VO for Ground-based Optical Spectroscopy

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Core Science Case wanted !

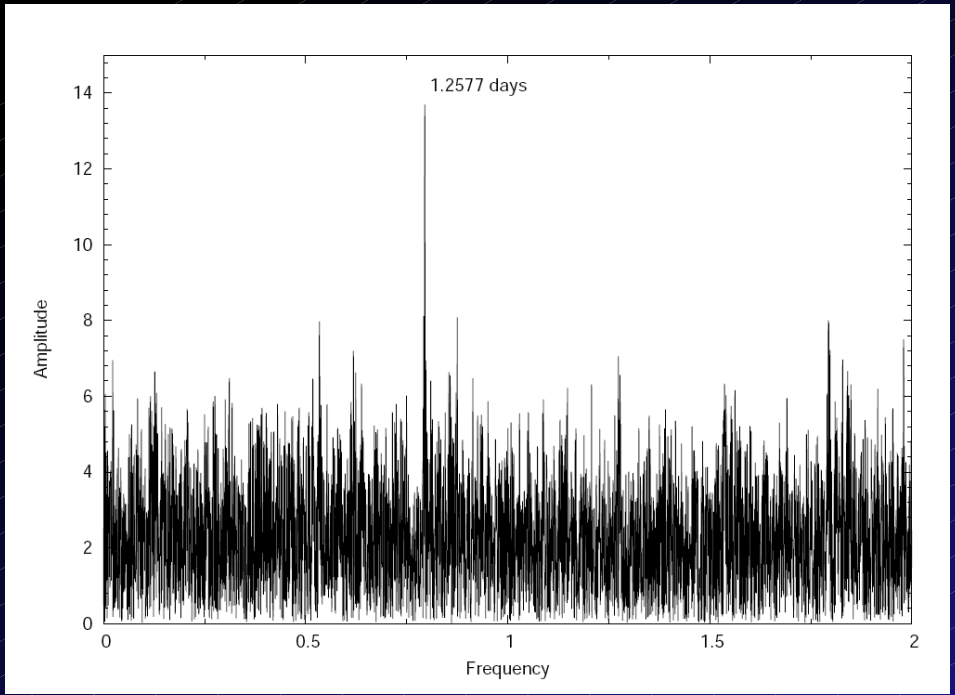
- ADASS 07 – D. Schade : The people will walk away (from VO) if they do not find their own favourite dataset
  - Crucial for applications (favourite methods of analysis)
- Most of VO – discovery of interesting targets
  - (XMATCH, identifying objects, high-z, Bdw.)
  - Synthesis of data – SED – strange physics
- Most of key astronomical research is target oriented (1 star, class of stars (Be), winds, Novae, Symbiotic, Cepheids, SPB, delta Sct)

Space vs. Time Query

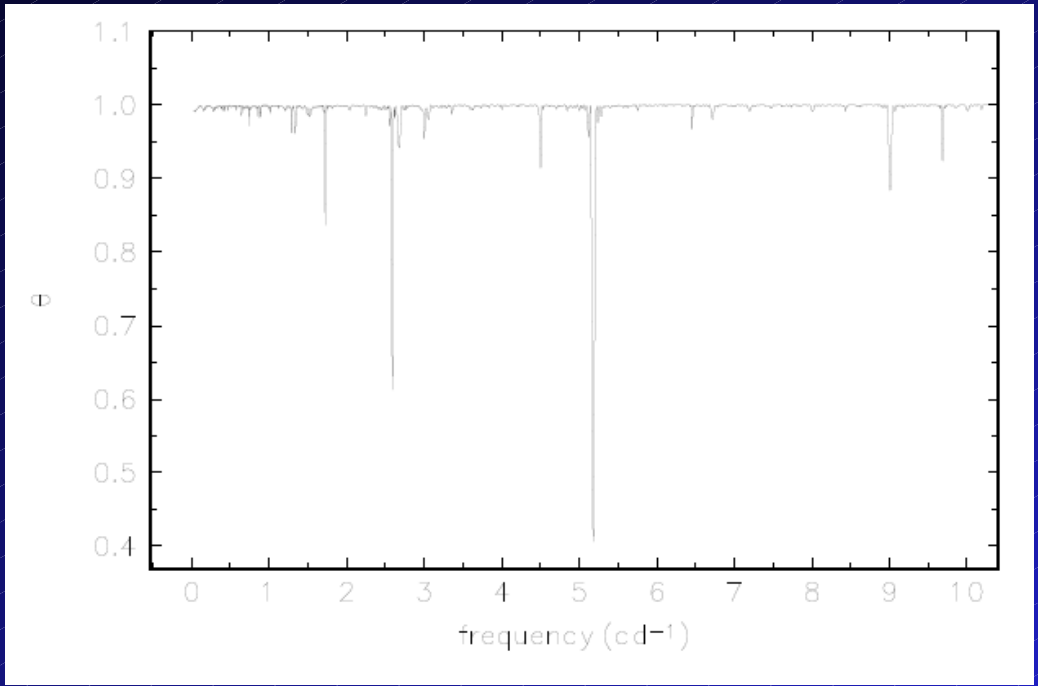
- Surveys = snapshots (position, phys. params)
  - suppose long-term stability of target (QSO will not have z=0 suddenly, radio source will emit tomorrow)
  - Spectrum of this star is G2V for many years
  - *Steady state* described by catalogues
- Interesting physics promissed by VARIABILITY
  - SN and Novae (even recurrent)
  - Emission episodes of Be, changes in spectral type
  - Line profile variability (Asteroseismology – COROT)
  - Winds (blobs, knots, instabilities, shock waves...)

Time variability - Current VO Support

- Period analysis – NONE (clients,services)

