Hewett 1 Imaged by Amateur

- Largest Planetary Nebula in Sky reported by Hewett, et al on 4 Nov2003.
  - Estimated to be 2 degrees diameter
- Serendipitous discovery by spectral analysis of Sloan Survey data
  - Emission detected in [OIII], [NII] and Ha
  - Emission strongest in [OIII]
- Images taken by Hewett of 0.8 x 0.8 degree zone
  - [OIII] and [SII] images reported (900sec exposure, Widefield Camera, Isaac Newton 2.5M telescope)

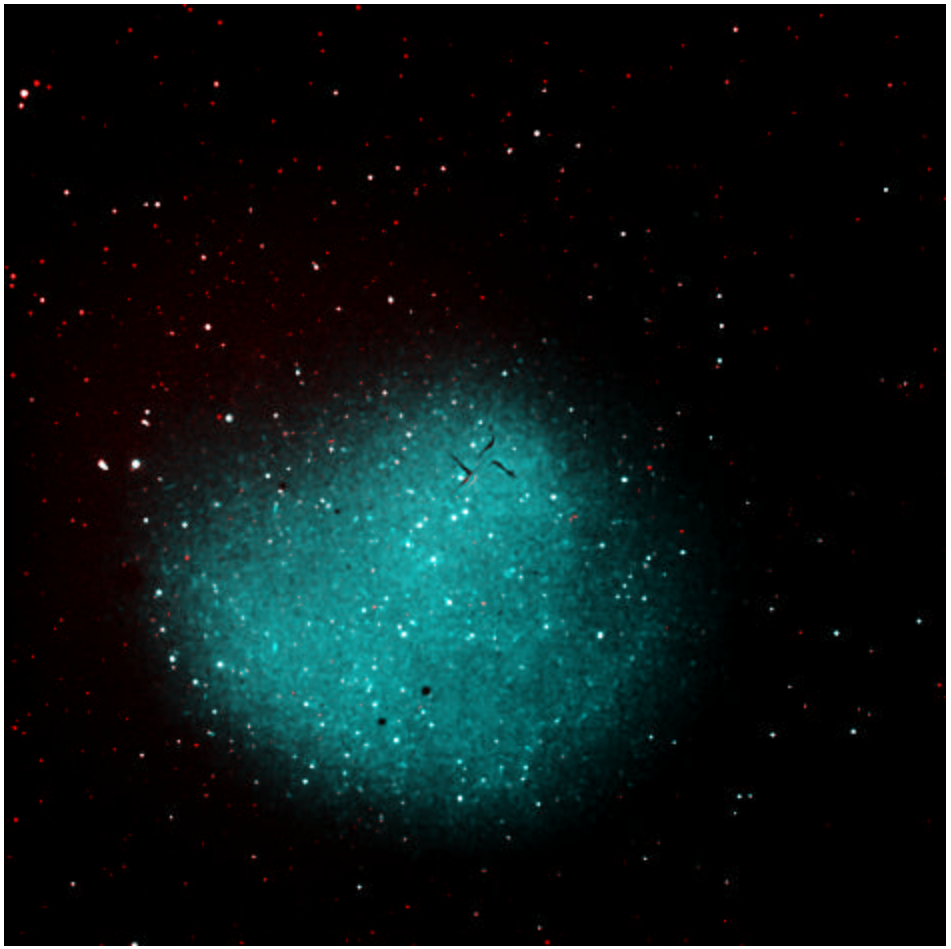
Goal is to take Amateur Image

- Use AP Traveler with 0.75x telecompressor, FLI IMG1024S camera (TK1024 sensor), Cust Sci 3nm FWHM emission line filters ([OIII], Ha, [SII]).
- System roughly 500mm focal length with a 105mm aperture
- Image capture time is limited by late visibility of object (imagable around 4am, twilight around 5:30am)

Images taken to date

- Nov 10:
  - Three images of 30 minutes through 3nm FWHM [OIII] (captures 500.7nm line only). Near full-moon, very dewy conditions with poor transparency. Concern about “hot centers” in image from skyglow.
  - Early image (3 x 30 minute [OIII]) sent to Hewett, reply received two days later thanking for sending image congratulations on the accomplishment and surprise it was captured with amateur equipment under such poor conditions considering the very low surface brightness
- Nov 11:
  - One image each of 45 minutes through 3nm FWHM [OIII] (captures 500.7 line only), Ha. Near full-moon, better transparency, less dew

