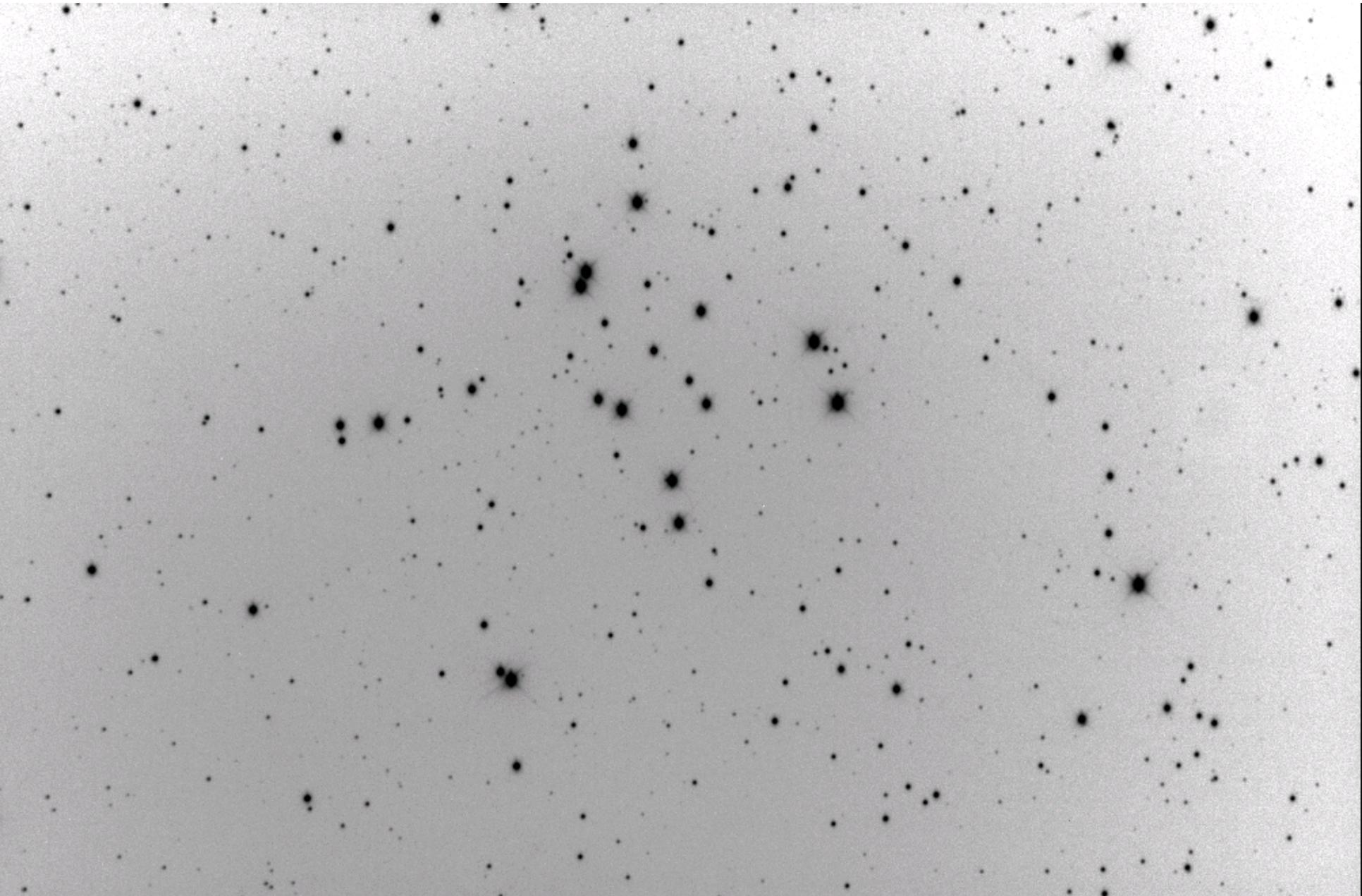
One field approximately centered on M34.

M34 V 300 sec unflattened



One field approximately centered on M34.

M34 B 300 sec unflattened



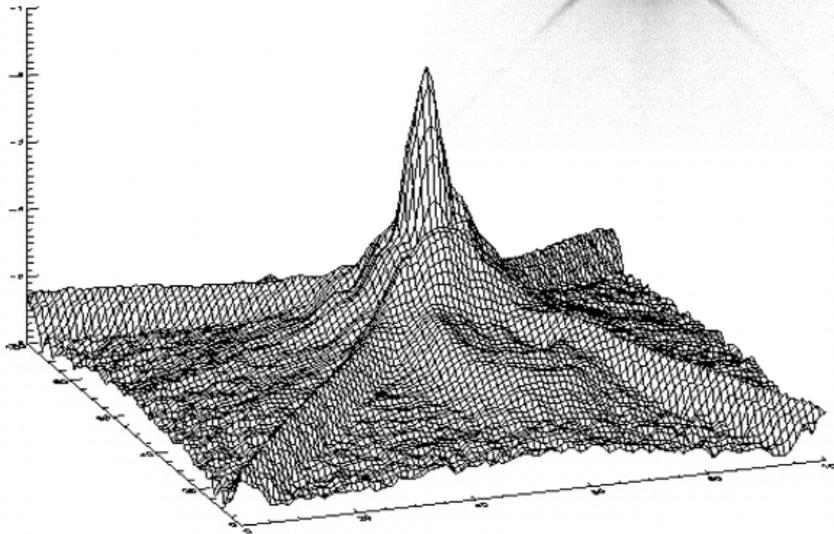
Faint stars have less signal than in V.