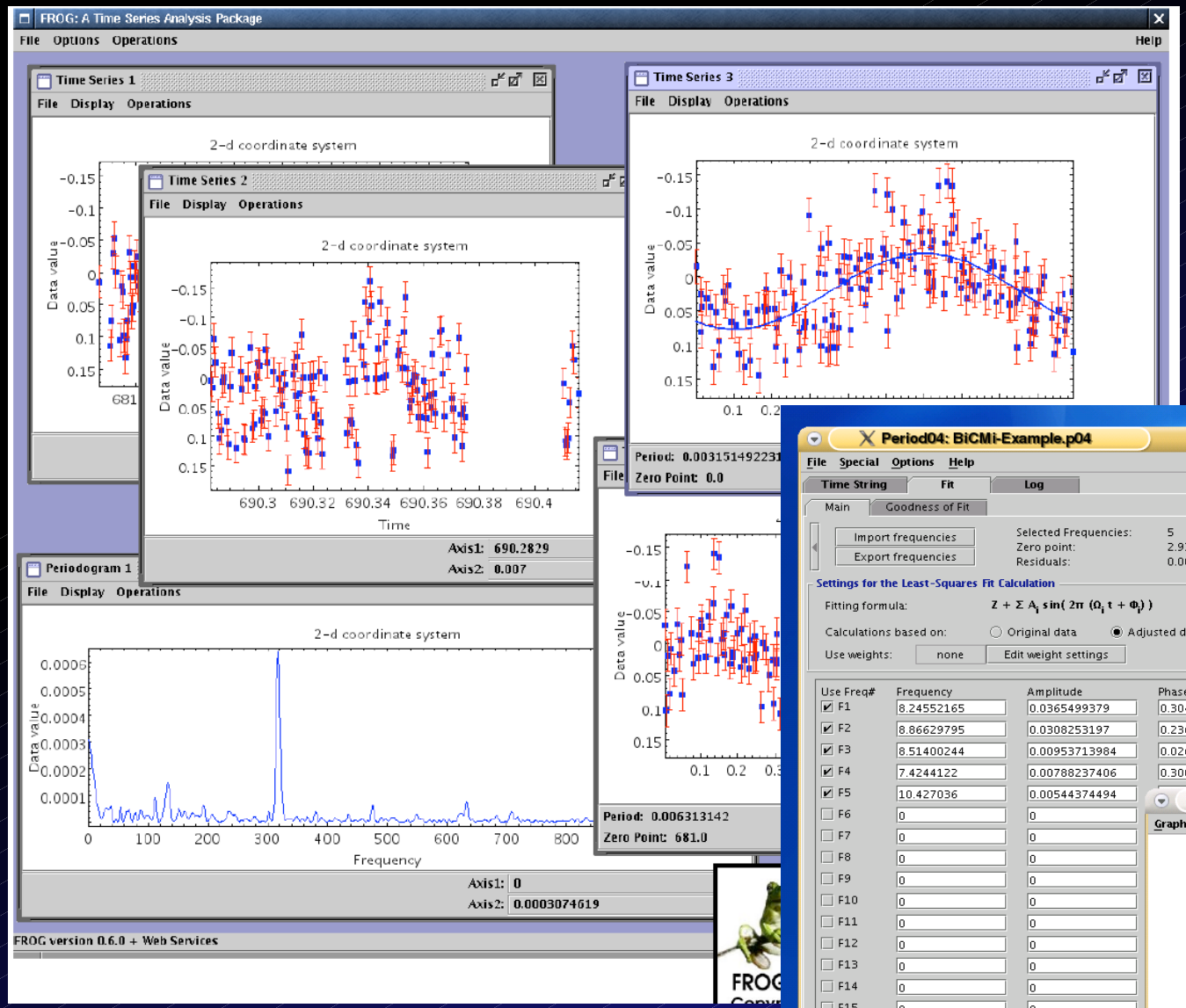


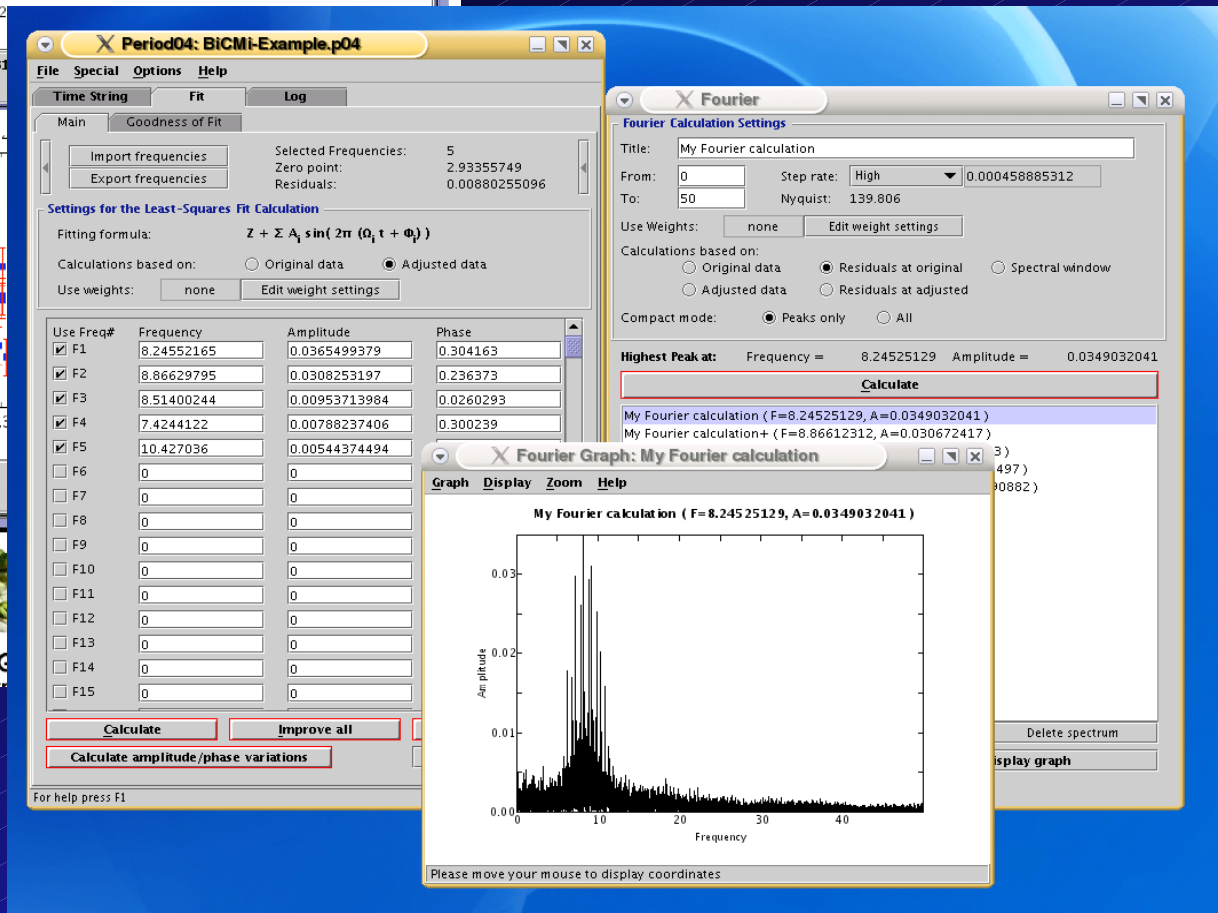
Power spectrum FT



Theta statistics

FROG (Dead ?) - Period04 (no VO)

