HOW FAINT CAN WE GO ?

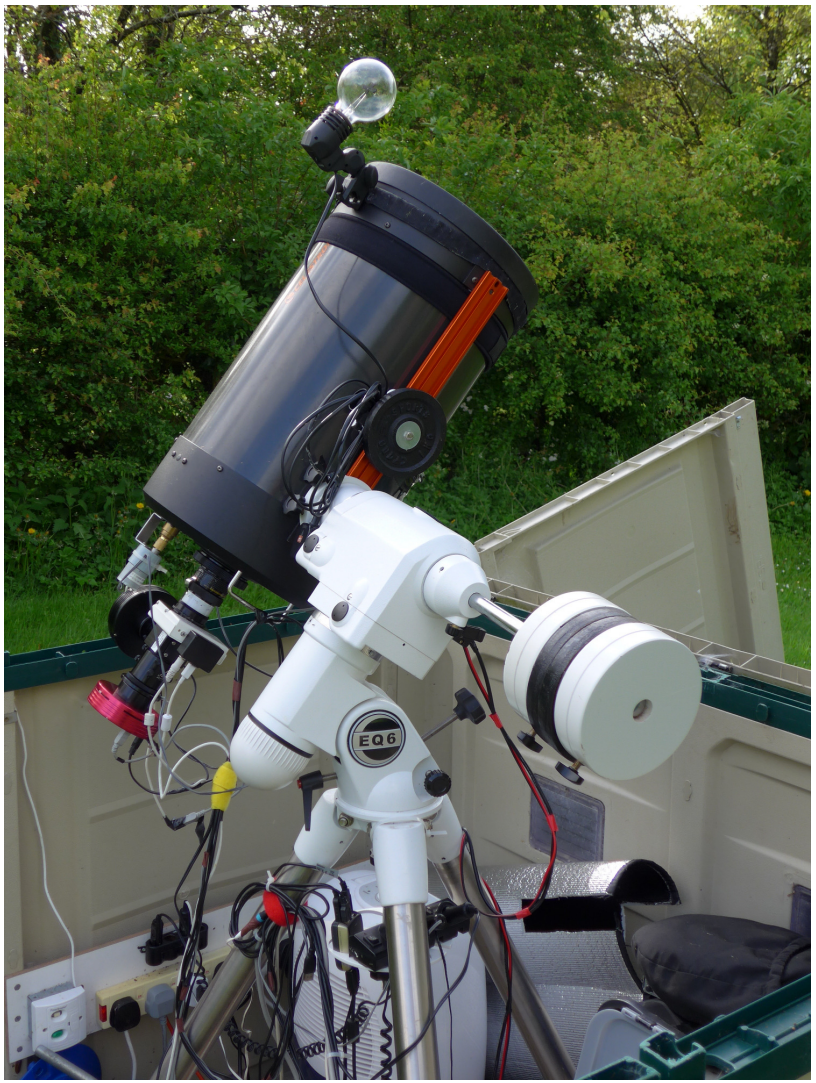
mag 14 ... 15 ... 16 ... 17 ? ... 18 ?? ....

Exploring the magnitude limits of amateur spectroscopy using a modified ALPY spectrograph at Three Hills Observatory

HOW FAINT CAN WE GO?

Modifying the ALPY Spectrograph for fainter objects

Robin Leadbeater



THREE HILLS OBSERVATORY UK

Celestron C11 on EQ6 mount
(EQMod, ASCOM, Cartes du Ciel)