M34 2nd field V 300 sec unflattened



Measuring Stellar Brightness

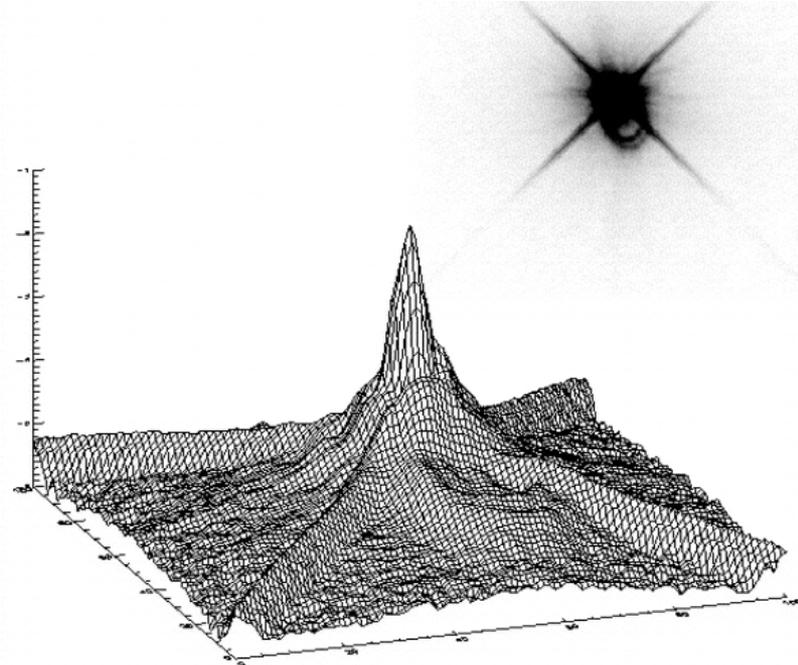
- Another method of measuring stellar brightness uses the shape of a stellar image – the PSF
 - For space telescopes (such as HST), the core (and spikes) are mostly determined by diffraction due to the telescope aperture. This is less variable with time than seeing (though still affected by focus changes).



Stellar “point spread function” (PSF) for the Space Telescope Imaging Spectrograph (O’Dowd & Urry 2005)

Measuring Stellar Brightness

- PSF-fitting method:
 - Fit a functional form for the PSF plus a constant sky to the pixel values. Volume under the function is a measure of the stellar brightness.
 - Bright pixels in the core have the highest weight in the fit → better S/N.
 - Can measure overlapping stars by simultaneously fitting two PSFs.
 - But greater complexity and higher computational cost.



Stellar Photometry in Images

- Steps
 - Correction of image to a uniform, linear response.
 - Identify and determine positions of stars.
 - Measure the brightness of each star.
 - Do the above two steps with the DAOPHOT software package, which searches for stars in an image and measures their location and brightness.
 - Will measure each image separately since combining images is complex when some clouds are present.

