

# X-ray emission from PTT stars

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# Summary

- Coordinated XMM-Newton and ground-based spectroscopic + photometric observations of two Post T Tauri stars.
- The observations were done in February → results are only preliminary !

# Acknowledgements

I would like to acknowledge the participation, contribution/support from:

- Gordon Bromage and Hannah Leigh Worters, UCLAN, **UK**
- Helen Mason, University of Cambridge **UK**
- Carl Foley, Hilary McKay, MSSL, **UK**
- Alan Whiting group (CTIO, **Chile**), in particular Melissa Rice.
- Carlos Alberto, Germano Quast and Ramiro Delareza (**Brasil**).
- The XMM/SOC at Villafranca, Madrid (**Spain**), for their professional support. In particular, of Nora Loiseau and Pedro M. Rodriguez Pascual.
- Federico Gonzalez (CASLEO), **Argentina**
- Massimo Landini, Univ. of Florence **Italy**
- PPARC

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- Multiwavelength **multiwavelength**  
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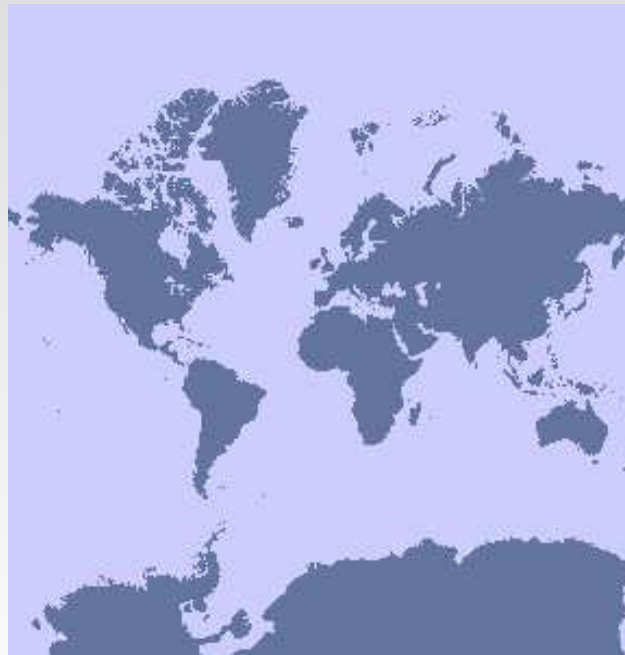
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- dK7e and dM3e fast rotating stars ( $v \sin i=12, 70$  km/s). Southern star is Li-rich.

# Pushing to the limits

- Problems in coordinating multi-wavelength observations
- XMM OM fast mode windows
- angular separation of 22'' – roll angle
- multi-continent, multi-cultural experience
- we need an observatory on Easter Island!





# Ground-based

Two-weeks observing in South Africa.

## Spectroscopy

- SAAO 1.9m grating spectrograph with 1 Å resolution and  $\simeq 90$  s exposures.
- Wavelength range: 3700 - 4360 Å
- 6 consecutive nights

## Photometry

- UBV aperture photometry with the SAAO 0.5-m telescope
- 3 nights

# On the XMM night (19-20 Feb 2004)



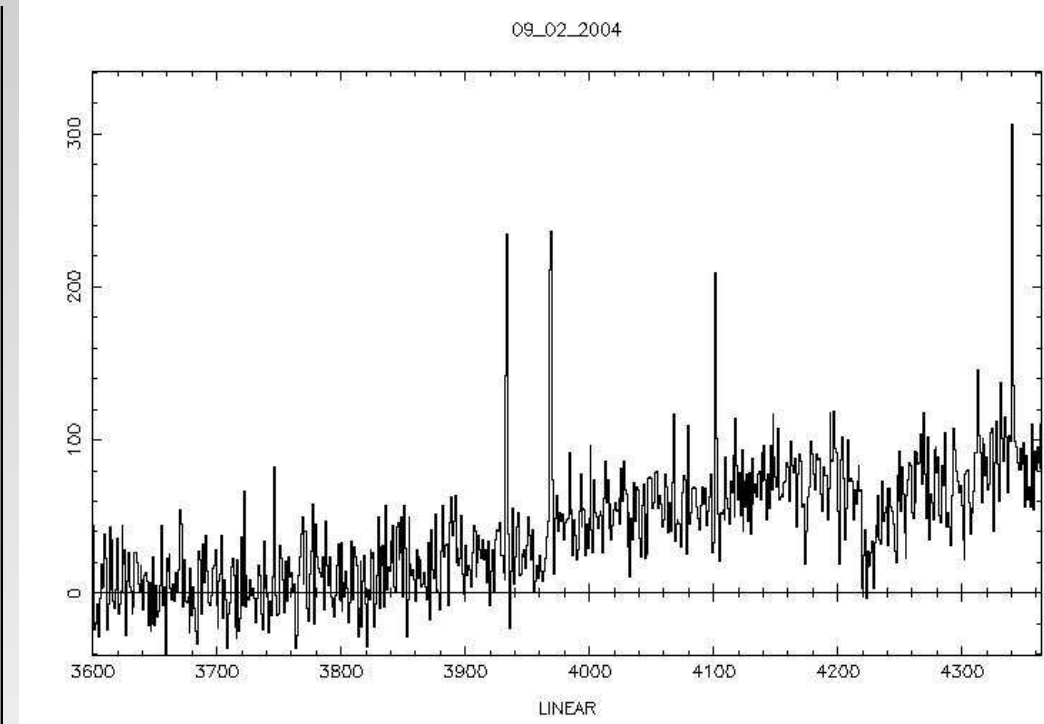
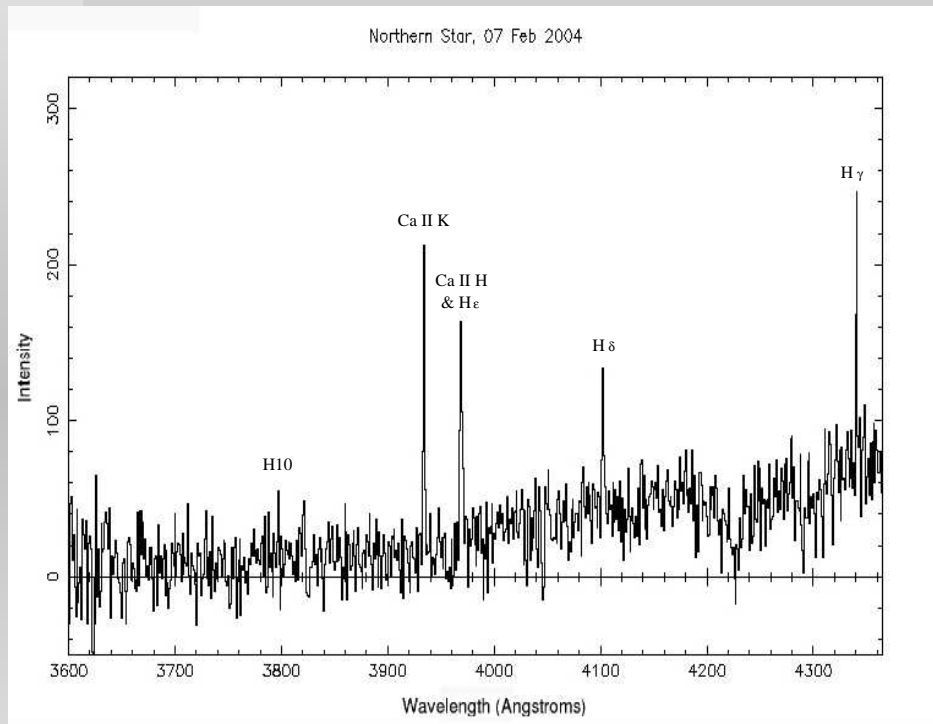
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- Argentina – CASLEO: cloudy !
- Brasil: B-band monitoring 23:00 – 00:30 UT then cloudy.
- Chile:
  - CTIO low-resolution ( $17.2 \text{ \AA}$  FWHM) spectra at the 1.5m
  - CTIO CCD B and U band photometry with the 0.9m 01:17 04:40 UT
- South Africa:
  - SAAO 1.9m spectra 18:32 UT – 00:04 UT
  - SAAO U-band monitoring