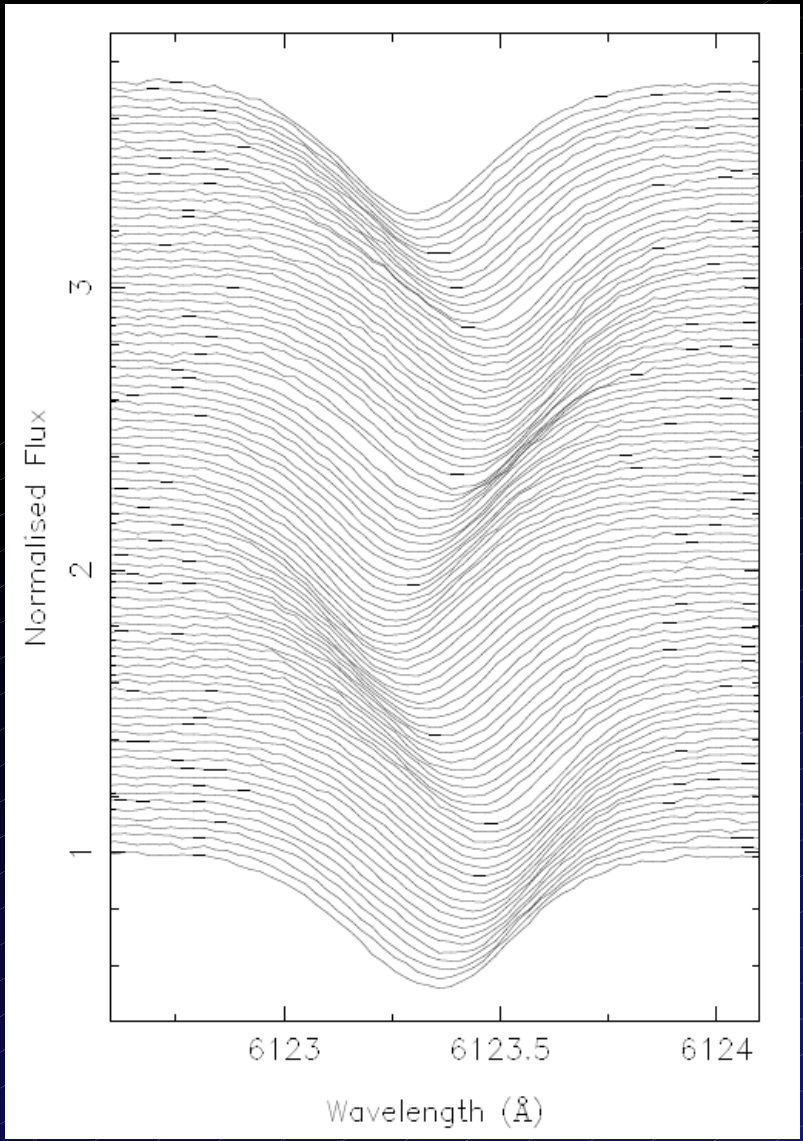




Time variability - Current VO Support

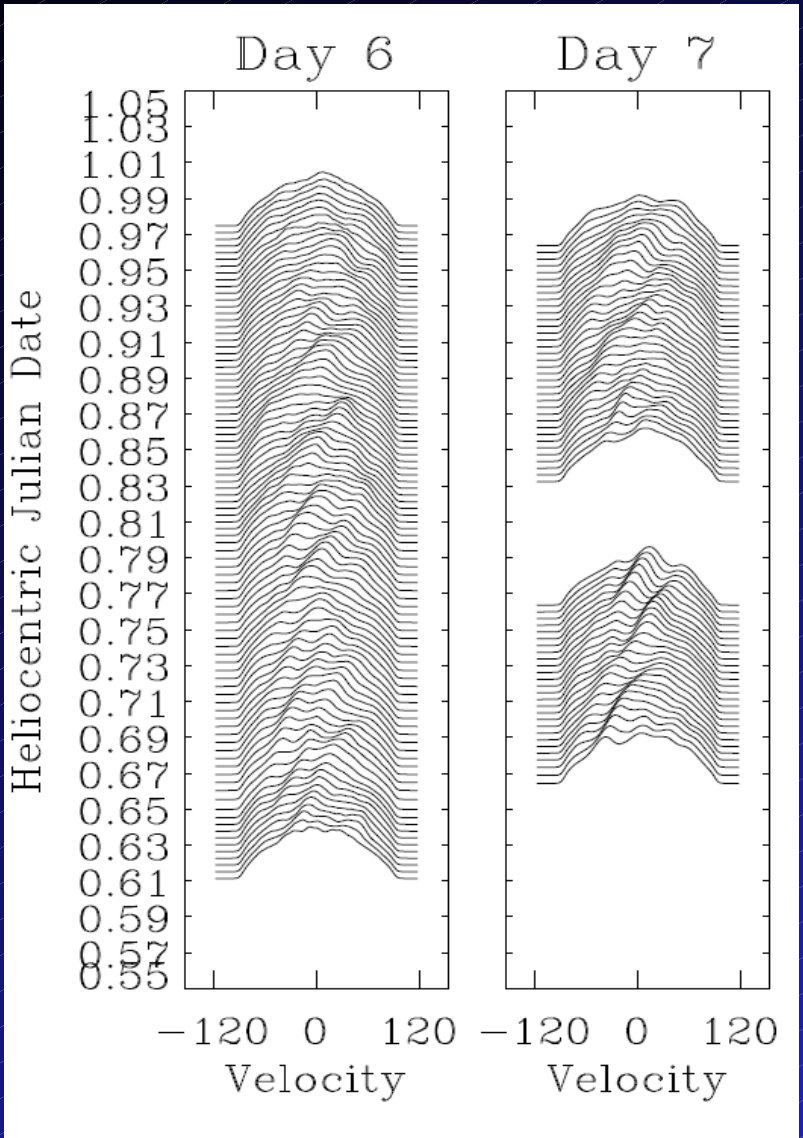
- Light curves in multicolour – SDM, but clients ?
- Spectra – most of astronomy of 20-th Century
  - Support in VO practically not worth of switching habits, learn new tools, jargoon... at least optical
- Reasons : many legacy core apps, too fresh standards (SSA), lack of key features in VO clients, services, Space-research biased (binary tables, absolute flux calibration, SED)
- Massive scaling ??? (overplot 1000 spectra?)
- Measure EW of 100 lines on 500 echelle sp.?