Composite Image



Red = 1 x 45 minutes Halpha

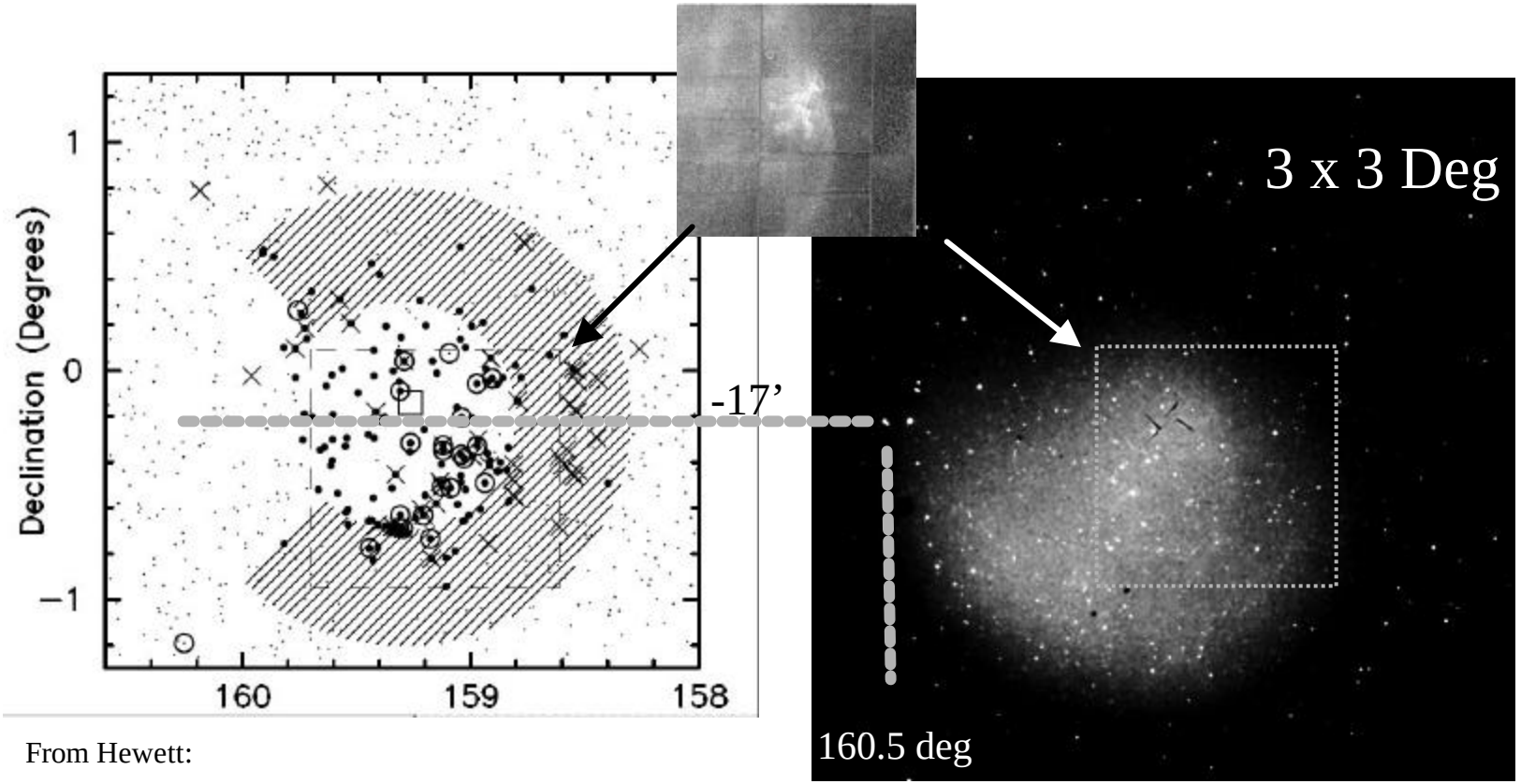
Green = 3 x 30 minutes [OIII] + 1 x 45 minutes [OIII]

Blue = 3 x 30 minutes [OIII] + 1 x 45 minutes [OIII]