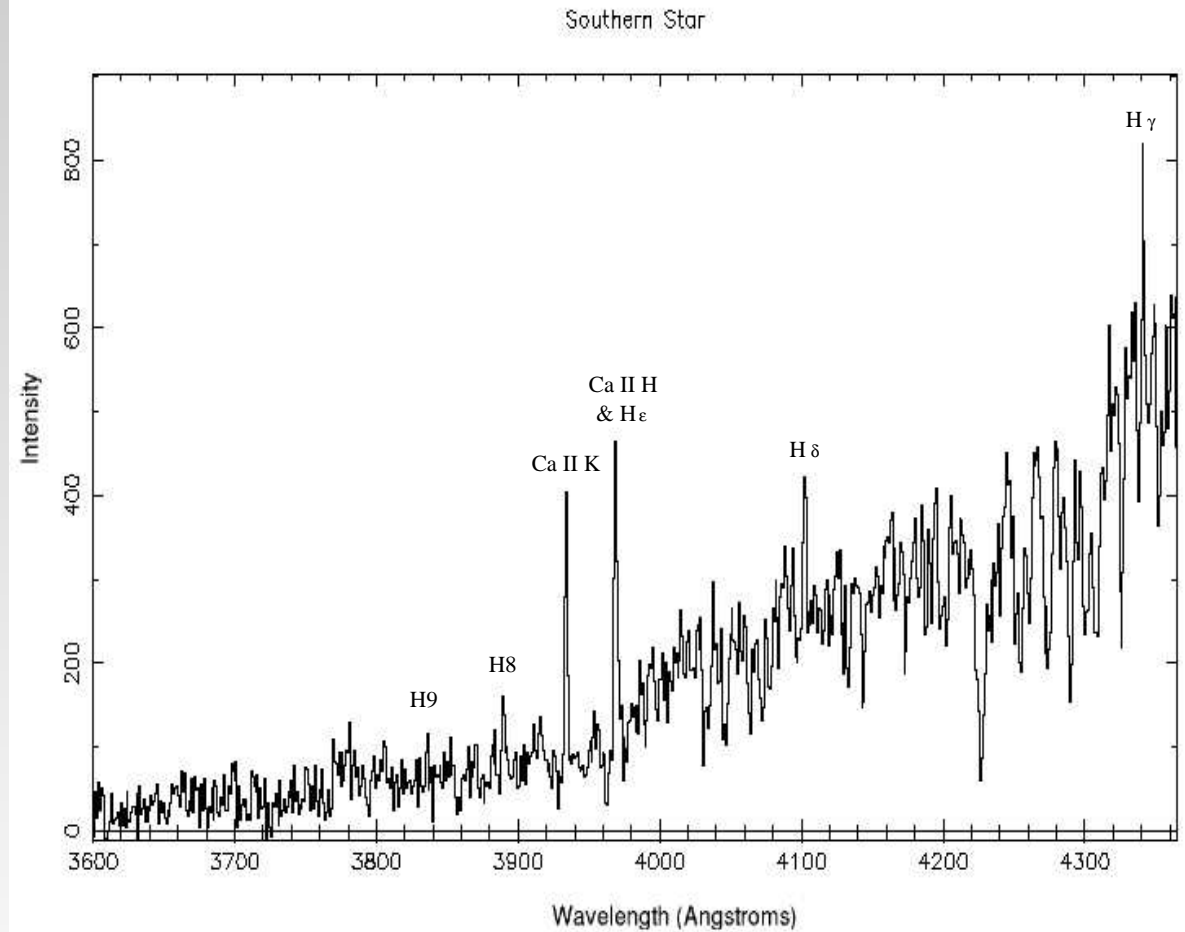
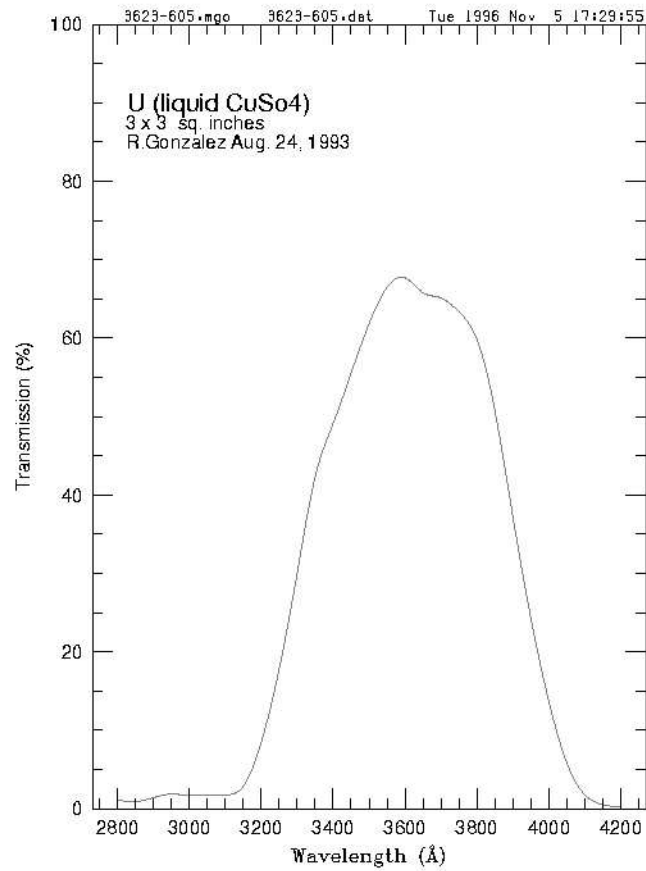
→ ground-based only covered part of the XMM observation

# SAAO spectra - northern star

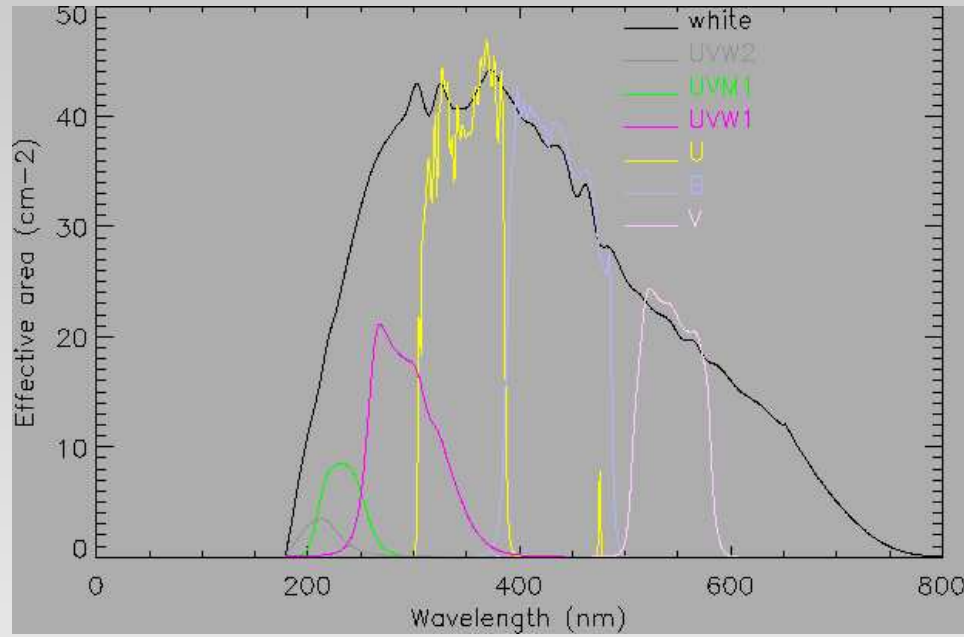
Two spectra on the 7th and 9th Feb 2004:



# Filters - CTIO

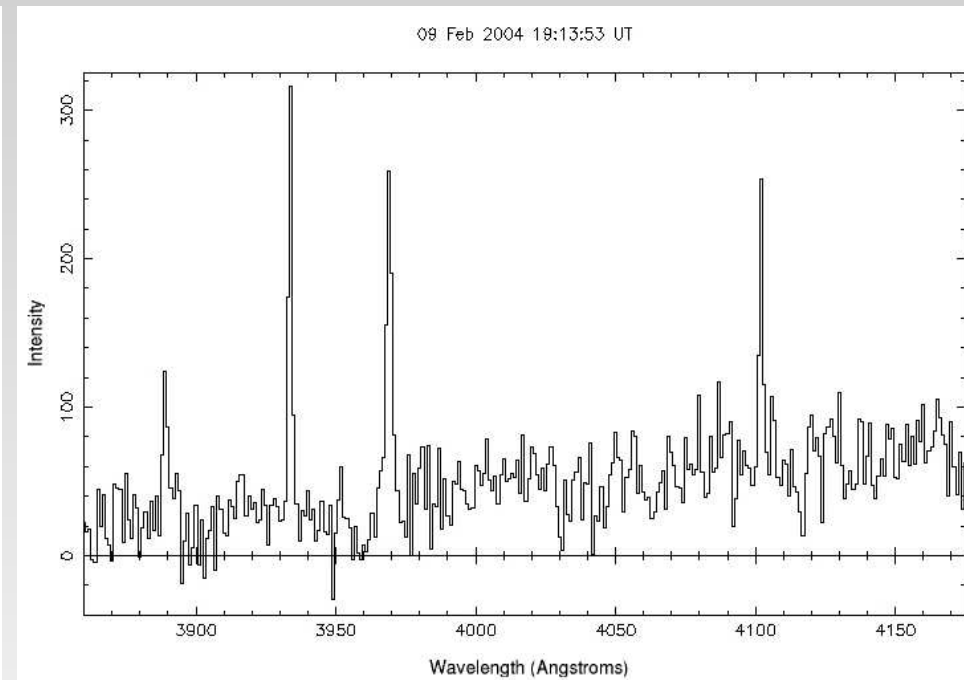
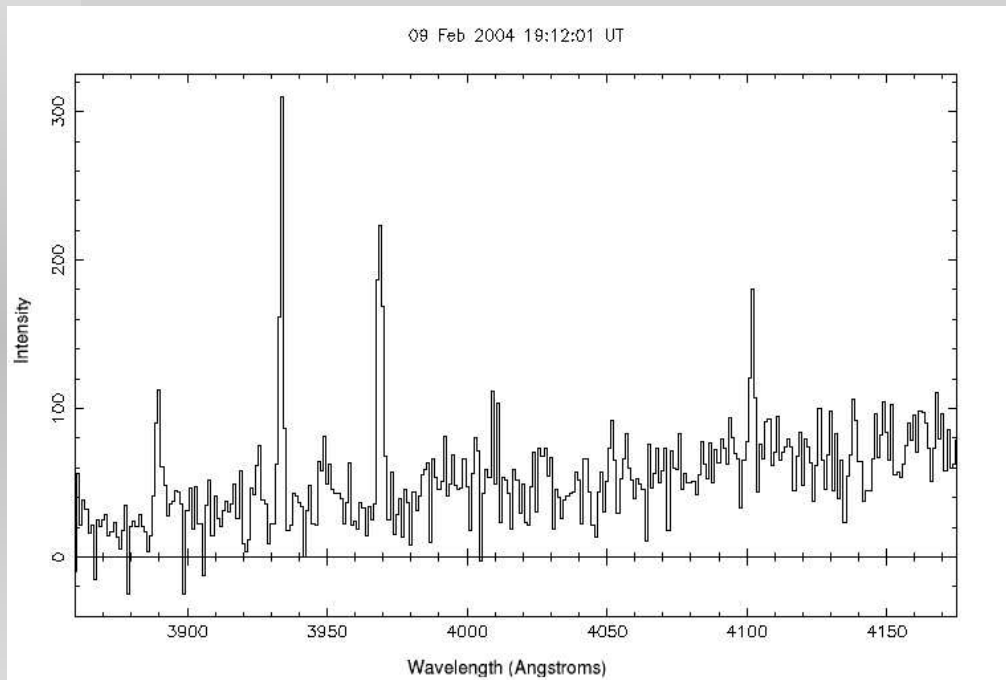