Measured Pulsations



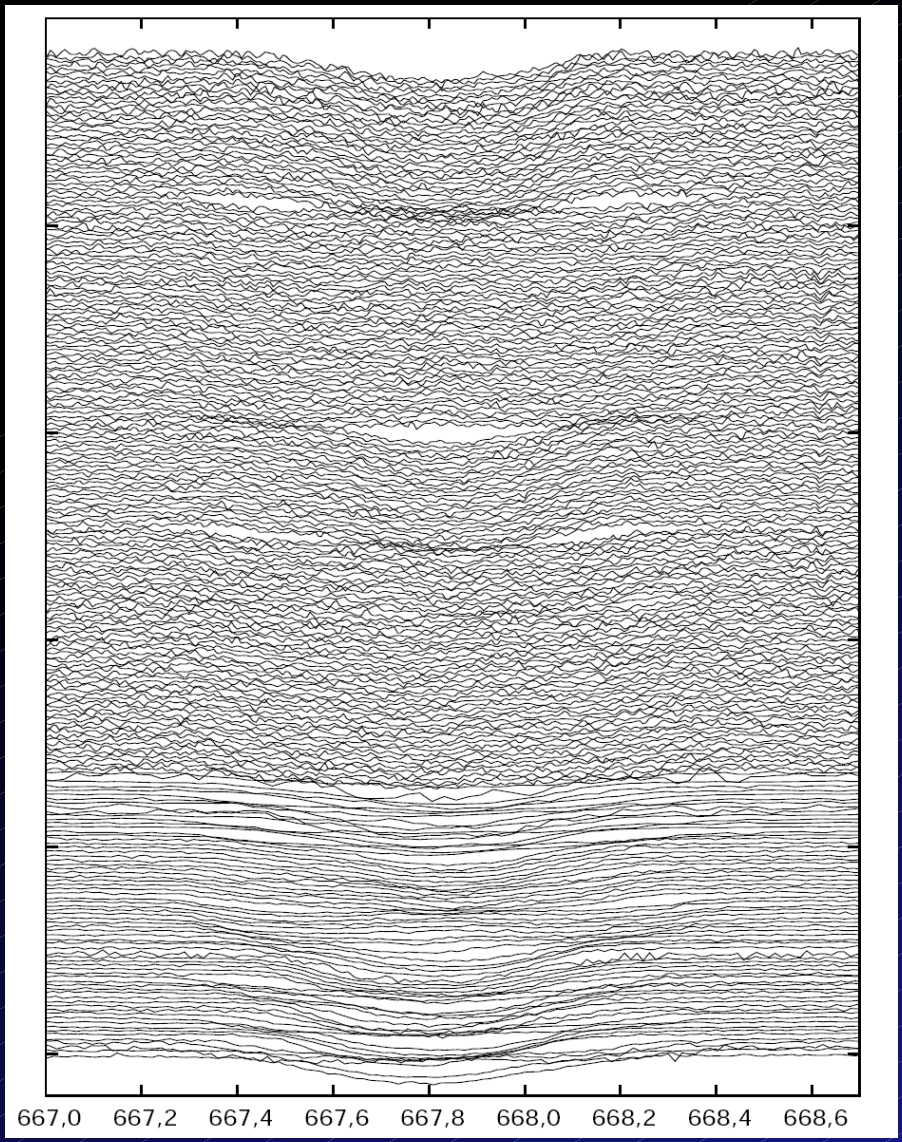
Rho Pup – del Sct type

Aerts 2003

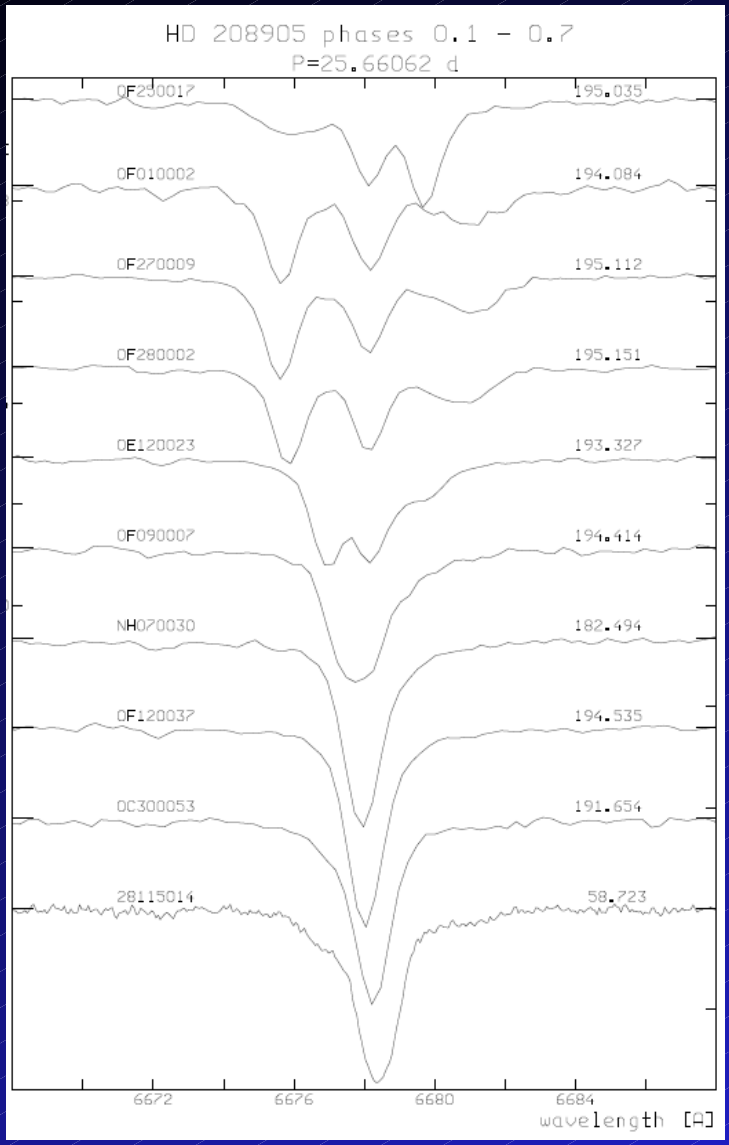


Eps Cep - del Sct type

Many spectra overploted to find cuts