Spectrographs:-

- LHIRES III (150,600,1200,2400)
- Star Analyser (100, 200)
- ALPY 600

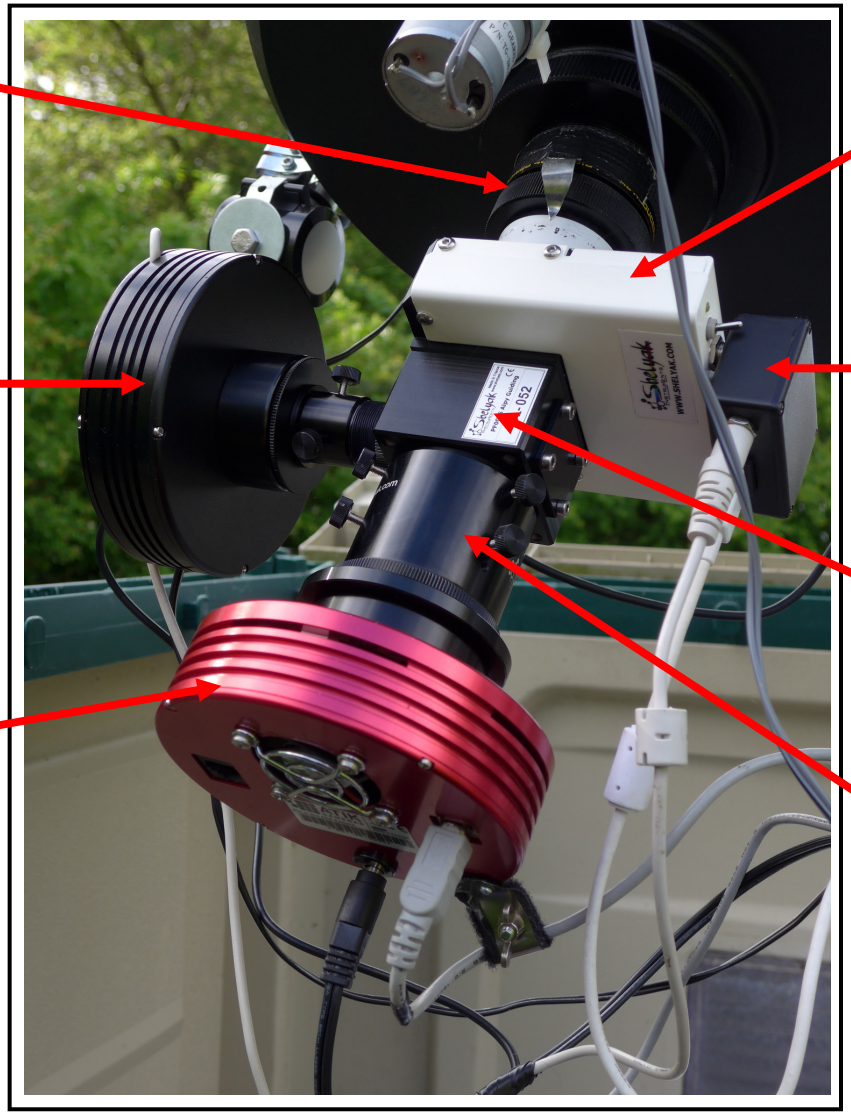
Remotely operated via wireless network
(Windows Remote Desktop)

ALPY SPECTROGRAPH

Focal Reducer
f6

Guide Camera
ATIK 16 IC-S
(cooled ICX415AL)

Science Camera
ATIK 314L+
(cooled ICX285AL)



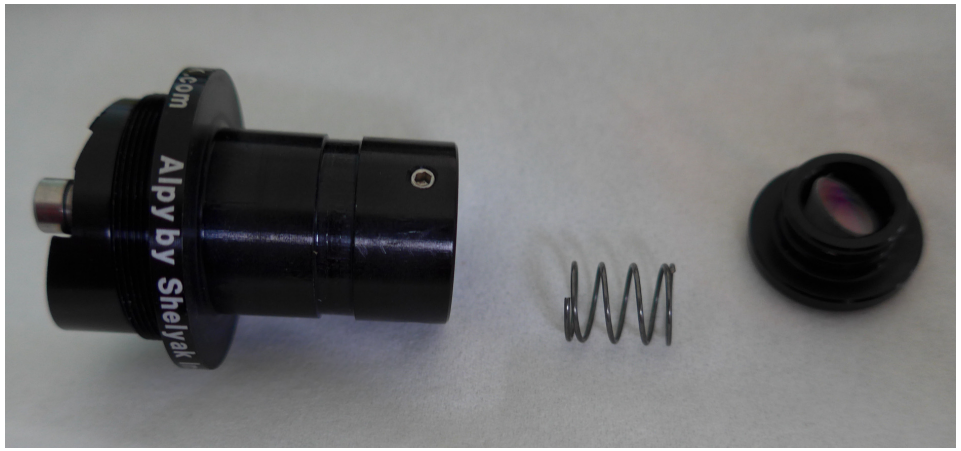
Calibration Module
Tungsten &
Ne/Ar/H lamps