# Filters - OM

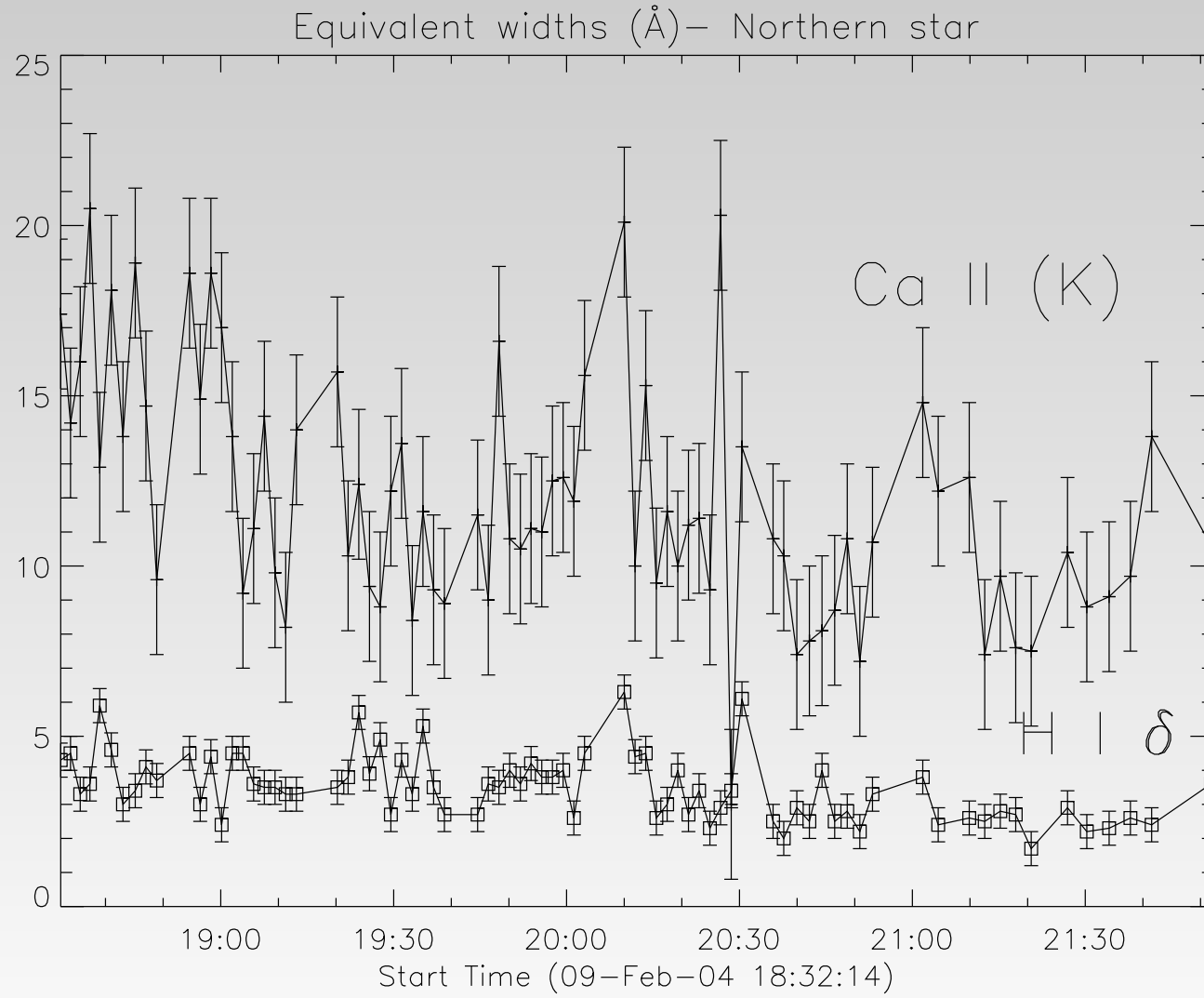


# Chromospheric variability

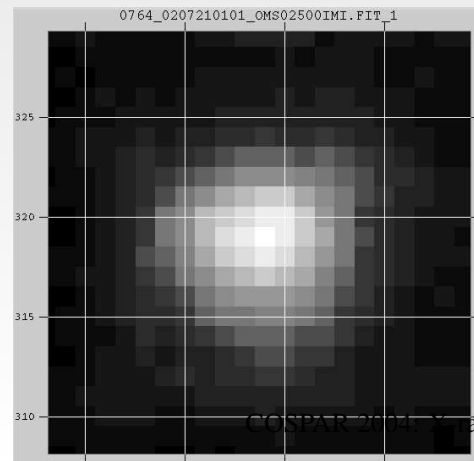
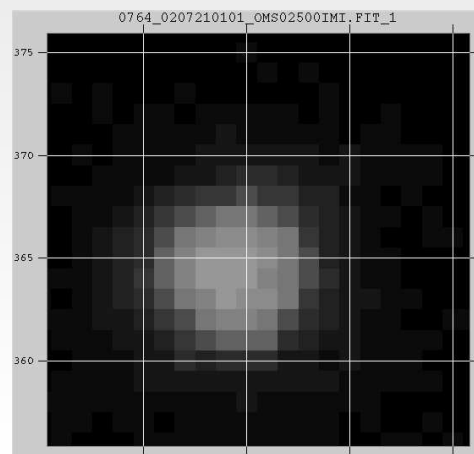
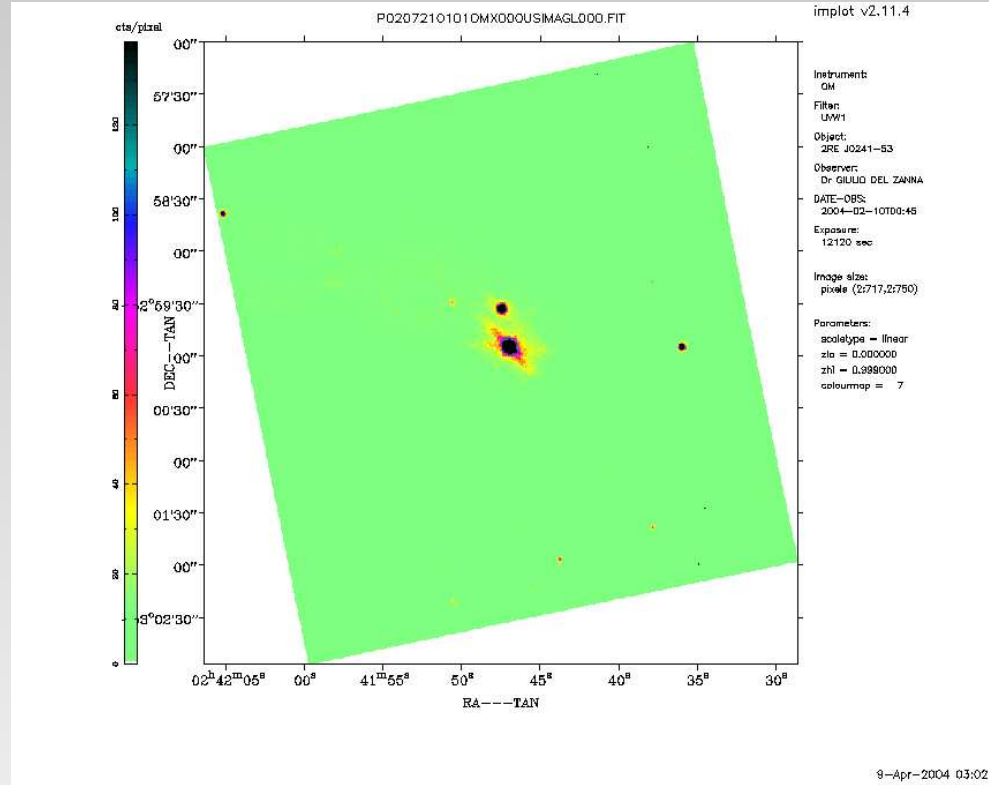
Consecutive 90s exposures from XMM night (19:12,19:14 UT). Notice the variation in the Ca II (H and K) and H  $\delta$ .



# EW for the Northern star

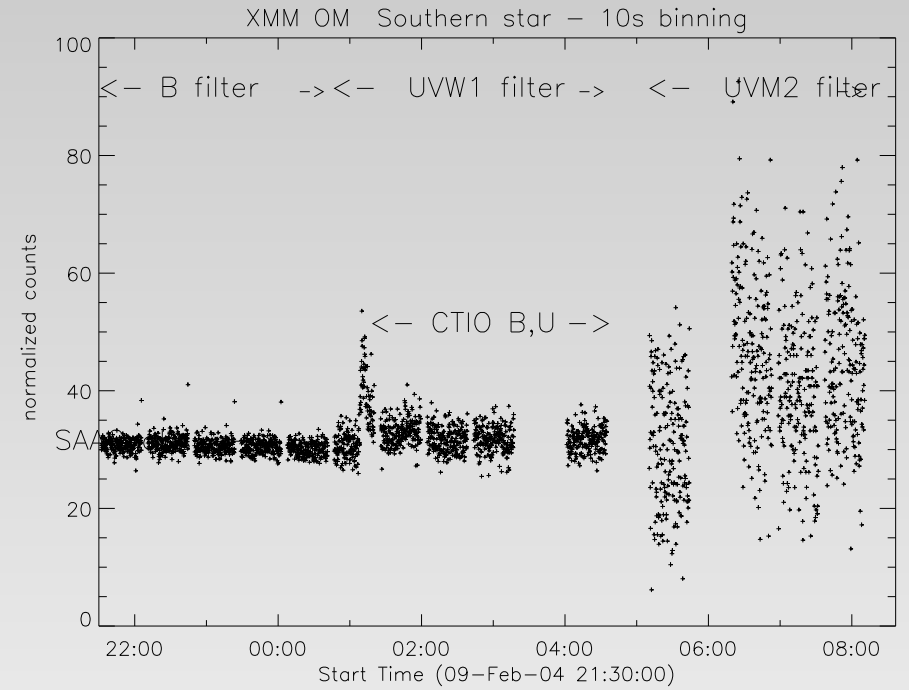
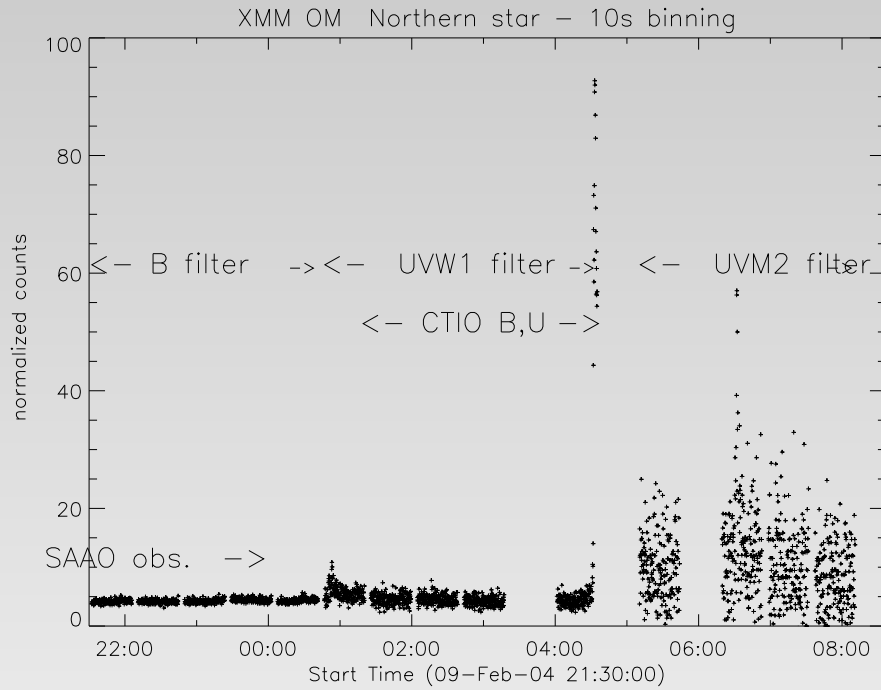