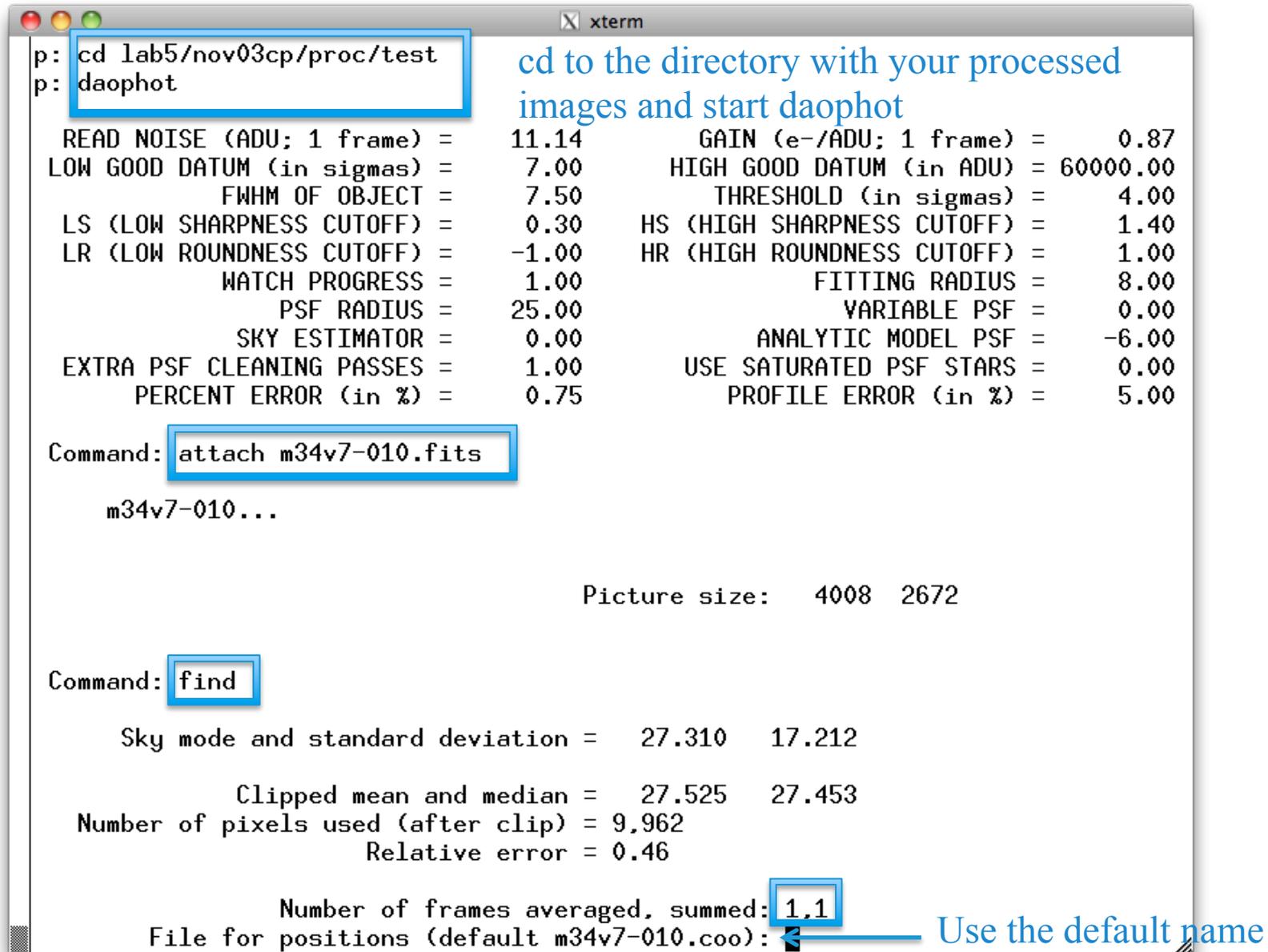
DAOPHOT/ALLSTAR Package

- Finds stars in images and does both aperture and psf-fitting photometry.
- Run in a Unix/Linux terminal window.
- Command line driven programs (i.e., you type in commands), so are less intuitive to use.
- Start-up files initialize parameters.
 - daophot.opt: sets the gain, read noise, and typical FWHM of stars (plus other more esoteric things)
 - photo.opt: sets the aperture and sky annulus radii
 - allstar.opt: sets some parameters for the psf-fitting photometry

DAOPHOT/ALLSTAR Package

- Daophot program finds stars in images and does aperture photometry.
 - Produces a number of files for each image, the most important of which is filename.ap, which contains the aperture photometry of the stars found in the image.

DAOPHOT – the *attach* command specifies the image to measure



The screenshot shows an xterm window with the following content:

```
p: cd lab5/nov03cp/proc/test
p: daophot
```

cd to the directory with your processed images and start daophot

READ NOISE (ADU; 1 frame) =	11.14	GAIN (e-/ADU; 1 frame) =	0.87
LOW GOOD DATUM (in sigmas) =	7.00	HIGH GOOD DATUM (in ADU) =	60000.00
FWHM OF OBJECT =	7.50	THRESHOLD (in sigmas) =	4.00
LS (LOW SHARPNESS CUTOFF) =	0.30	HS (HIGH SHARPNESS CUTOFF) =	1.40
LR (LOW ROUNDNESS CUTOFF) =	-1.00	HR (HIGH ROUNDNESS CUTOFF) =	1.00
WATCH PROGRESS =	1.00	FITTING RADIUS =	8.00
PSF RADIUS =	25.00	VARIABLE PSF =	0.00
SKY ESTIMATOR =	0.00	ANALYTIC MODEL PSF =	-6.00
EXTRA PSF CLEANING PASSES =	1.00	USE SATURATED PSF STARS =	0.00
PERCENT ERROR (in %) =	0.75	PROFILE ERROR (in %) =	5.00

Command: `attach m34v7-010.fits`

m34v7-010...

Picture size: 4008 2672

Command: `find`

Sky mode and standard deviation =	27.310	17.212
Clipped mean and median =	27.525	27.453
Number of pixels used (after clip) =	9,962	
Relative error =	0.46	

Number of frames averaged, summed: `1,1`

File for positions (default m34v7-010.coo): `←` *Use the default name*

DAOPHOT – the *find* command finds the stars in the image

```

ID #   X   Y   Mag  shape parameters
4952 3198.0 2672.0  -0.3  -10.00  -10.00
4953 3270.0 2672.0   0.0  -10.00  -10.00
4954 3298.0 2672.0  -0.2  -10.00  -10.00
4955 3423.0 2672.0  -0.3  -10.00  -10.00
4956 3559.0 2672.0  -0.2  -10.00  -10.00
4957 3575.0 2672.0  -0.4  -10.00  -10.00
4958 3693.0 2672.0  -0.2  -10.00  -10.00
4959 3761.0 2672.0  -0.2  -10.00  -10.00
4960 3778.0 2672.0   0.0  -10.00  -10.00
4961 3789.0 2672.0  -0.3  -10.00  -10.00
4962 3819.0 2672.0  -0.2  -10.00  -10.00
4963 3933.0 2672.0  -0.3  -10.00  -10.00

Are you happy with this? y

Command: phot

File with aperture radii (default photo.opt):

A1 RADIUS OF APERTURE 1 = 8.00   A2 RADIUS OF APERTURE 2 = 0.00
A3 RADIUS OF APERTURE 3 = 0.00   A4 RADIUS OF APERTURE 4 = 0.00
A5 RADIUS OF APERTURE 5 = 0.00   A6 RADIUS OF APERTURE 6 = 0.00
A7 RADIUS OF APERTURE 7 = 0.00   A8 RADIUS OF APERTURE 8 = 0.00
A9 RADIUS OF APERTURE 9 = 0.00   AA RADIUS OF APERTURE 10 = 0.00
AB RADIUS OF APERTURE 11 = 0.00  AC RADIUS OF APERTURE 12 = 0.00
IS   INNER SKY RADIUS = 50.00    OS   OUTER SKY RADIUS = 60.00

PHO> Are given the option to alter the radii here, but you do not need to.

Input position file (default m34v7-010.coo):
Output file (default m34v7-010.ap):
```

Many stars found, some of which will turn out to be noise.