USB
remote control for
calibration module

Guiding Module
23um mirror slit

Core Module
Collimator
Grism
Camera lens

MODIFYING THE ALPY SPECTROGRAPH (ALPY 200)



Removing the the Grism from the ALPY Core Module

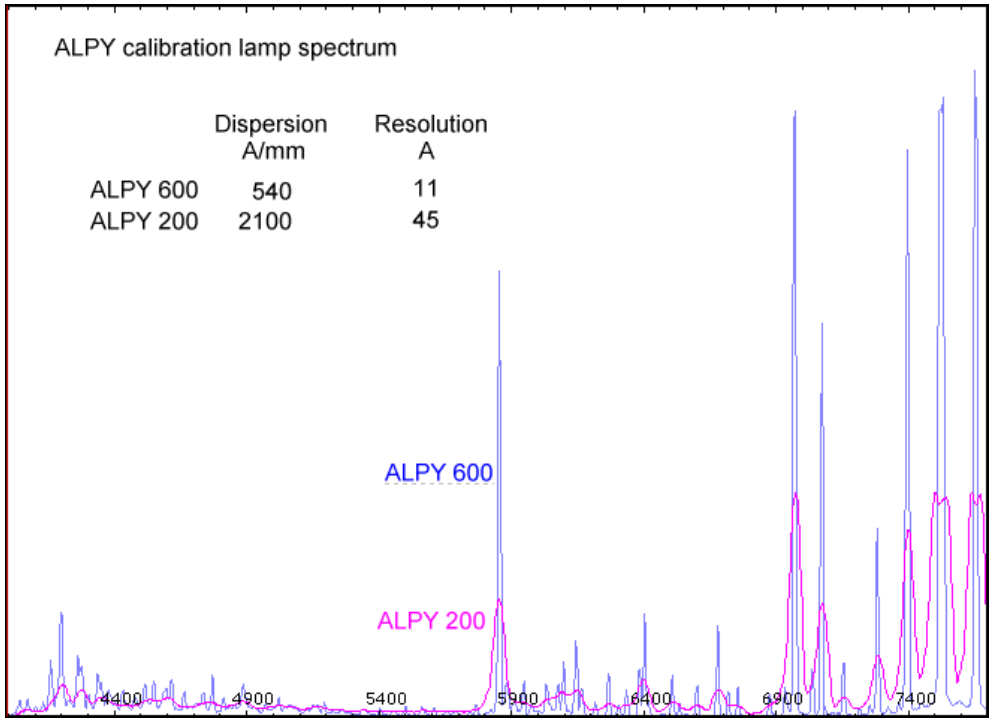
Taking care that the collimator lens does not fall out!