# XMM OM

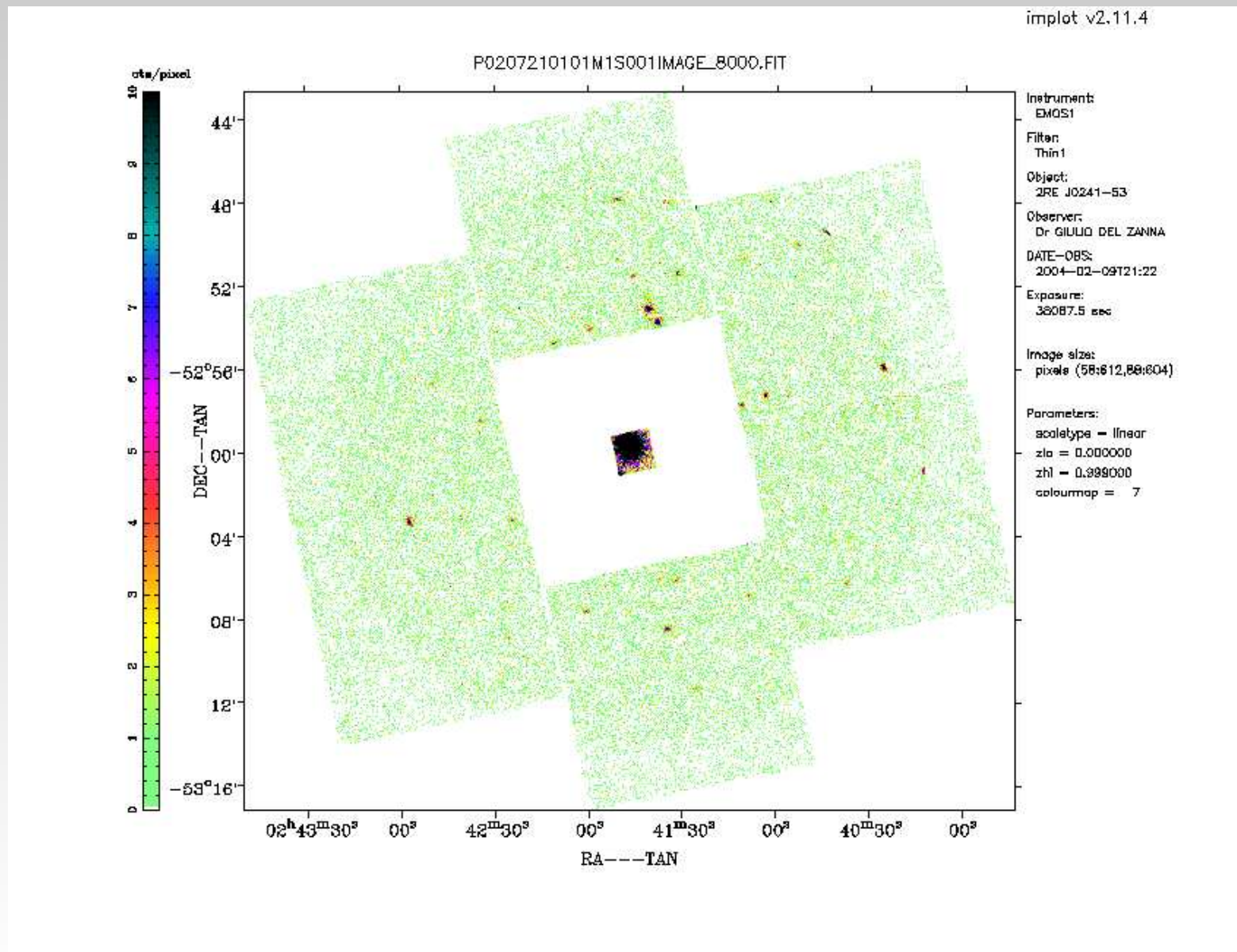




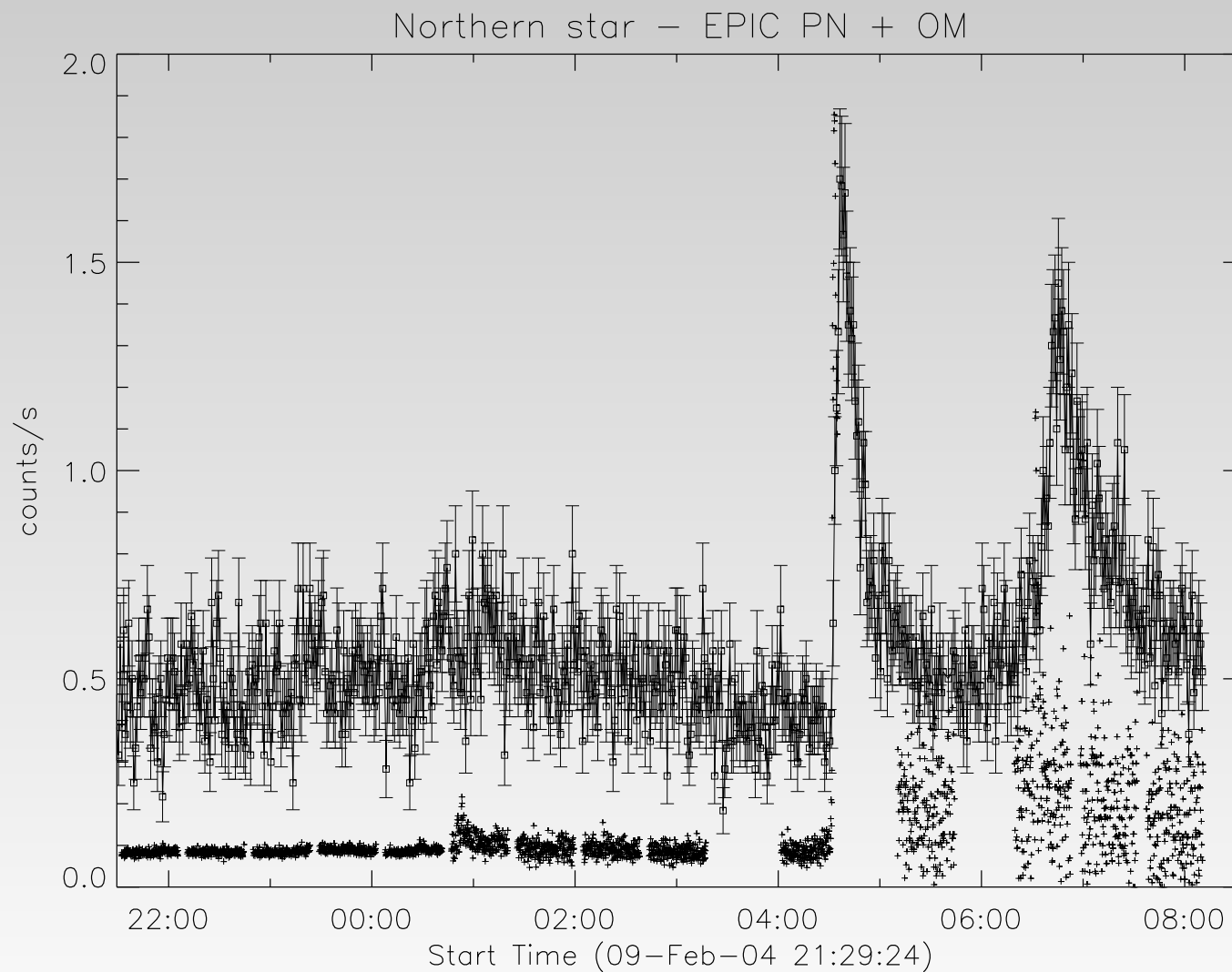
# OM light curves



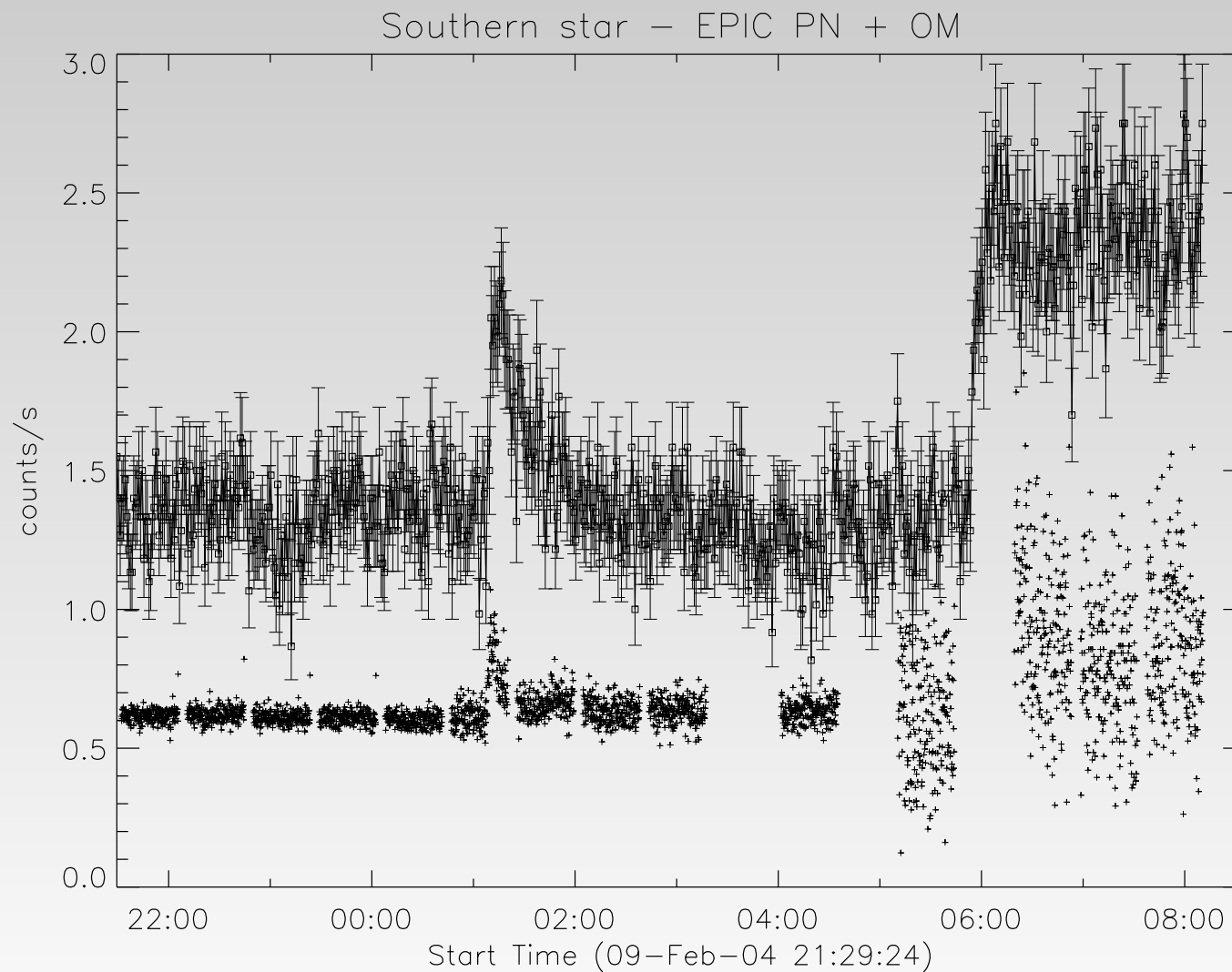
# EPIC MOS 1 image



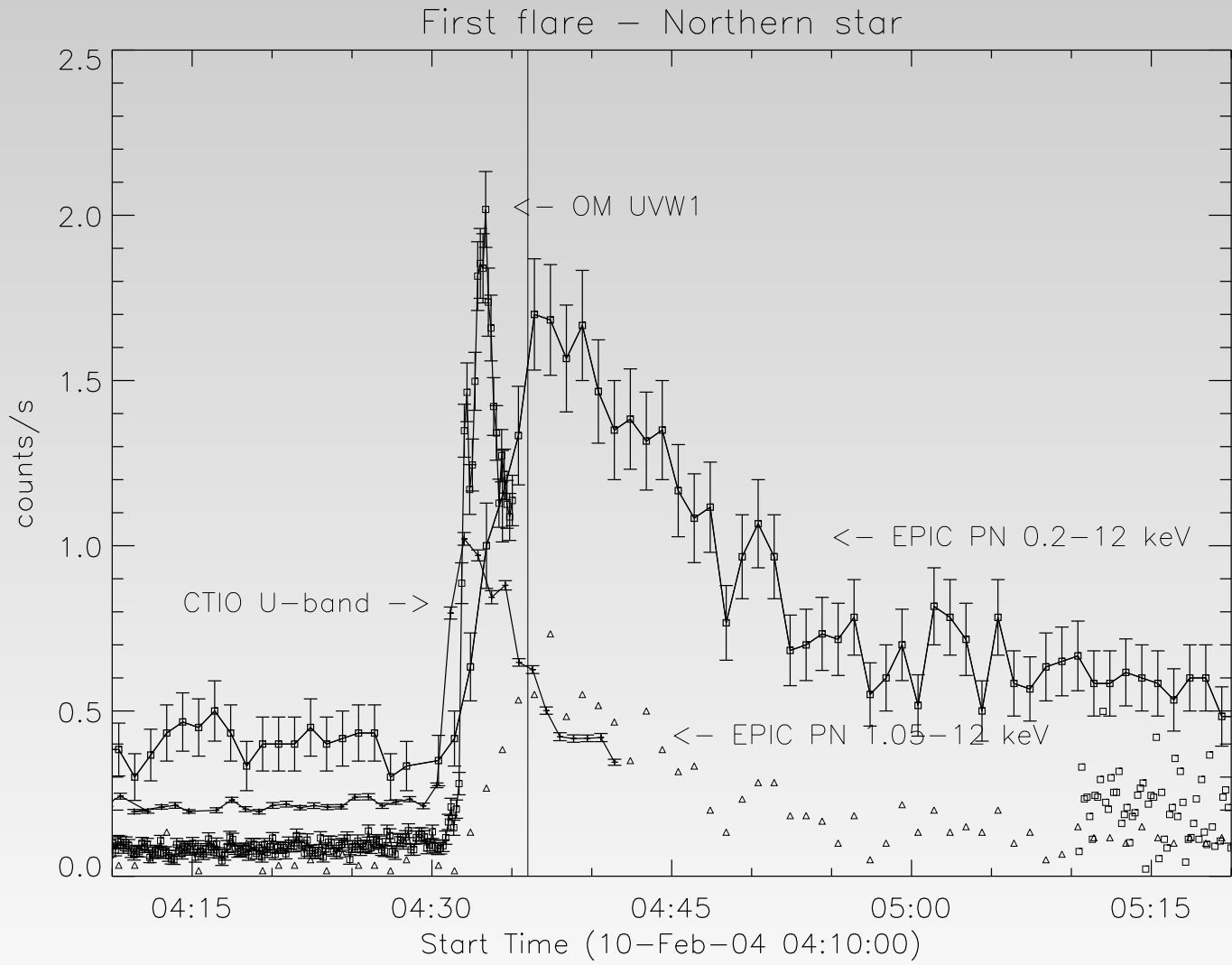