Use default names

DAOPHOT – the *phot* command performs aperture photometry

```

ID #   X       Y       Ap Mag  unc   sky level
-----
4942 2635.00 2672.00  97.999 +- 9.999   27.2
4943 2742.00 2672.00  97.999 +- 9.999   27.6
4944 2758.00 2672.00  97.999 +- 9.999   28.5
4945 2802.00 2672.00  97.999 +- 9.999   27.8
4946 2880.00 2672.00  97.999 +- 9.999   28.1
4947 2928.00 2672.00  97.999 +- 9.999   27.2
4948 2951.00 2672.00  97.999 +- 9.999   28.6
4949 3004.00 2672.00  97.999 +- 9.999   27.6
4950 3015.00 2672.00  97.999 +- 9.999   27.6
4951 3190.00 2672.00  97.999 +- 9.999   27.8
4952 3198.00 2672.00  97.999 +- 9.999   28.0
4953 3270.00 2672.00  97.999 +- 9.999   27.8
4954 3298.00 2672.00  97.999 +- 9.999   27.4
4955 3423.00 2672.00  97.999 +- 9.999   27.5
4956 3559.00 2672.00  97.999 +- 9.999   28.5
4957 3575.00 2672.00  97.999 +- 9.999   28.9
4958 3693.00 2672.00  97.999 +- 9.999   29.1
4959 3761.00 2672.00  97.999 +- 9.999   27.6
4960 3778.00 2672.00  97.999 +- 9.999   28.3
4961 3789.00 2672.00  97.999 +- 9.999   27.6
4962 3819.00 2672.00  97.999 +- 9.999   27.4
4963 3933.00 2672.00  97.999 +- 9.999   28.3

Estimated magnitude limit (Aperture 1): 16.9 +- 0.4 per star.

Command: pick
          Input file name (default m34v7-010.ap):
          Desired number of stars, faintest magnitude: 30.99
          Output file name (default m34v7-010.lst):
```

Pick 30 stars, regardless of magnitude.

DAOPHOT – *pick* chooses bright, unsaturated stars to determine the psf

```
xterm
4950 3015.00 2672.00 97.999 +- 9.999 27.6
4951 3190.00 2672.00 97.999 +- 9.999 27.8
4952 3198.00 2672.00 97.999 +- 9.999 28.0
4953 3270.00 2672.00 97.999 +- 9.999 27.8
4954 3298.00 2672.00 97.999 +- 9.999 27.4
4955 3423.00 2672.00 97.999 +- 9.999 27.5
4956 3559.00 2672.00 97.999 +- 9.999 28.5
4957 3575.00 2672.00 97.999 +- 9.999 28.9
4958 3693.00 2672.00 97.999 +- 9.999 29.1
4959 3761.00 2672.00 97.999 +- 9.999 27.6
4960 3778.00 2672.00 97.999 +- 9.999 28.3
4961 3789.00 2672.00 97.999 +- 9.999 27.6
4962 3819.00 2672.00 97.999 +- 9.999 27.4
4963 3933.00 2672.00 97.999 +- 9.999 28.3

Estimated magnitude limit (Aperture 1): 16.9 +- 0.4 per star.

Command: pick

      Input file name (default m34v7-010.ap):
Desired number of stars, faintest magnitude: 30.99
      Output file name (default m34v7-010.lst):

      30 suitable candidates were found.

Command: psf

File with aperture results (default m34v7-010.ap):
File with PSF stars (default m34v7-010.lst):
File for the PSF (default m34v7-010.psf):
```

Keep using default names

DAOPHOT – *psf* uses the picked stars to determine the psf. It shows a simple plot of each star and you decide whether to use it or not.


```
xterm
236 2796.85 390.97 12.391 27.6 Brightest pixel: 1749
Use this one? y

Chi Parameters...
>> 0.0475 4.00399 3.89406
>> 0.0665 2.54644 2.53558 -0.05137
>> 0.0413 3.54019 3.43217 -0.00949
>> 0.0411 3.66591 3.55743 -0.00837
>> 0.0615 3.28475 3.14228 -0.01441
>> 0.0410 3.62599 3.52361 0.64871 -0.01181

Profile errors:

514 0.021 1802 0.027 1054 0.042 3969 0.035 461 0.069
267 0.046 1100 0.028 1588 0.030 3821 0.042 1044 0.049
1426 0.025 840 0.029 1193 0.034 4237 0.049 4647 0.025
1835 0.102 ? 2230 0.028 1538 0.025 179 0.041 236 0.035
1728 0.027 23 0.135 * 1114 0.029 2665 0.034
3410 0.027 695 0.029 1142 0.031 2735 0.049

Computed 103 rows of 103 in the PSF.

File with PSF stars and neighbors = m34v7-010.nei

Command: exit

Good bye.

p: █
```

Tries six different functional forms for the psf and chooses the one that fits best. Differences from the functional form are handled with a look-up table (so any psf shape can be accommodated).