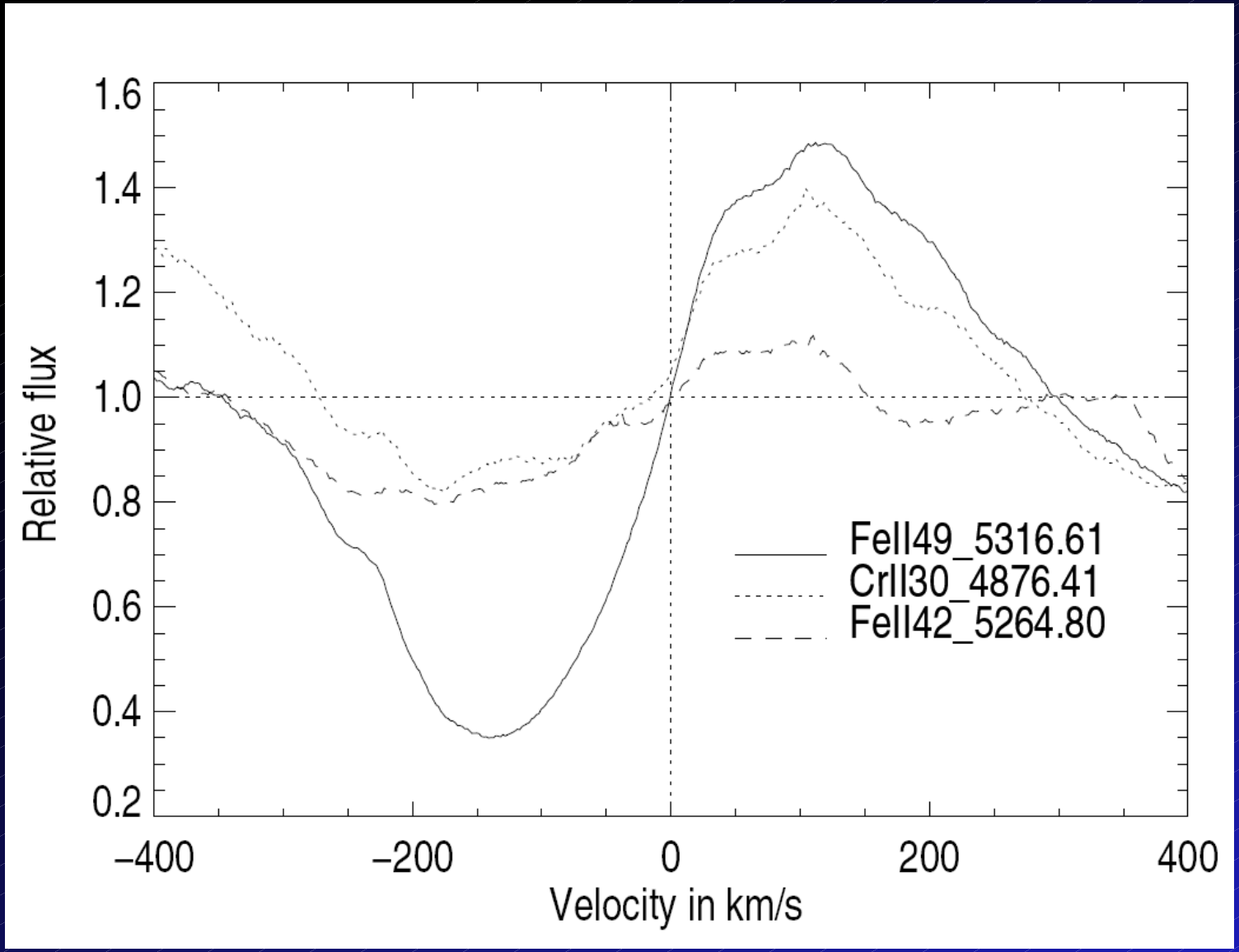


V436 Per : Janik 2003



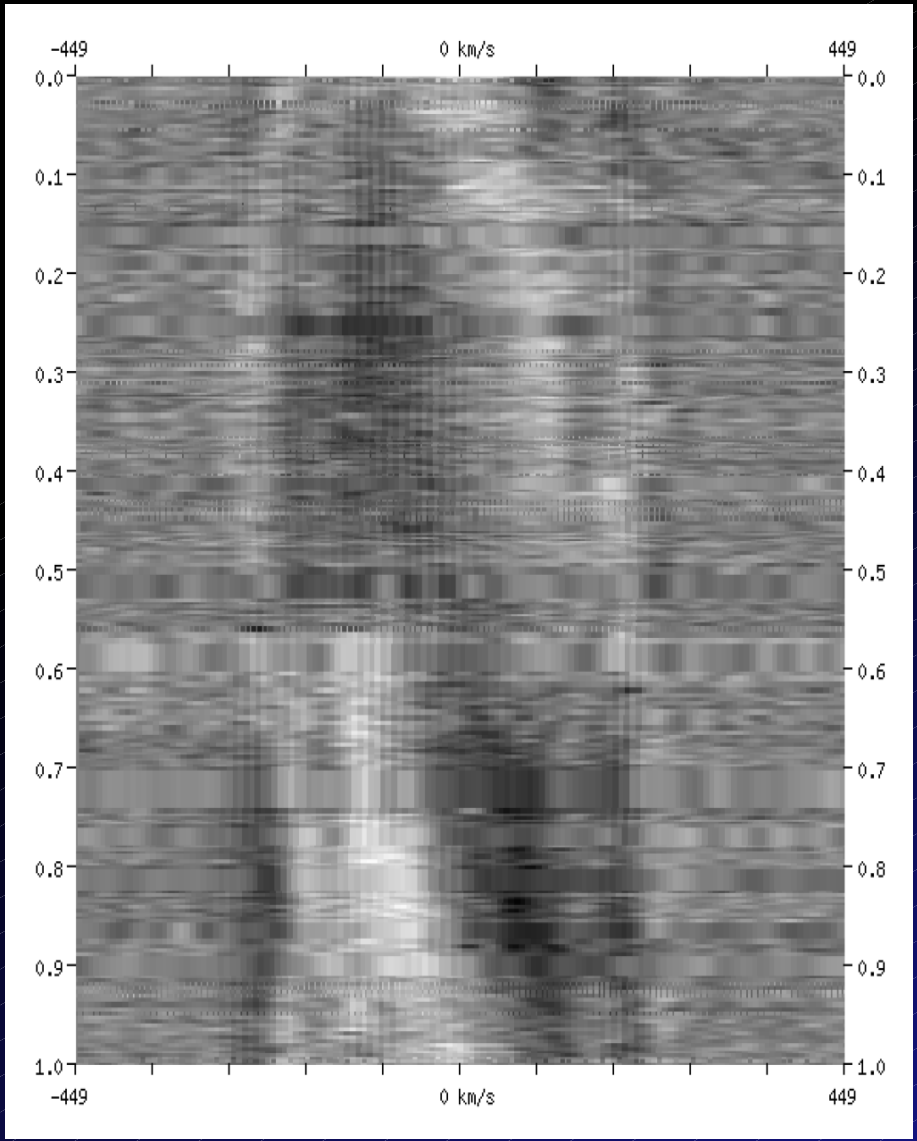
HD208905: Koubsky et al. 2006

Different Lines overploted in RV (cutout service for echelle?)