Standard 600 l/mm Grism

Modified 200 l/mm Grism (Made using the Star Analyser 200 master grating)

BENCH TESTS - ALPY 200 v 600

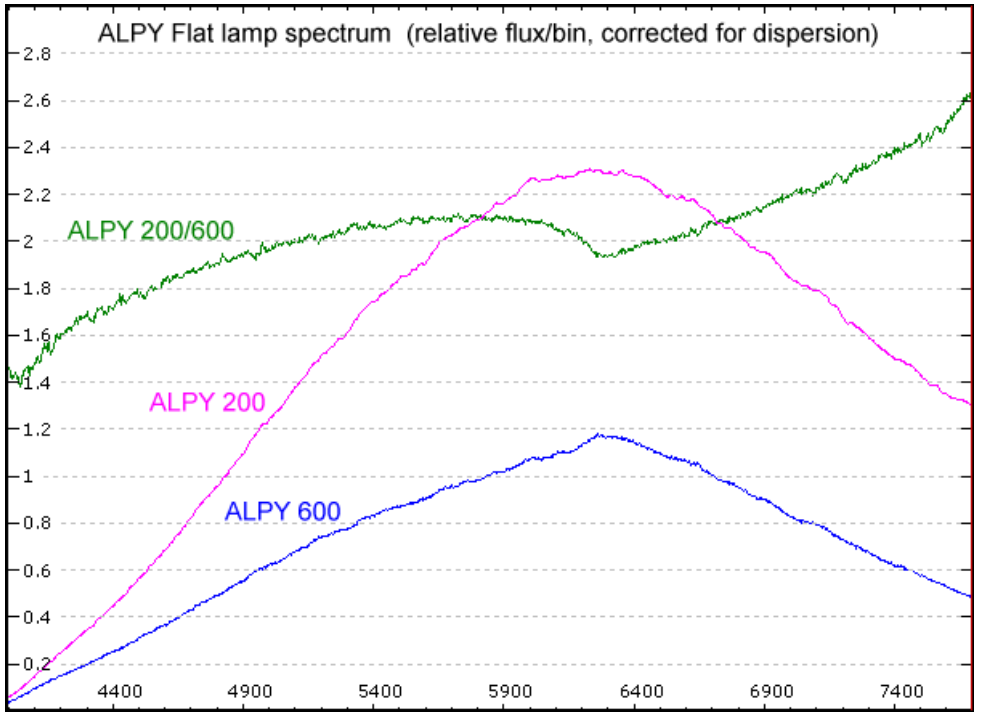
Resolution



The dispersion and resolution of the ALPY200 are ~ 4 lower compared with the ALPY 600

R = 130 at 6000 A is sufficient for supernova identification for example

Efficiency



The efficiency of the 200 l/mm grism is ~ 2x that of the 600 l/mm grism

Combining this with the 4x reduction in dispersion results in an **8x brighter spectrum**

ADVANTAGES OF THE ALPY 200

Compared with the Star Analyser

The slit reduces the sky background level by a factor of ~100, reducing sky noise and eliminating interference from field stars and their spectra.

The mirror slit guider allows longer individual exposures, reducing the total camera read noise contribution.

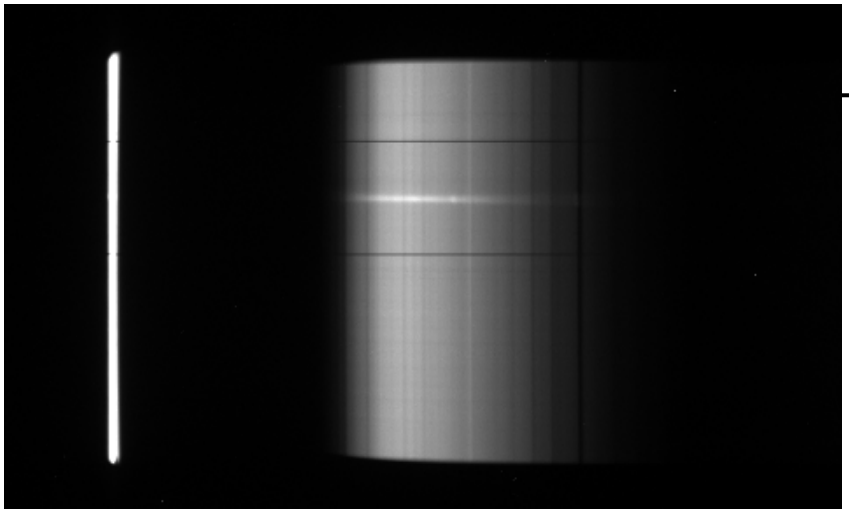
The fully collimated optics produce a sharp spectrum over the full wavelength range, allowing a lower dispersion to be used for the same resolution.