# EPIC PN light curves



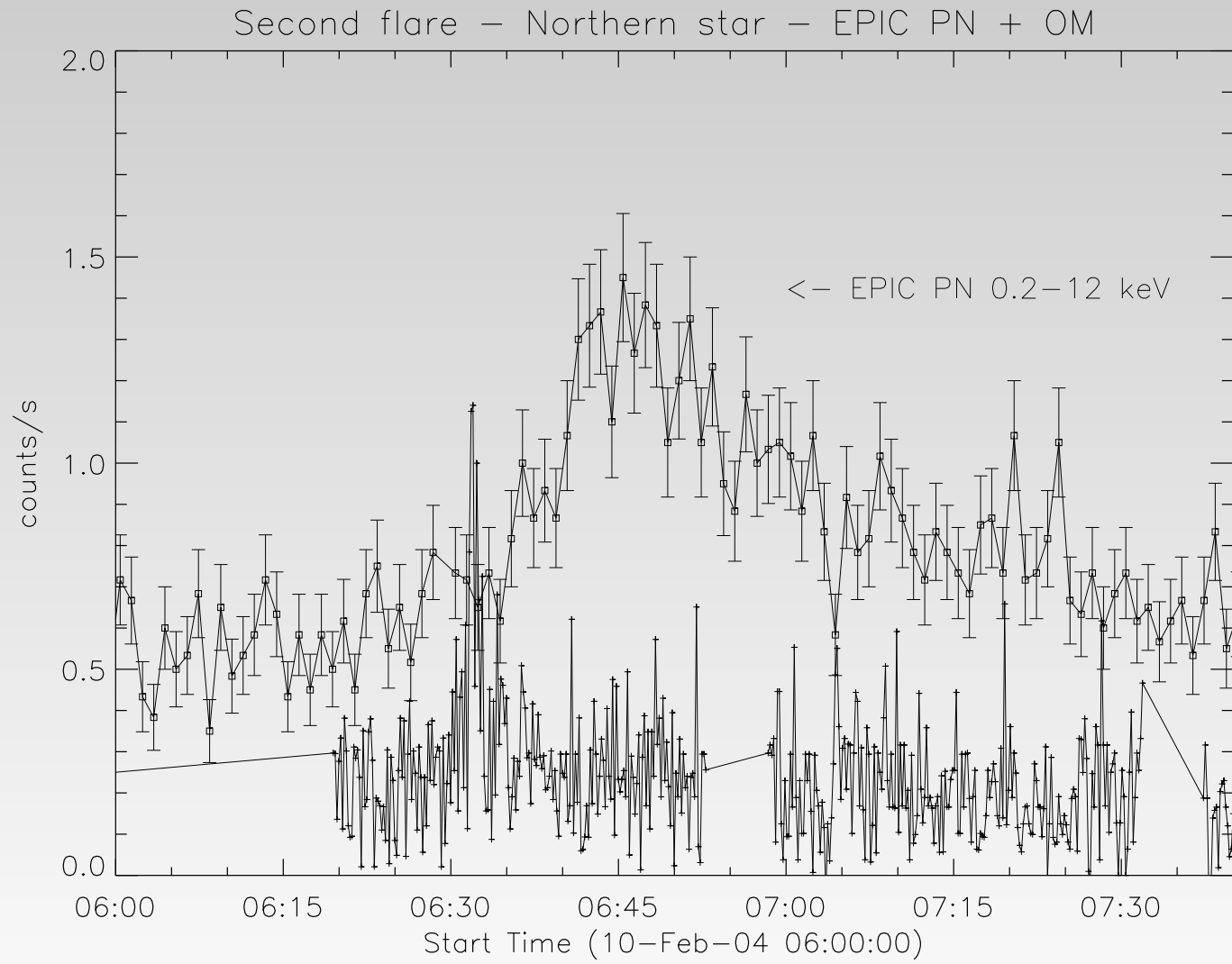
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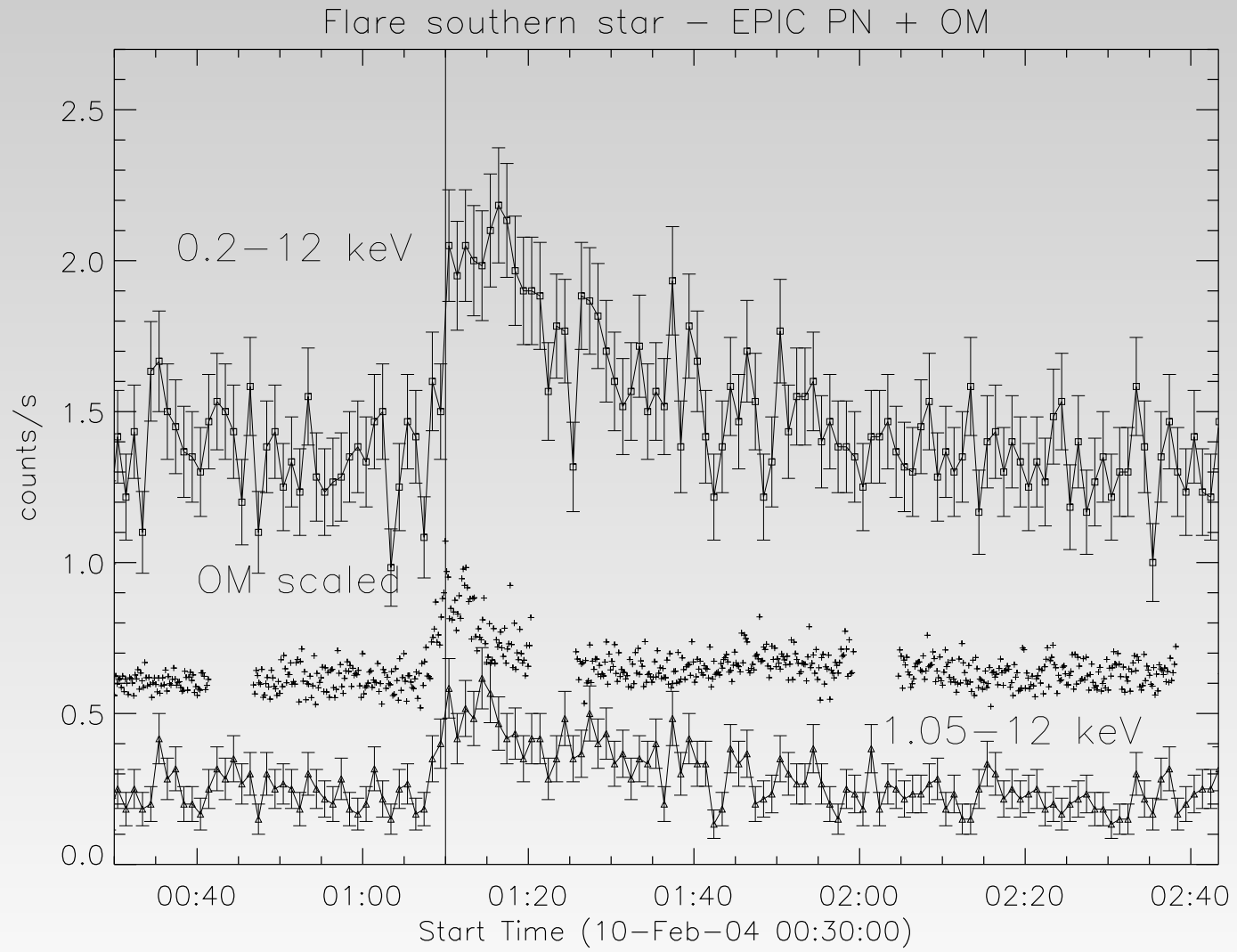
# Flares on Northern star