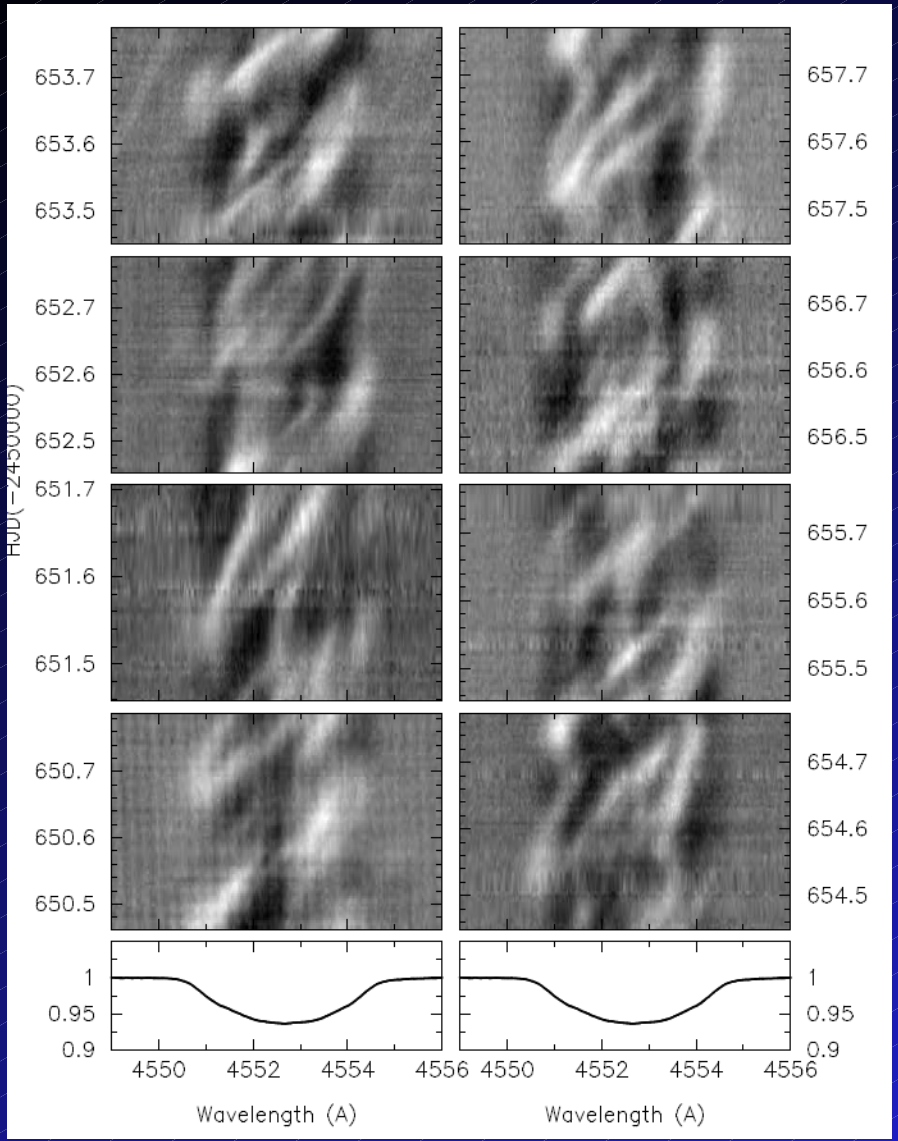


V838 Mon: Kipper et al. 2004

Dynamic Spectra



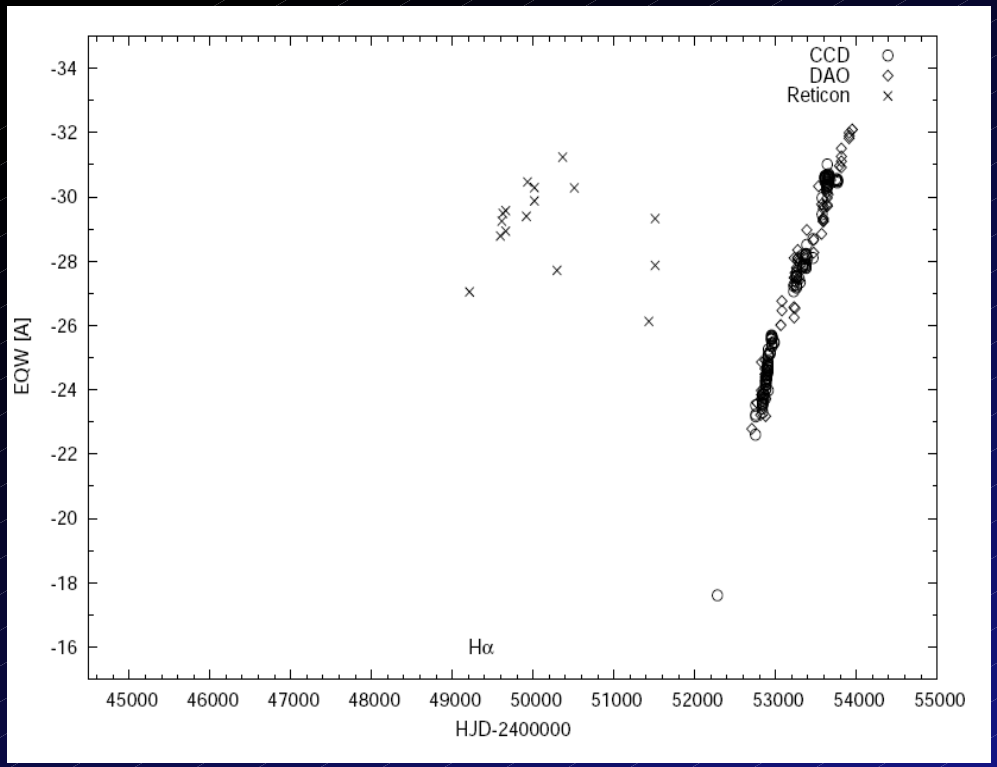
6 Cep: Netolický 2004



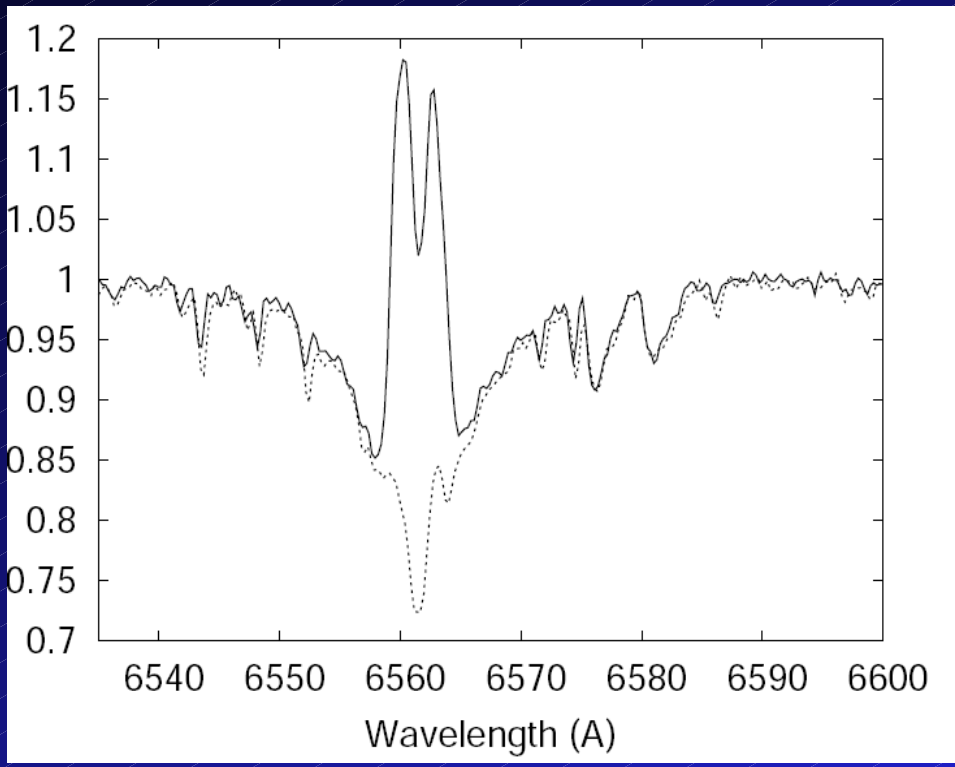
Lambda Sco: Uytterhoeven 2004

Changes of EW in Time

- Batchmode processing, workflows