Compared with the ALPY 600

The higher efficiency of the 200 l/mm grism increases the flux in the spectrum.

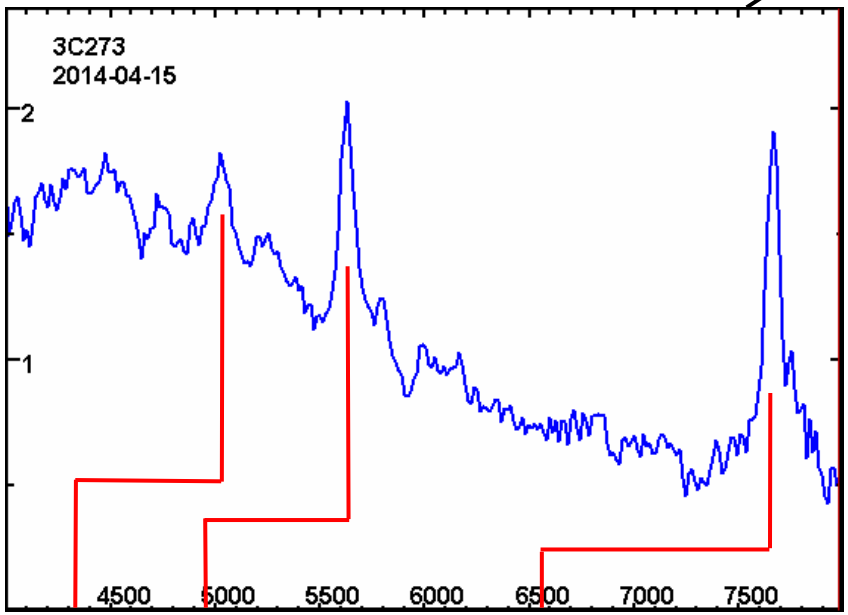
The reduced dispersion minimises the camera thermal noise contribution compared with increasing the effective pixel size by in camera binning

FIRST RESULTS -
QSO 3C273 (mag 12.5) 20 deg from full moon

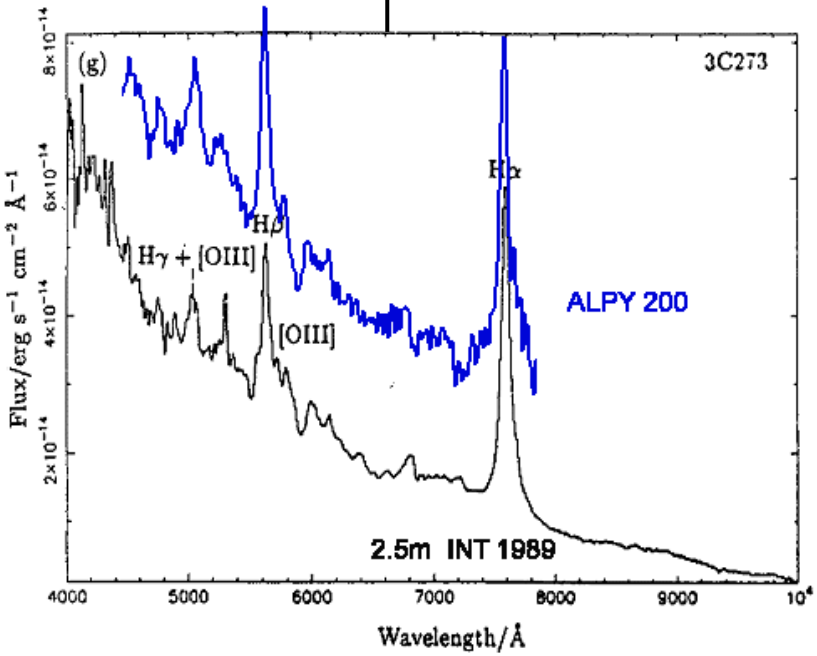


Raw spectrum with H beta emission line visible against the bright lunar spectrum and Na D from street lights