DAOPHOT – *exit* returns to the Unix command line

DAOPHOT/ALLSTAR Package

- Daophot program finds stars in images and does aperture photometry.
 - Produces a number of files for each image, the most important of which is filename.ap, which contains the aperture photometry of the stars found in the image.

```
p: more m34ev7-009.ap
NL    NX    NY  LOWBAD  HIGHBAD  THRESH    AP1  PH/ADU  RNOISE  FRAD
  2  2004  1336    31.1  60000.0   67.88    6.00   1.78   15.50   4.00

      1  995.000    1.000   97.999
        152.349  11.81   0.01   9.9999

      2  425.770    8.040   15.980
        153.462  12.28   0.00   0.0396

      3  873.000   25.090   16.480
        151.738  12.22   0.02   0.0598

      4 1252.420   55.100   15.006
        154.789  12.78   0.02   0.0176

      5 1830.990   65.220   16.636
        161.665  13.64   0.00   0.0762
```

DAOPHOT/ALLSTAR Package

- Daophot program finds stars in images and does aperture photometry.
 - Produces a number of files for each image, the most important of which is filename.ap, which contains the aperture photometry of the stars found in the image.
- Allstar program takes the list of stars with aperture photometry and measures brightnesses using psf-fitting photometry.

```
xterm
p: allstar

      FITTING RADIUS =      8.00      CE (CLIPPING EXPONENT) =      6.00
REDETERMINE CENTROIDS =      1.00      CR (CLIPPING RANGE) =      2.50
      WATCH PROGRESS =      1.00      MAXIMUM GROUP SIZE =     50.00
      PERCENT ERROR (in %) =      0.75  PROFILE ERROR (in %) =      5.00
      IS (INNER SKY RADIUS) =     35.00  OS (OUTER SKY RADIUS) =     50.00

OPT> (are given the option to change parameters here, but this is unnecessary)

      Input image name: m34v7-010.fits

m34v7-010...

      Picture size:      4008  2672

      File with the PSF (default m34v7-010.psf):
      Input file (default m34v7-010.ap):
      File for results (default m34v7-010.als):
Name for subtracted image (default m34v7-010s):

4963 stars. <<

I = iteration number
R = number of stars that remain
D = number of stars that disappeared
```

Use the default input and output filenames.

ALLSTAR – does the psf-fitting photometry

I = iteration number

R = number of stars that remain

D = number of stars that disappeared

C = number of stars that converged

I	R	D	C	
1	4963	0	0	<<
2	4963	0	0	<<
3	4963	0	0	<<
4	4800	89	74	<<
5	4203	194	566	<<
6	3002	703	1258	<<
7	2148	1436	1379	<<
8	1508	1820	1635	<<
9	1179	2111	1673	<<
10	946	2319	1698	<<
11	702	2537	1724	<<
12	477	2744	1742	<<
13	292	2915	1756	<<
14	131	3063	1769	<<
15	46	3139	1778	<<
16	39	3139	1785	<<
17	29	3139	1795	<<
18	24	3139	1800	<<
19	14	3139	1810	<<
20	14	3139	1810	<<
21	12	3139	1812	<<

ALLSTAR fits all of the stars in the image simultaneously, so overlapping stars are handled correctly (assuming that both stars are in the input list). The solution is done iteratively.

DAOPHOT/ALLSTAR Package

- Daophot program finds stars in images and does aperture photometry.
- Allstar program takes the list of stars with aperture photometry and measures brightnesses using psf-fitting photometry.
 - Produces the file filename.als with the photometry.

p: more m34ev7-009.als

NL	NX	NY	LOWBAD	HIGHBAD	THRESH	AP1	PH/ADU	RNOISE	FRAD
1	2004	1336	31.1	60000.0	67.88	6.00	1.78	15.50	4.00
2	425.784	8.097	15.842	0.0319	153.258	4.	0.809	-0.231	
3	873.033	25.118	16.388	0.0412	152.051	4.	0.638	-0.262	
5	1831.009	65.199	16.443	0.0504	161.033	4.	0.752	-0.567	
7	28.090	75.584	14.973	0.0266	158.046	4.	1.398	-0.566	
12	935.358	101.587	13.640	0.0145	153.754	4.	1.904	-0.478	
16	616.994	158.965	15.384	0.0246	153.930	4.	0.915	-0.559	
21	474.005	205.141	16.326	0.0430	154.094	4.	0.713	-0.432	
27	1932.841	264.414	16.510	0.0631	162.679	4.	0.895	-0.569	
28	722.355	267.434	12.934	0.0132	154.070	4.	2.481	-0.529	
30	301.696	278.430	13.178	0.0171	156.263	4.	2.892	-0.748	
32	232.085	304.477	16.335	0.0428	156.518	4.	0.698	-0.513	

DAOPHOT/ALLSTAR Package

- Daophot program finds stars in images and does aperture photometry.
- Allstar program takes the list of stars with aperture photometry and measures brightnesses using psf-fitting photometry.
 - Produces the file filename.als with the photometry.
 - Also produces filenames.fits, which is the original image with the fitted psf's subtracted.