- Intrinsically parallel – simple algorithm
- Result – one number – plot for each line in time



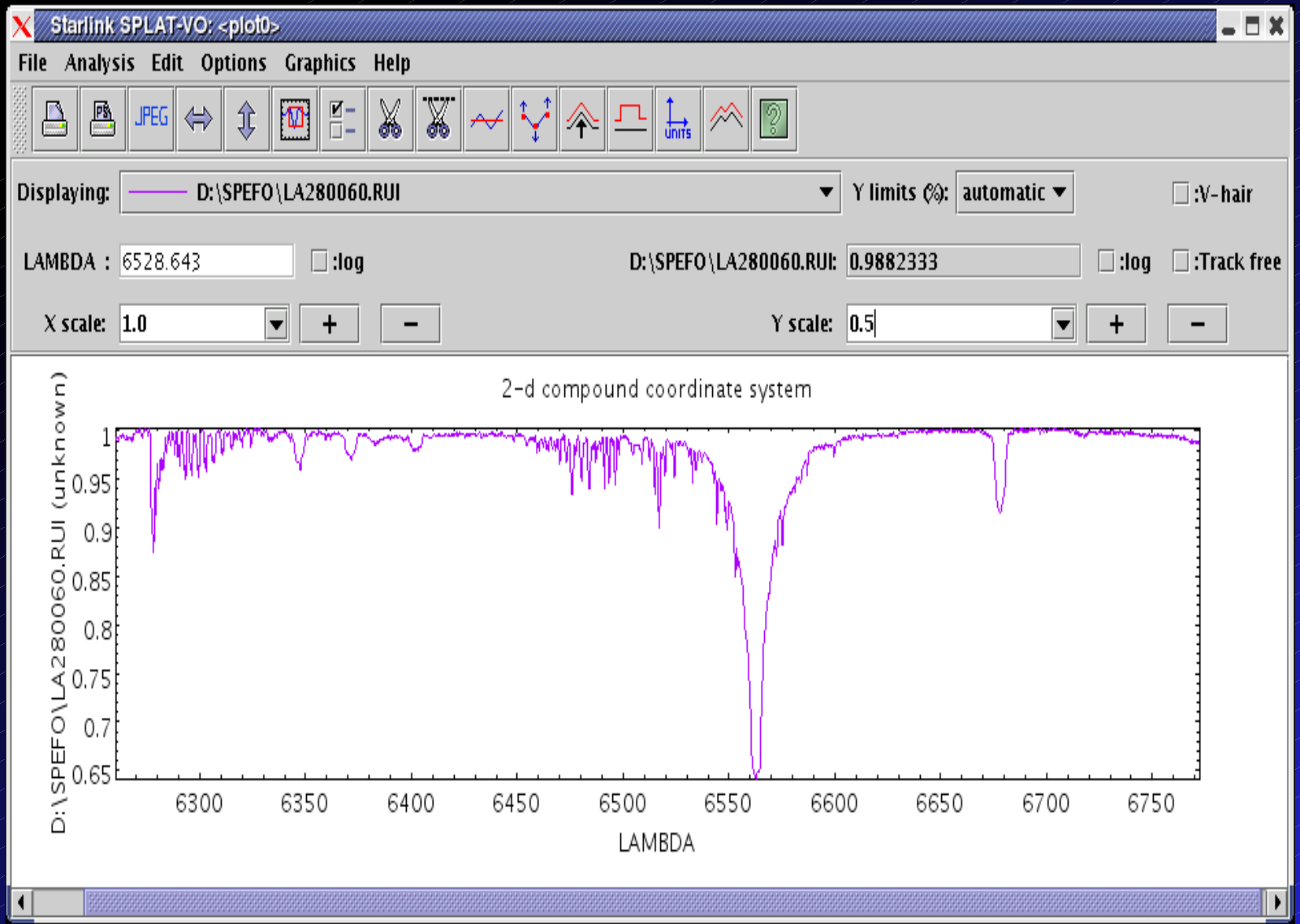
Omi Cas : Koubsky et al. 2004



HD6226 : Slechta and Skoda 2004

SPLAT-VO

- VO Client for analysis (SSA and local files)
  1D FITS IRAF WCS (CRVAL1, CDELT1)