North is up, East to left

Dark dots and dark lines on nebula are from sensor defects

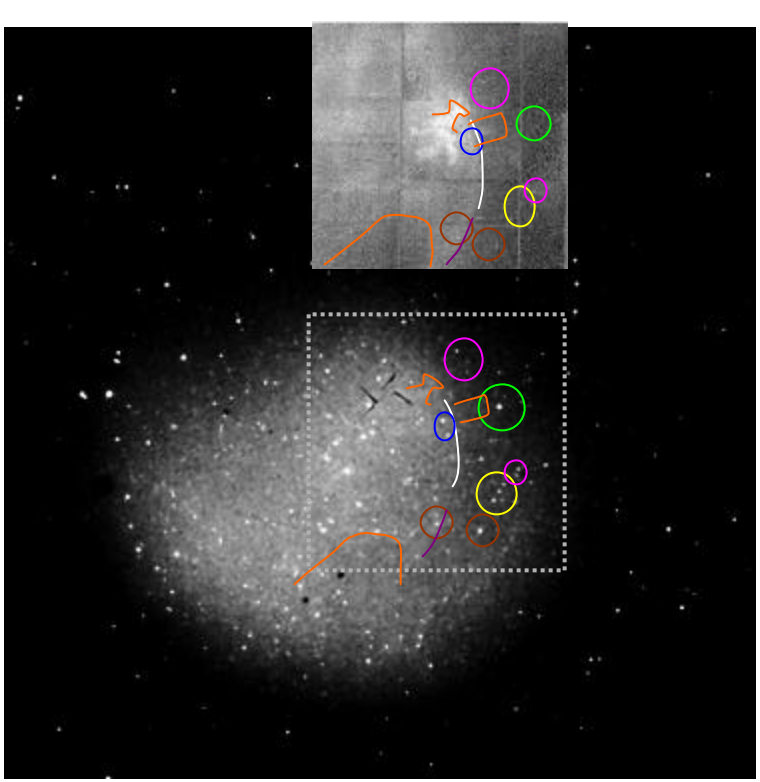
Comparison to Paper

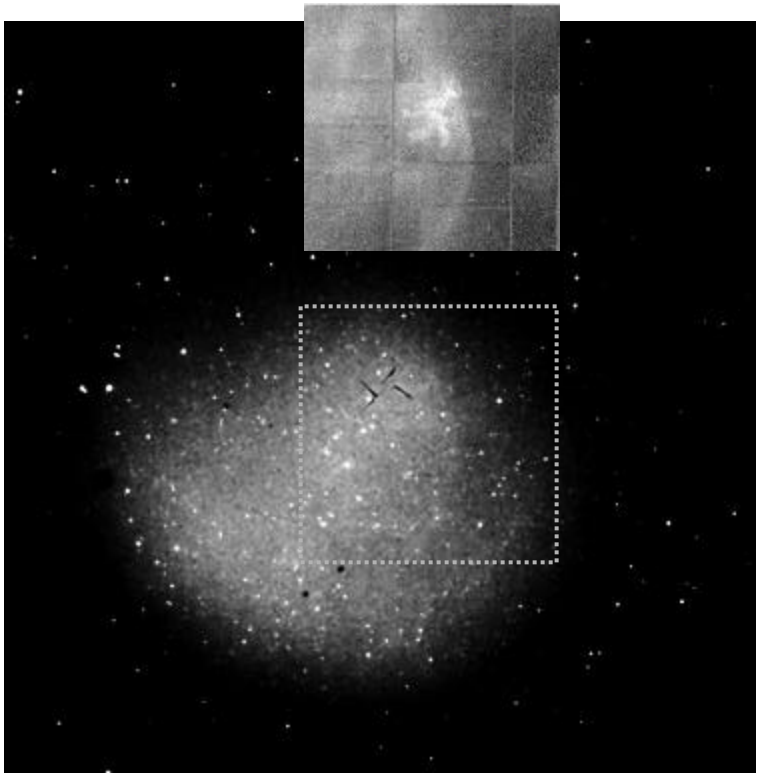


From Hewett:

Spatial distribution of spectra with detectable [O III] 4959,5007 (•), H (?), and [N II] 6583 (×). The hatched area indicates a region where composite spectra also show unambiguous evidence of [O III] 4959,5007 emission. Positions of objects with SDSS spectra for which no individual detections were obtained are also indicated (·). The dashed outline shows the area included in the narrow–band images of Figure 3. The location of the white dwarf PG 1034+001 is marked by a small square.