Original 7-second, V-band image

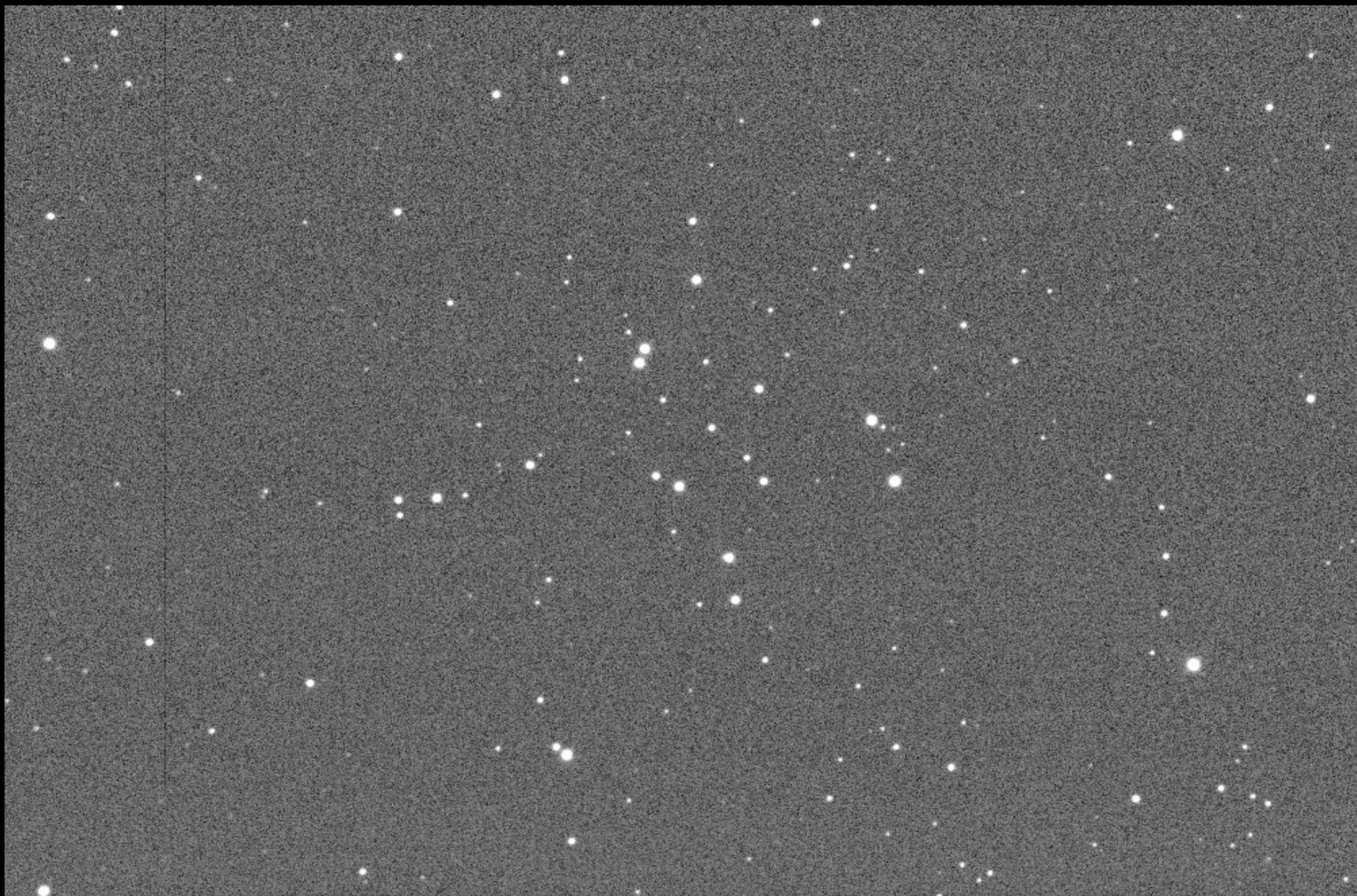


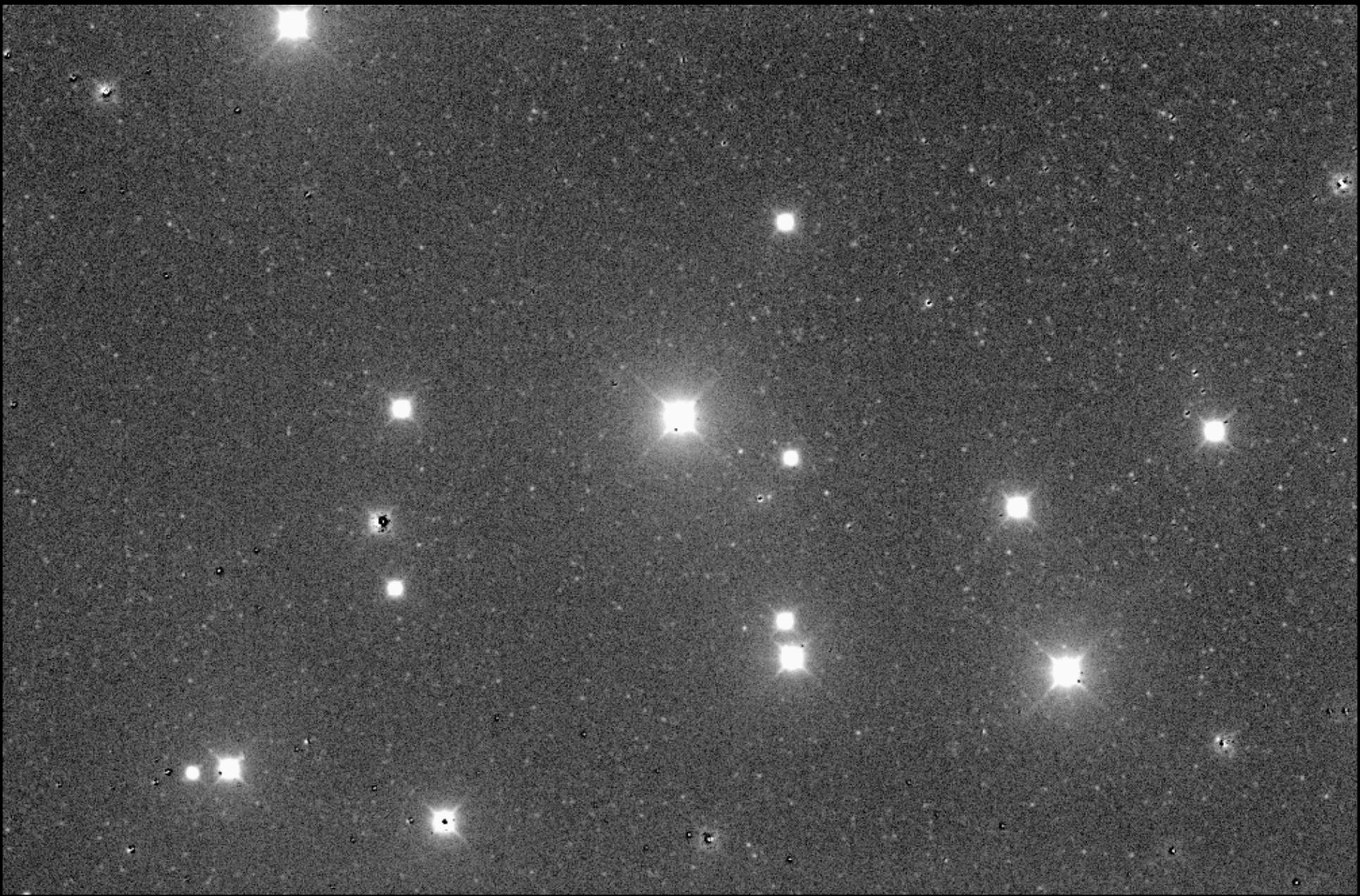
Image with the fitted psf's subtracted – produced by Allstar