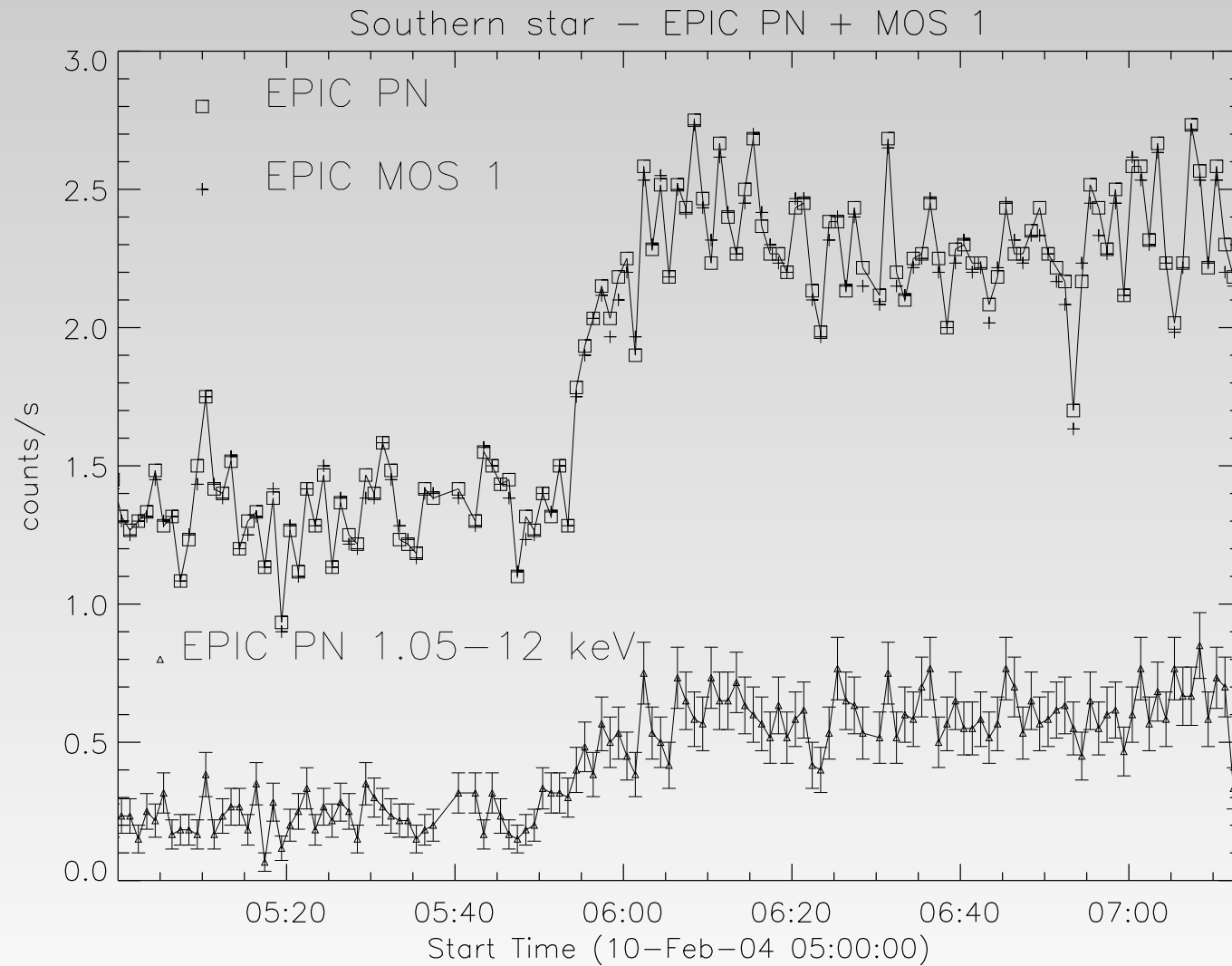
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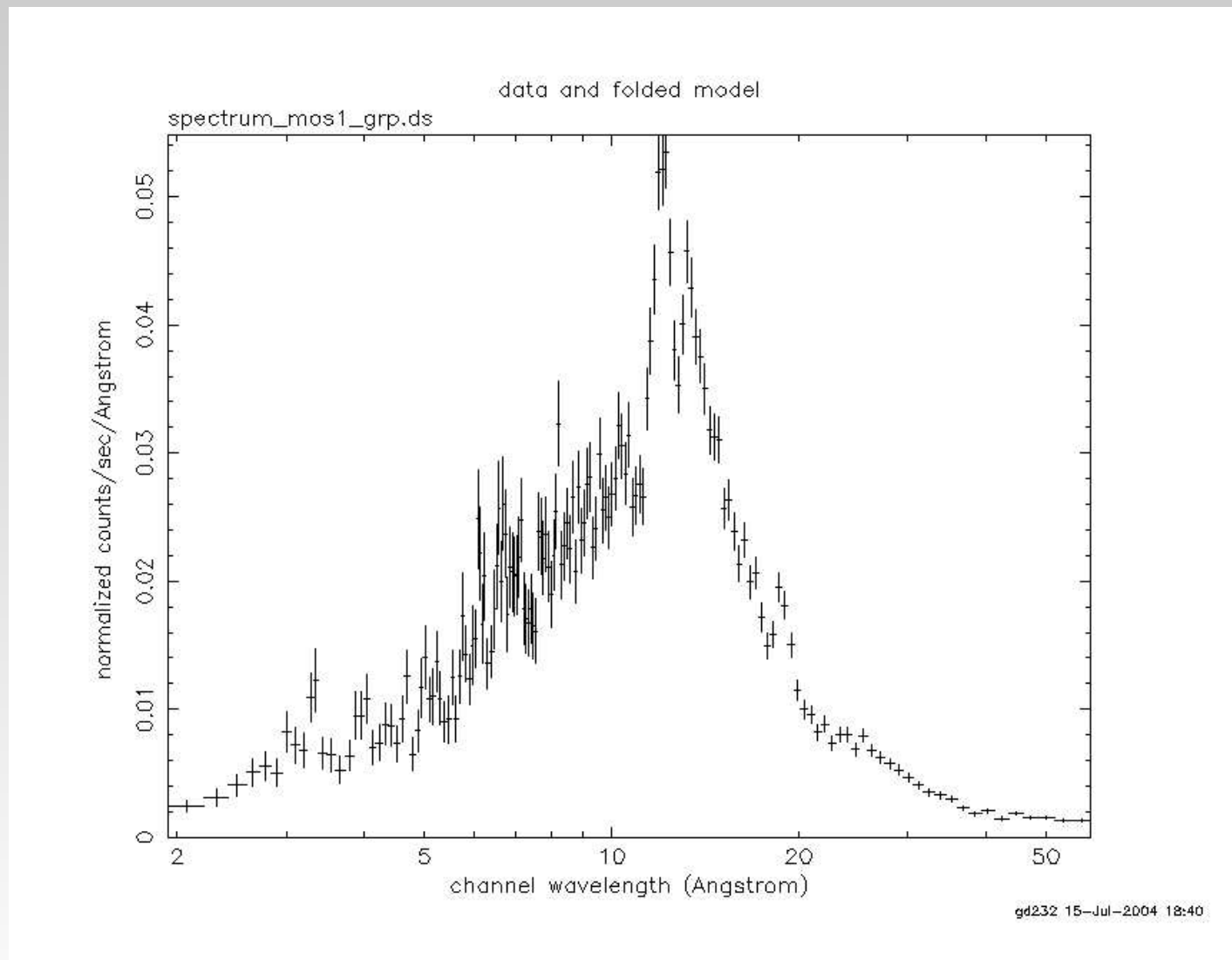