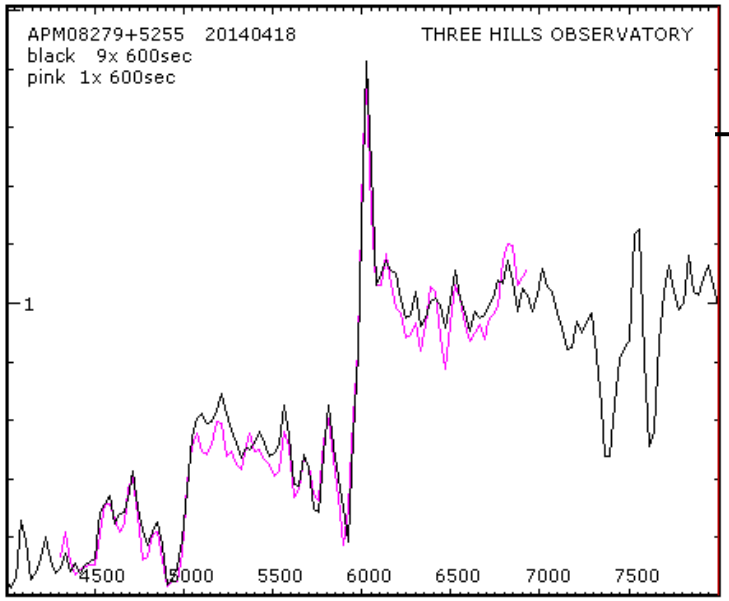
Reduced spectrum showing red shifted Balmer lines (z = 0.17)