Long exposure, V-band image



Fitted psf's subtracted. Note saturated stars are not fitted.



DAOPHOT/ALLSTAR Package

- Daophot program finds stars in images and does aperture photometry.
- Allstar program takes the list of stars with aperture photometry and measures brightnesses using psf-fitting photometry.
- Daomatch and Daomaster programs handle the job of combining output from multiple images.
 - First combine all exposure times from both fields for each filter separately.

-rw-r--r-- 1 pryor staff 106946 Nov 8 17:23 m34v7-043.als

p: daomatch

Master input file: m34v7-010.als

Output file name (default m34v7-010.mch):

Next input file: m34v7-042.als

```

          Frame 2:
    star  1  2  3
    +-----+
Frame 1: 1 | 1  -  -
          2 | -  1  -
          3 | -  -  1

```

```

m34v7-042.als          -2      1  1.000  0.000  0.000  1.000  0.
03

```

```

          3  0.994  0.000  0.000  0.003  0.002
          2  2.000  2.000  0.400  0.500
WT  0.9942961  <  2.000000

```

```

          Frame 2:
    star  1  2  3  4
    +-----+
Frame 1: 1 | 3  -  -  -
          2 | -  3  -  -
          3 | -  -  3  -
          4 | -  -  -  3

```

```

m34v7-042.als          -2      1  1.000  0.000  0.000  1.000  C

```

daomatch begins the process of matching stars in the ALLSTAR output files for each image

```
m34v180-049.als          0    3  1.000  0.000  0.000  1.000  3.
60
      12    1.985    0.000    0.000    0.016    0.005
      5     2.000    2.000    0.400    0.500
WT  1.984952    <    2.000000
```

Frame 2:

star	1	2	3	4	5	6
Frame 1: 1	6	-	-	-	-	-
2	-	6	-	-	-	-
3	-	-	6	-	-	-
4	-	-	-	-	-	6
5	-	-	-	-	6	-
6	-	-	-	-	-	-

```
m34v180-049.als          0    3  1.000  0.000  0.000  1.000  3.
53
      30    6.941    0.000    0.000    0.021    0.005
      11    2.000    2.000    0.400    0.500
      45    >          6
```

Next input file (default EXIT):

Good bye.

p:

Keep entering files until have done all of them for a given filter (V or B)

daomaster finishes the job of matching the stars in the “als” files.

```
p: daomaster
MONGO version

File with list of input files: m34v7-010.mch

9 input files

Maximum permitted number of stars in the master list: 500,000

Minimum number, minimum fraction, enough frames: 3.0.33.3
Maximum sigma: 10.

Desired degrees of freedom ---
2: Translations only
4: Translations, rotation, and scale
6: Six-constant linear transformation
12: Quadratic transformation
20: Cubic transformation

Your choice: 6
Critical match-up radius: 3.0

0.55 0.47 -2 1 1.000 0.000 0.000 1.000 0.03 0.017 236 2 m34v7-042.als
0.57 0.50 -2 1 1.000 0.000 0.000 1.000 -0.86 0.026 156 2 m34v7-043.als
0.54 0.45 0 3 1.000 0.000 0.000 1.000 1.30 0.029 252 2 m34v35-044.als
0.54 0.51 -1 2 1.000 0.000 0.000 1.000 1.36 0.027 272 2 m34v35-045.als
0.55 0.51 -1 3 1.000 0.000 0.000 1.000 1.53 0.032 281 2 m34v35-046.als
0.60 0.54 1 2 1.000 0.000 0.000 1.000 3.42 0.046 288 2 m34v180-047.als
```

Keep stars that appear in one or more images (so should answer first input with 1,0.16,1).