# EPIC MOS 1 spectrum of the Southern star

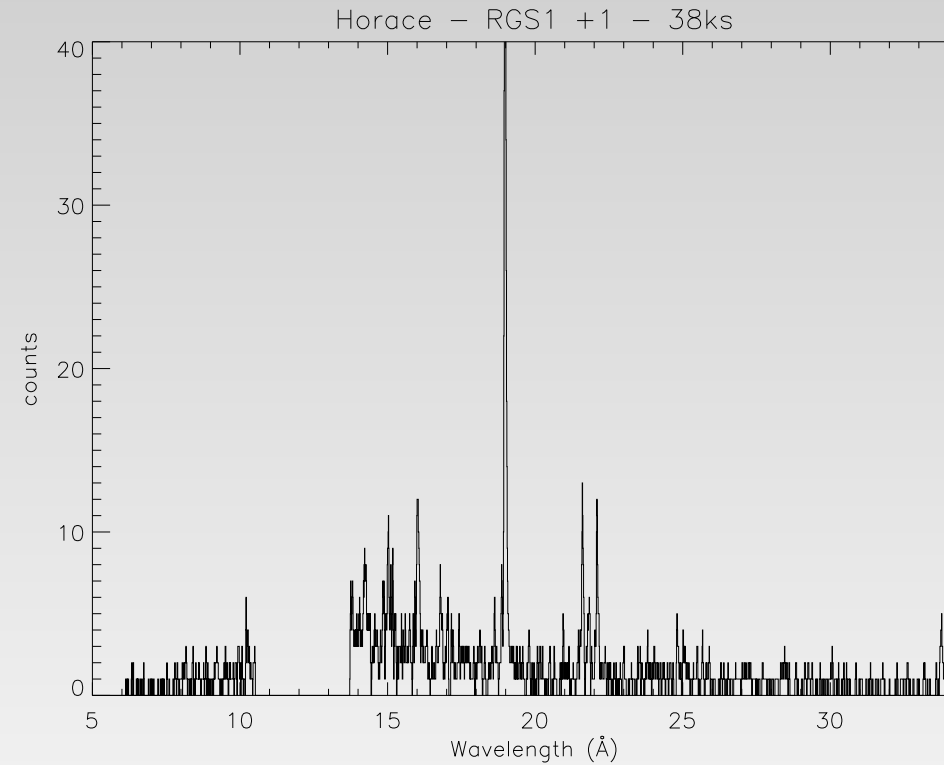
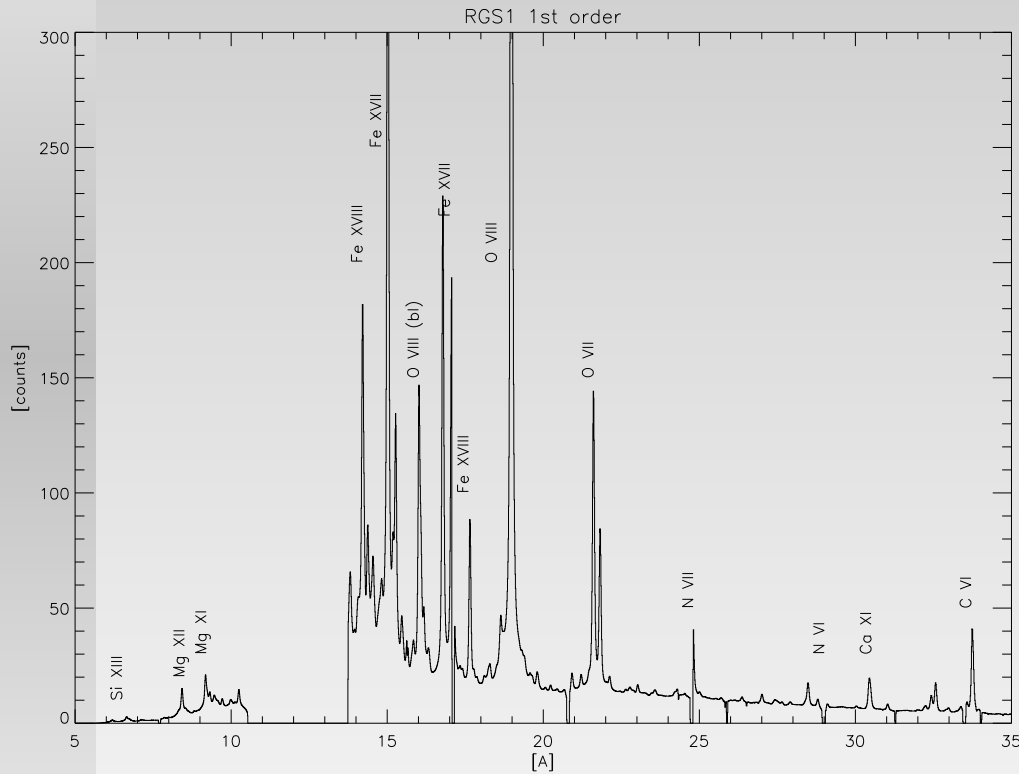


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# RGS - here is why we need spectroscopy