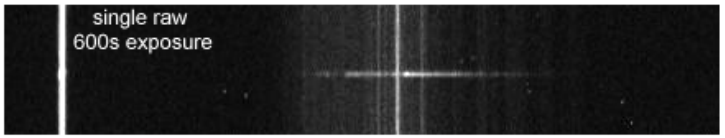


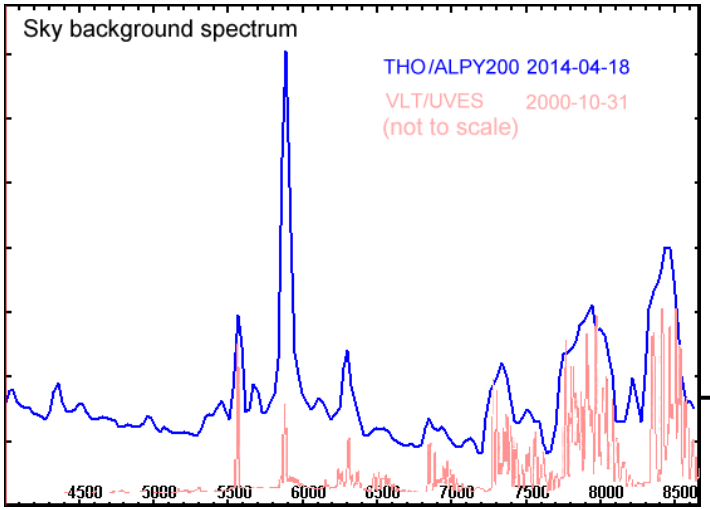
Comparison with professional spectrum



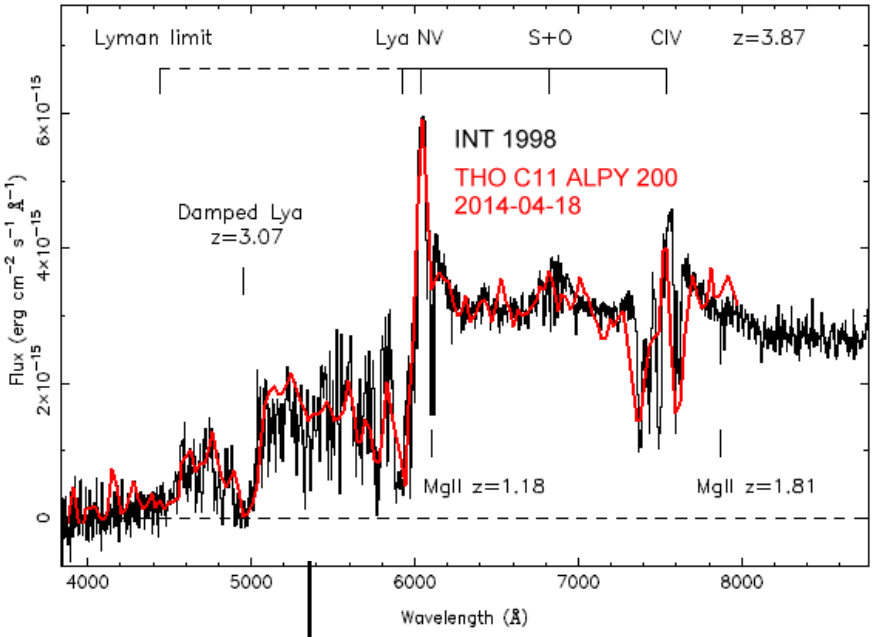
QSO APM 08279 +5255 (mag 15.5 and 12GLyr)







The key features in the spectrum are clear even in a single 600s exposure. The features at ~6000A and ~7500A are red shifted from the UV (z=3.91, 12 GLyr). The absorption at~5000A is from a gravitationally lensing object in the line of sight at z=3.07

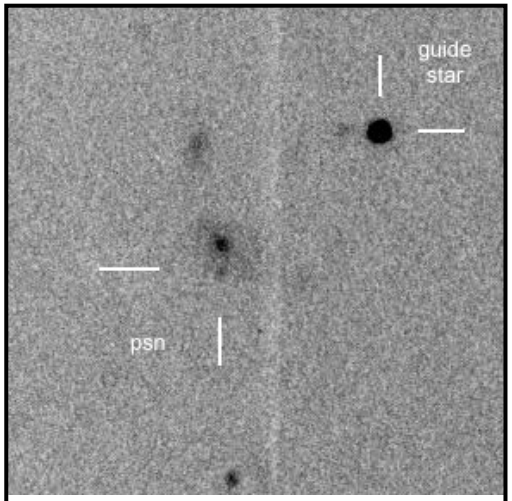


Comparison with professional spectrum

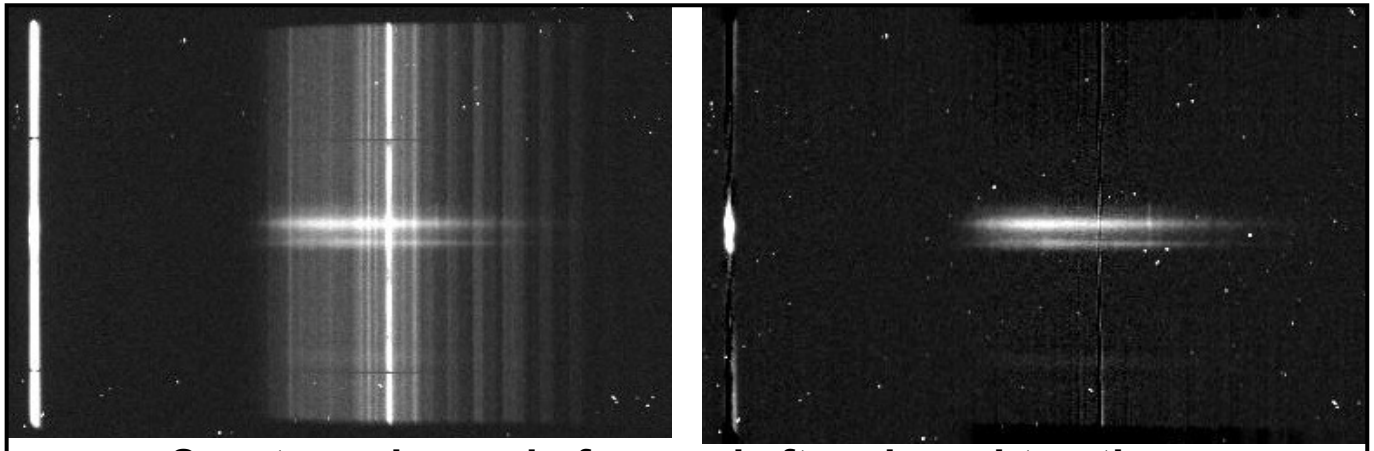
Light pollution spectrum at THO compared with VLT Paranal
Note the natural airglow molecular bands in IR from OH