Actually use 2 here.

```
jedrusiak@astrolab:~  
0.54 0.45      0      3  1.000  0.000  0.000  1.000  1.30 0.029  252  2  m34v35-044.als  
0.54 0.51     -1      2  1.000  0.000  0.000  1.000  1.36 0.027  272  2  m34v35-045.als  
0.55 0.51     -1      3  1.000  0.000  0.000  1.000  1.53 0.032  281  2  m34v35-046.als  
0.60 0.54      1      2  1.000  0.000  0.000  1.000  3.42 0.046  288  2  m34v180-047.als  
0.60 0.59      0      2  1.000  0.000  0.000  1.000  3.56 0.047  290  2  m34v180-048.als  
0.61 0.57      0      3  1.000  0.000  0.000  1.000  3.56 0.050  289  2  m34v180-049.als  
  
811 stars within radius 3.000  
  
New match-up radius (0 to exit): 0  
  
Transformations are in the sense STANDARD = fn(OBSERVED).  
  
Assign new star IDs? n  
  
Now, do you want...  
A file with mean magnitudes and scatter? y  
Output file name (default m34v7-010.mag):  
A file with corrected magnitudes and errors? y  
Output file name (default m34v7-010.cor):  
A file with raw magnitudes and errors? n  
A file with the new transformations? n  
A file with the transfer table? n  
Individual .COO files? n  
Simply transfer star IDs? n  
  
Good bye.  
  
p: edit m34v7-010.mag  
p: edit m34v7-010.cor  
p: █
```

Answer y to this question and use and output filename of, for example, m34v.mag or m34b.mag.

Answer no to the rest of the questions.

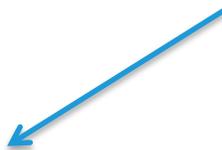
DAOPHOT/ALLSTAR Package

- Daophot program finds stars in images and does aperture photometry.
- Allstar program takes the list of stars with aperture photometry and measures brightnesses using psf-fitting photometry.
- Daomatch and Daomaster programs handle the job of combining output from multiple images.
 - First combine all exposure times from both fields for each filter separately.
 - Then combine the combined V and B photometry into a file that keeps both instrumental magnitudes.

```
jedrusiak@astrolab:~  
0.54 0.45      0      3  1.000  0.000  0.000  1.000  1.30 0.029  252  2 m34v35-044.als  
0.54 0.51     -1      2  1.000  0.000  0.000  1.000  1.36 0.027  272  2 m34v35-045.als  
0.55 0.51     -1      3  1.000  0.000  0.000  1.000  1.53 0.032  281  2 m34v35-046.als  
0.60 0.54      1      2  1.000  0.000  0.000  1.000  3.42 0.046  288  2 m34v180-047.als  
0.60 0.59      0      2  1.000  0.000  0.000  1.000  3.56 0.047  290  2 m34v180-048.als  
0.61 0.57      0      3  1.000  0.000  0.000  1.000  3.56 0.050  289  2 m34v180-049.als  
  
811 stars within radius 3.000  
  
New match-up radius (0 to exit): 0  
  
Transformations are in the sense STANDARD = fn(OBSERVED).  
  
Assign new star IDs? n  
  
Now, do you want...  
A file with mean magnitudes and scatter? y  
Output file name (default m34v7-010.mag):  
A file with corrected magnitudes and errors? y  
Output file name (default m34v7-010.cor):  
A file with raw magnitudes and errors? n  
A file with the new transformations? n  
A file with the transfer table? n  
Individual .COO files? n  
Simply transfer star IDs? n  
  
Good bye.  
  
p: edit m34v7-010.mag  
p: edit m34v7-010.cor  
p: █
```

Answer n to the above questions and y to this one. Use an output filename like m34bv.raw.

Answer no to the rest of the questions.



DAOPHOT/ALLSTAR Package

- Daomatch and Daomaster programs handle the job of combining output from multiple images.
 - First combine all exposure times from both fields for each filter separately.
 - Then combine the combined V and B photometry into a file that keeps both instrumental magnitudes.

p: more M34bv.raw

NL	NX	NY	LOWBAD	HIGHBAD	THRESH	AP1	PH/ADU	RNOISE	FRAD
1	2004	1336	-500.0	60000.0	83.13	6.00	1.78	15.50	4.00
1		-6.040	1381.071	16.7460	0.0373	17.2080	0.0474	1.0530	-0.4945
2		0.874	1957.021	15.4050	0.0154	15.6720	0.0166	1.3535	-0.2675
3		1.133	1602.247	17.8290	0.0786	18.6260	0.1708	0.9330	-1.6125
4		1.325	771.538	16.1970	0.0210	16.9070	0.0321	1.0095	-0.6415
5		3.636	1158.937	15.3510	0.0133	15.8030	0.0126	1.5440	-0.5310
6		5.074	1638.648	16.6380	0.0331	17.1250	0.0373	0.9255	-0.3760
7		9.995	1070.020	15.2160	0.0130	15.5690	0.0106	1.6215	-0.5795
8		11.265	392.488	17.5940	0.0804	17.8790	0.1000	1.1820	-0.8500
9		12.723	523.524	13.4860	0.0156	14.2920	0.0098	3.0075	-0.7750
10		19.449	970.575	17.1510	0.0534	17.6280	0.0583	1.0435	-0.3095
11		21.628	1092.049	16.1150	0.0163	16.4610	0.0175	1.0925	-0.4065
12		21.908	113.231	17.0120	0.0491	17.4360	0.0622	1.1580	-0.8630
13		24.524	1111.436	17.9820	0.1128	18.3800	0.1471	1.1310	-1.0085

DAOPHOT/ALLSTAR Package

- Read the m34bv.raw (or whatever) file into excel (or your other favorite data-manipulation language).
 - Compute a column that is b-v.
 - Plot v vs b-v. (Remember to make the axes go the right way and include uncertainties on the points.)

M34 instrumental (v, b-v) color-magnitude diagram.

1,235 stars