## Where is all the Iron gone ?



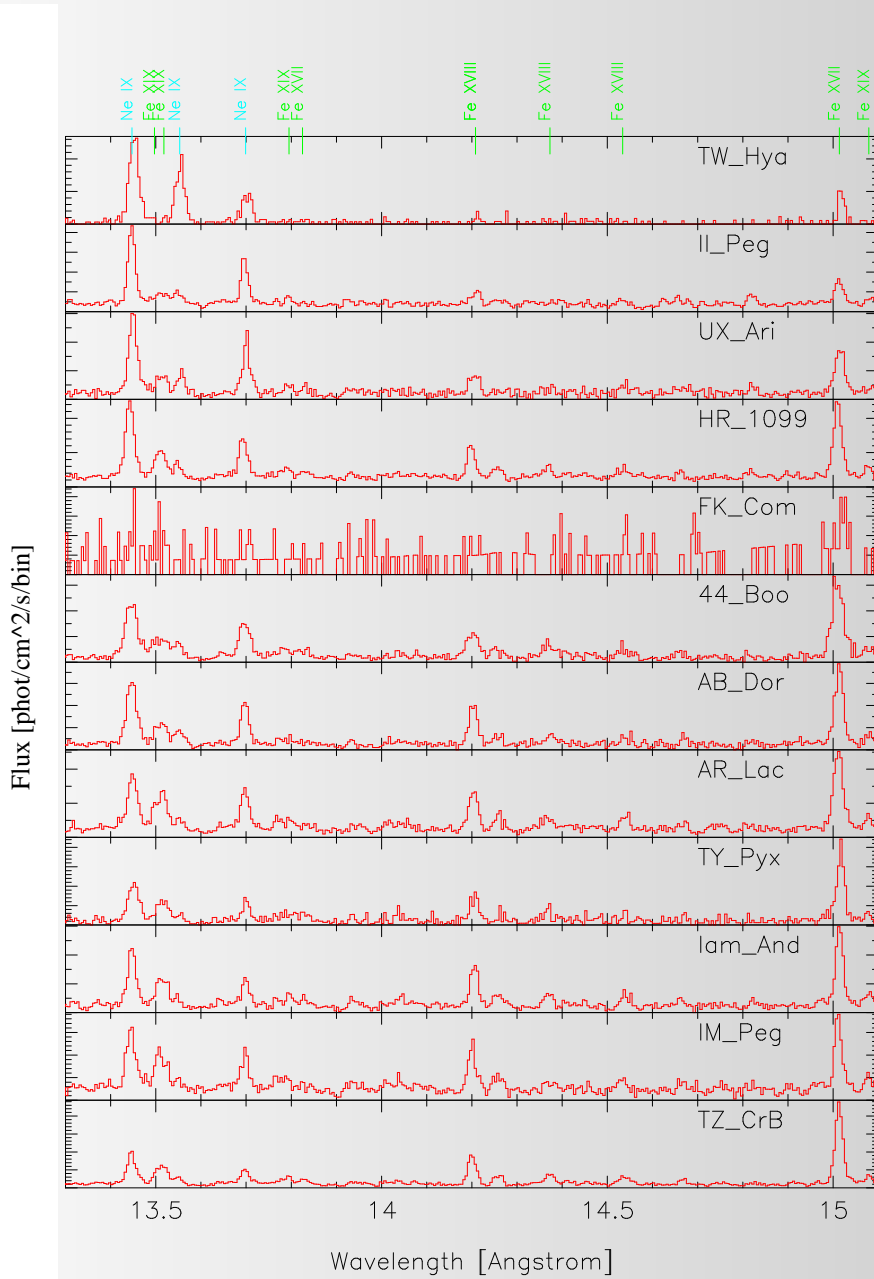
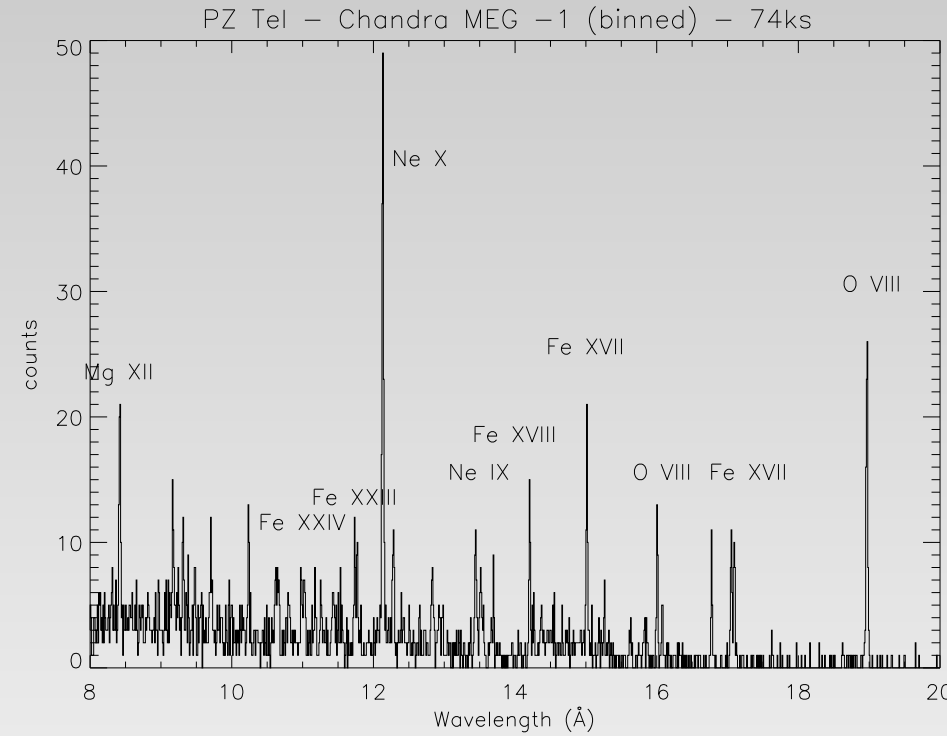
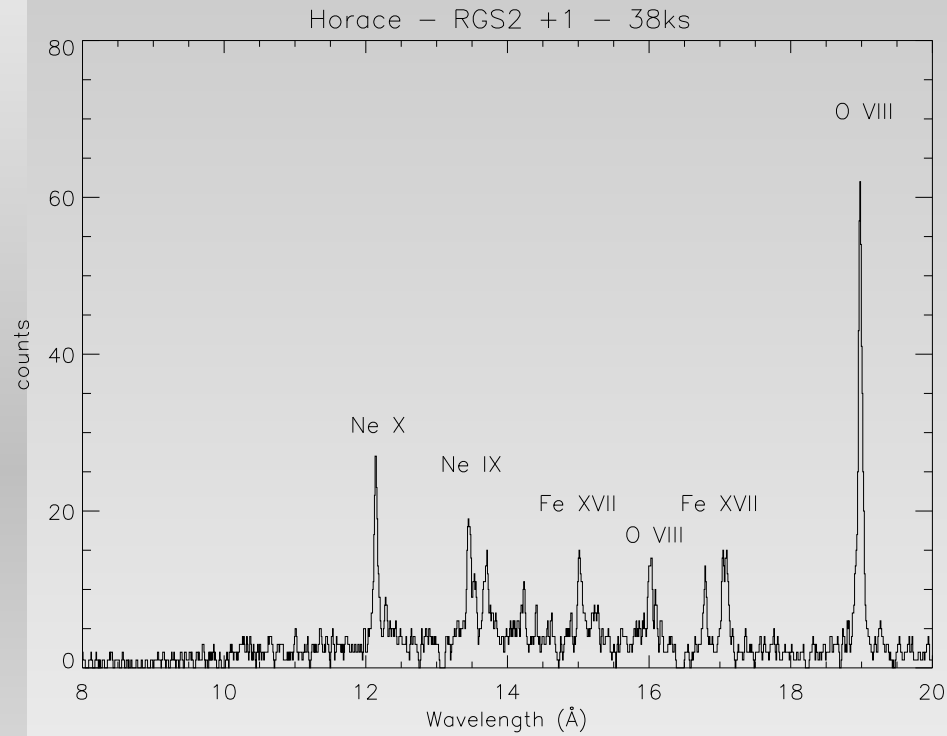
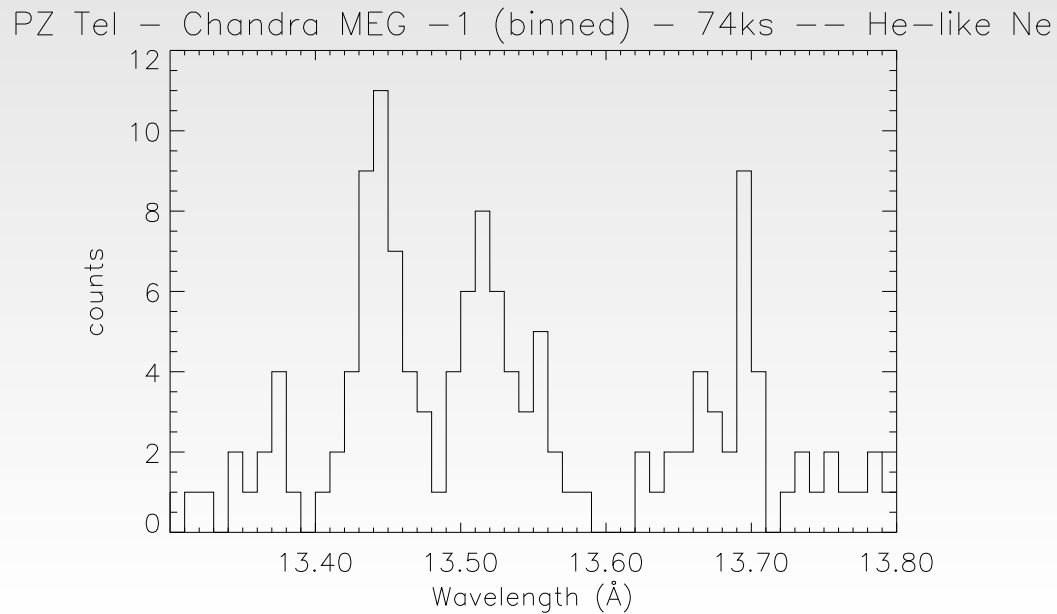
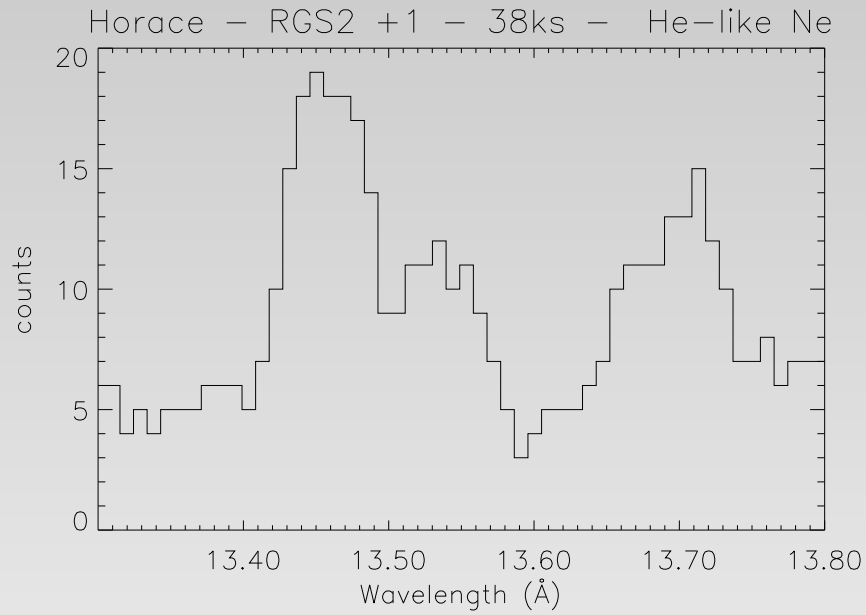


Figure 4. Gallery of spectra, for a very diverse collection of cool stars. The Ne IX triplet lines (13.44, 13.55, 13.70 Å) are at the left, and Fe XVII, which has a similar emissivity distribution with temperature, is at the right (15.02 Å). Spectra have been ordered by relative strength of Ne IX to Fe XVII, a mainly abundance-dependent ratio.

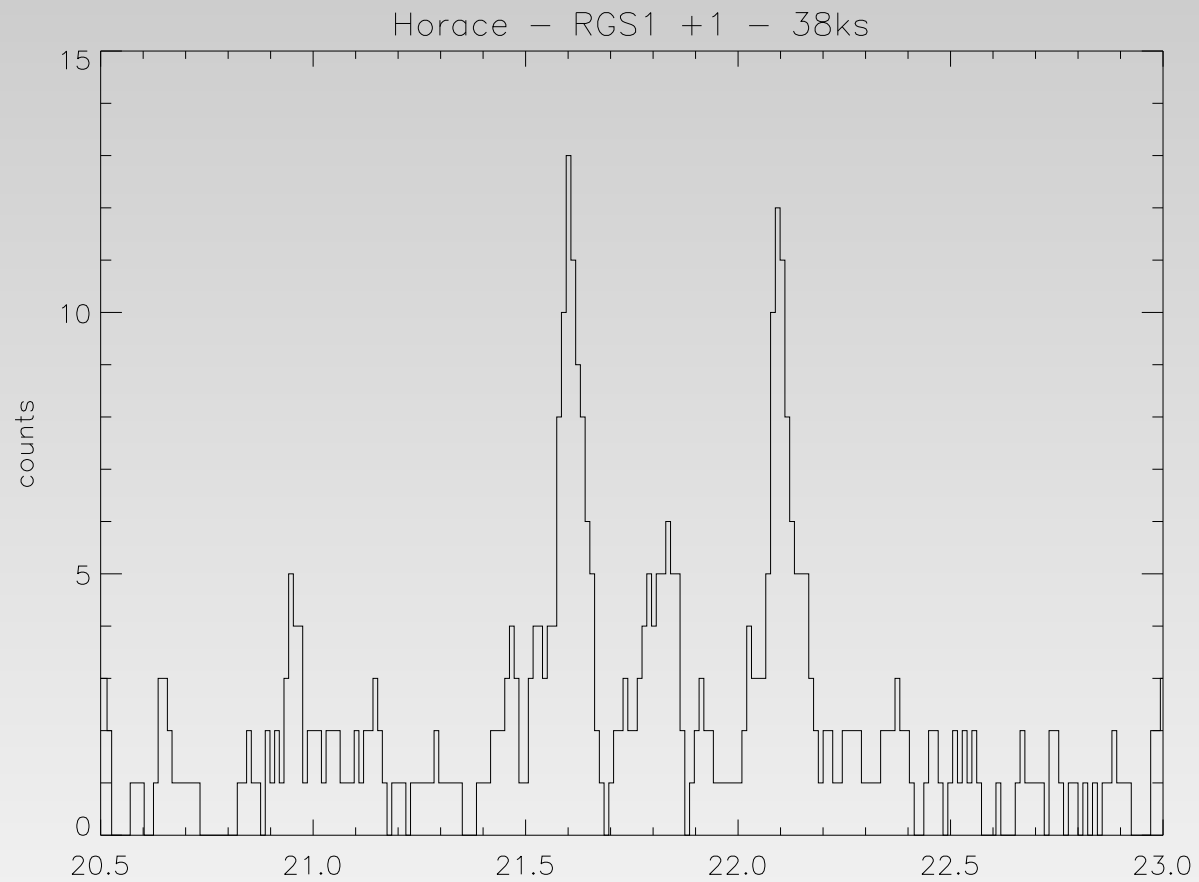
# Horace vs. PZ Tel



# Densities - Ne IX



# Densities - O VII



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- We confirm Linsky’s law (the most interesting events occur at the end of the observation).