SN 2014AS in NCG 5410 (type 1c mag 16.5)

Discovered by amateur Dave Grennan 2014- 04-18

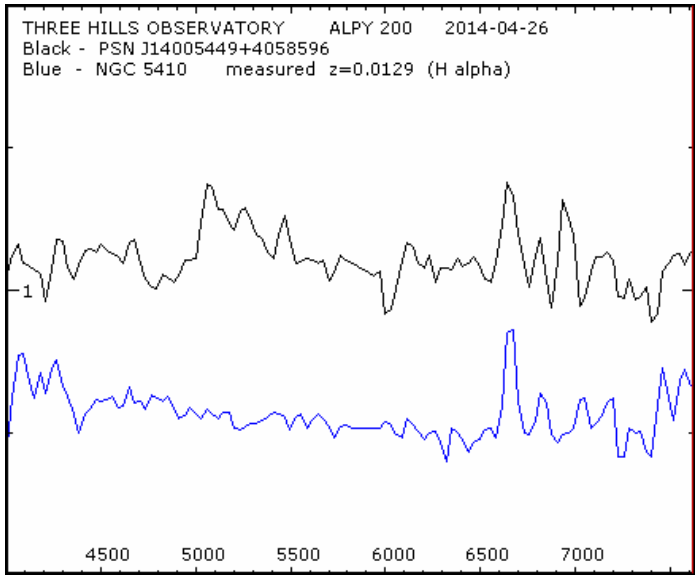


Guide camera image. The sn was not visible during guiding so a mag 13 field star was used



Spectrum image before and after sky subtraction

Spectra of the supernova and galaxy core above it. Note the clear H alpha emission from the galaxy core and OH air glow bands in the IR

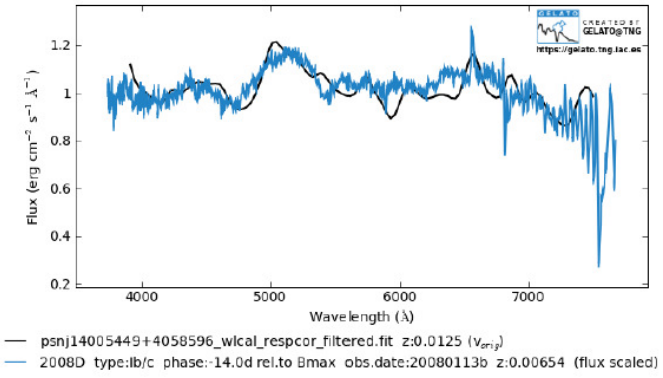


Reduced spectra for galaxy and supernova.

Exposure 110 min SNR ~30

The sn spectrum does not show strong H alpha emission or Si 6150 absorption features (not type II or 1a)

The measured red shift of NGC5410 (Ha) = 0.0124 (published figure = 0.0129)



GELATO

supernova identification program suggests a best fit to type 1b/c