Correlation of Features

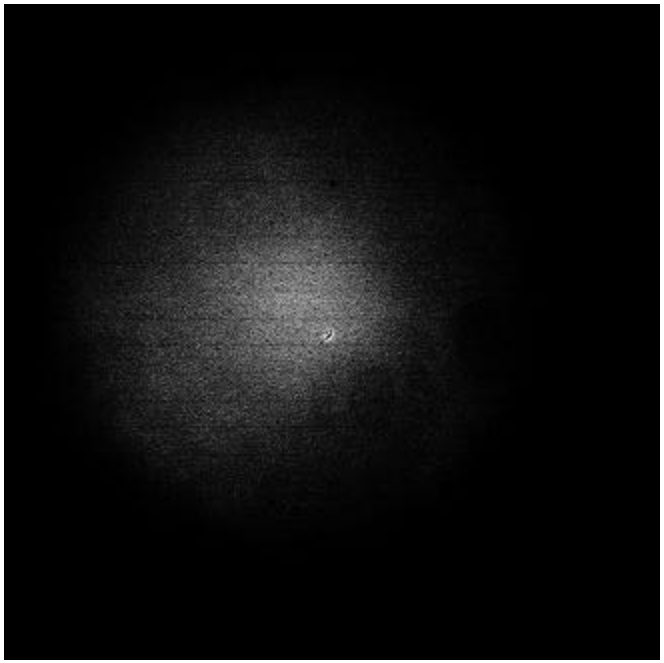




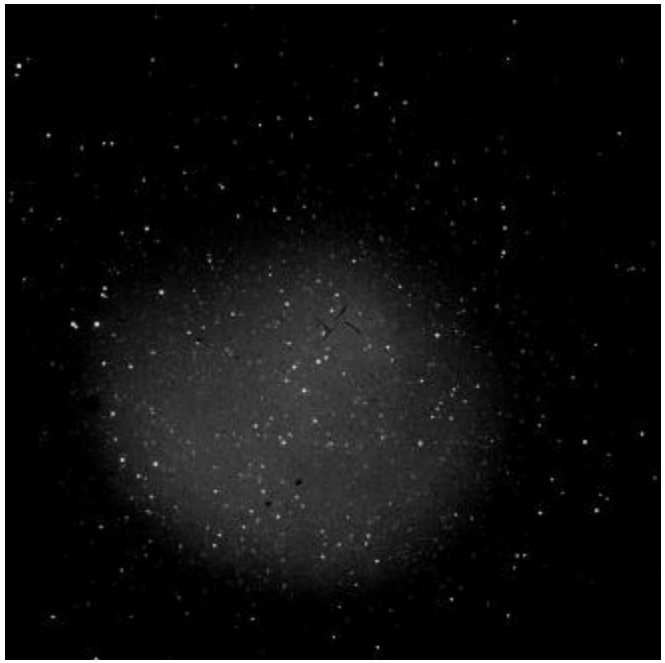
What about “Hot Spots”

- If background sky is too bright, sometimes flat fielding doesn’t completely remove the vignetting pattern
  - If image is “pushed hard” then systematic artifacts may be visible
- Hot spots would be bound by vignetting pattern visible in flatfield
  - Compare object location in image to flatfield
  - look to see if object is in a different place than vignetting pattern in flatfield

Comparison: flatfield to Image



[OIII] Flatfield
Pushed hard
Same orientation as image



[OIII] Image data
Pushed hard
Same orientation as flat

What about exposure times?

- Hewett reported 900 sec sub exposures through 10nm FWHM [OIII] (captures both lines), 900-1200 sec for 9.5nm Ha + [SII]
- What would be the required exposure time for the Traveler/IMG1024S/3nm filter system?

Exposure Benchmark Comparison: WFC/INT

- Lewis, et al report that E2V 2K x 4K sensors are used in WFC and “the coverage of each of the chips is 22.8 x 11.4 arcmin”
  - E2V sensor has 13.5 x 13.5 micron pixels
- Isaac Newton Telescope is reported to be an f/3.29 instrument with an 8357mm focal length

Exposure Benchmark Comparison: Traveler/IMG

- Traveler with 0.75x telecompressor and IMG camera works out to be 500mm focal length with a 105mm aperture; Focal ratio = 4.76
- Camera uses TK1024 sensor: 24 x 24 micron pixels
- Hewett shows relative line strength of 495.9 and 500.7 line to be 1:2.7 (Table 1).

Exposure Benchmark Comparison: Calculations

- Assumptions:
  - QE for sensors: 90% for E2V and 80% for TK1024
- Exposure ratio considering only QE: 1.125
- Exposure ratio considering only focal ratios: 2.09
- Exposure ratio considering only pixel size: 0.316
- Exposure ratio considering both [OIII] lines for Hewett versus one for Traveler/IMG: 1.27
- Overall exposure ratio:

  1.125 * 2.09 * 0.316 * 1.27 * = **0.946**

Discussion

- It is possible that Hewett 1 was imaged using Traveler/IMG camera
- A hot center in the [OIII] data would likely look different based on analysis of flatfield
  - Assumes hot spots would be in same shape of flatfield
- Exposure time used was significantly longer than reported by Hewett
  - Equivalent exposure times determined to be approximately equivalent for the amateur equipment (851 sec vs 900 sec)
  - Actually used longer exposures to assist in capturing image (1800 sec and 2700 sec) from suburban backyard

Conclusions

- I am almost certain that Hewett 1 has been successfully imaged by an amateur
- The initial data and analysis thereof looks encouraging
- More data should be taken at the earliest available opportunity

Next Steps

- Image nearby sky at same anticipated elevation before object rises to see what hot spot looks like after flat-fielding and pushing hard
- Take additional images in [OIII] and Ha, begin [SII]
- Take the additional images with slightly different framing to see if object moves in frame