SpecView 2.14.1

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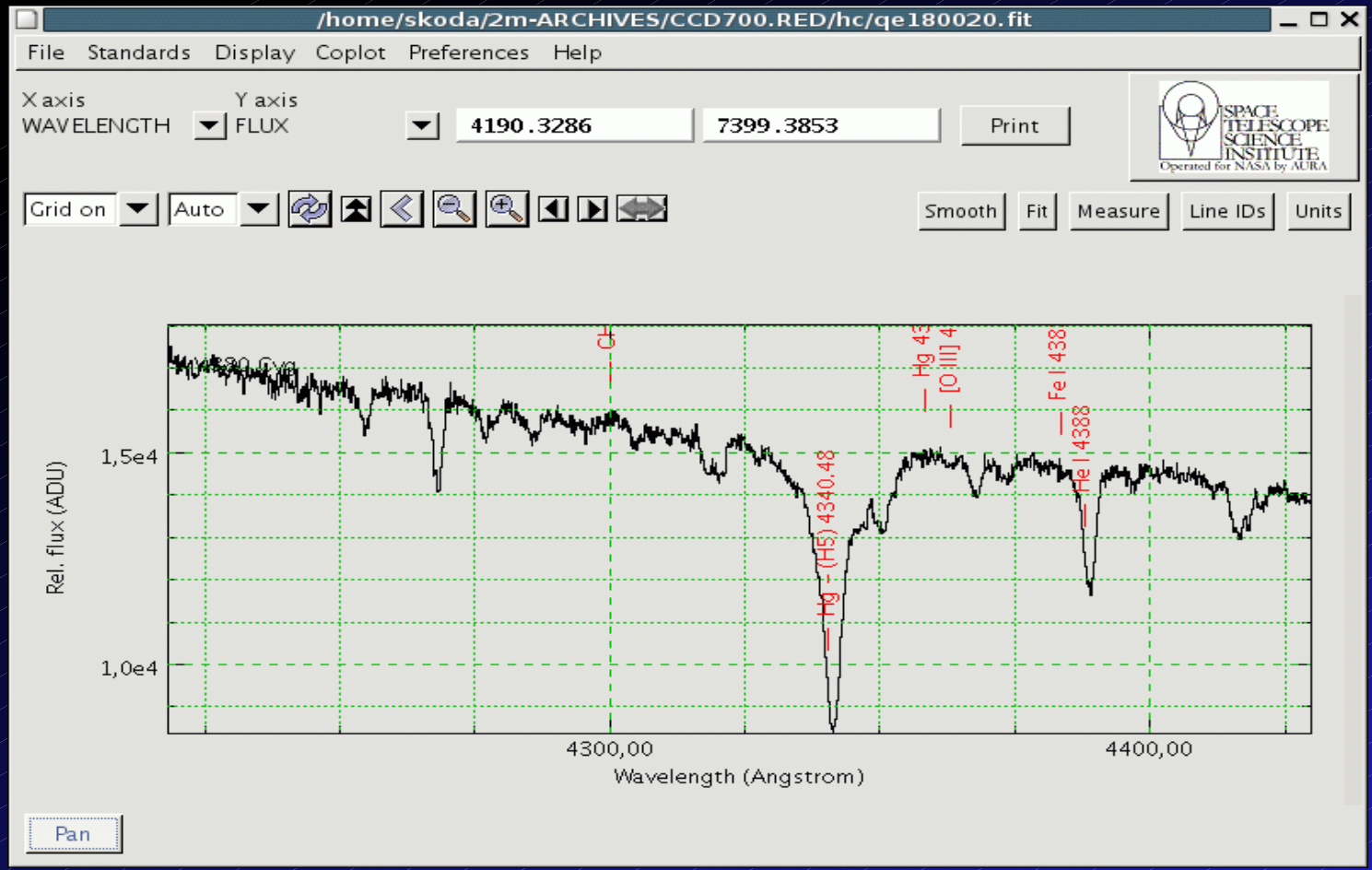
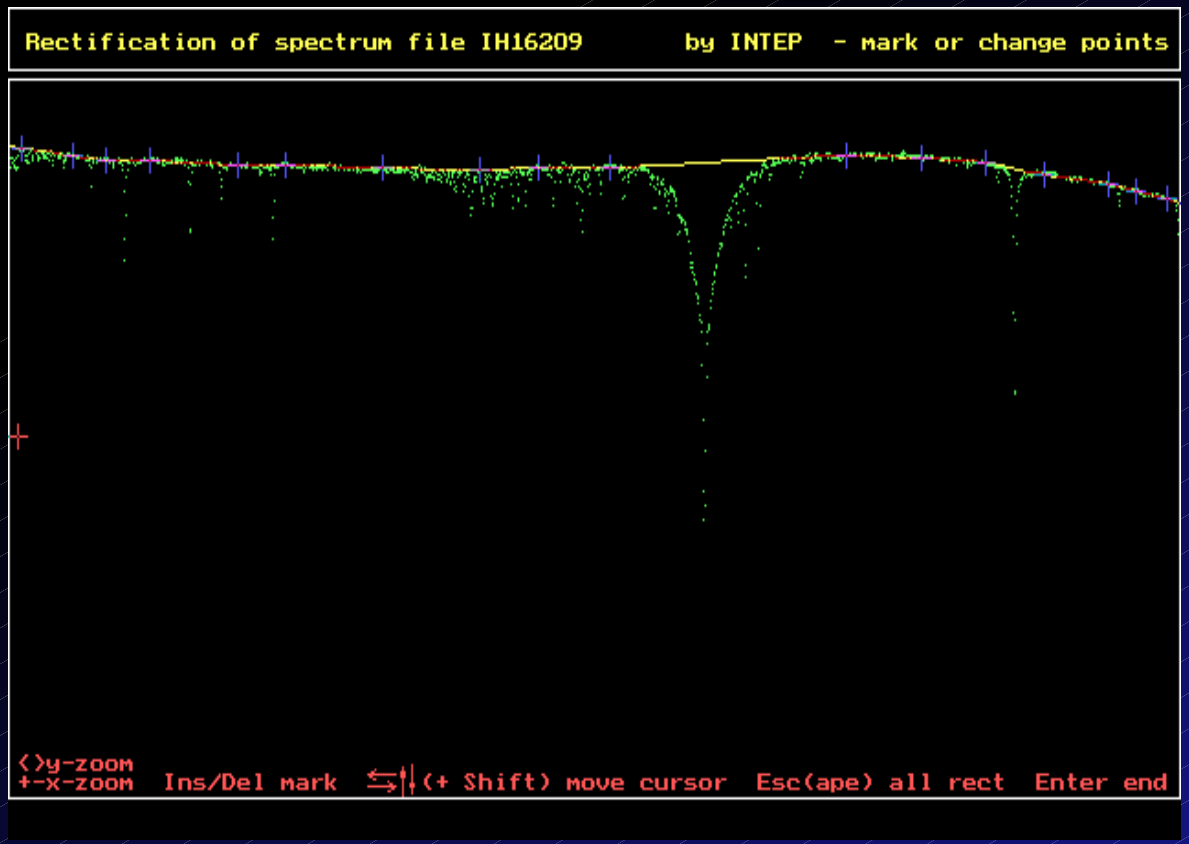
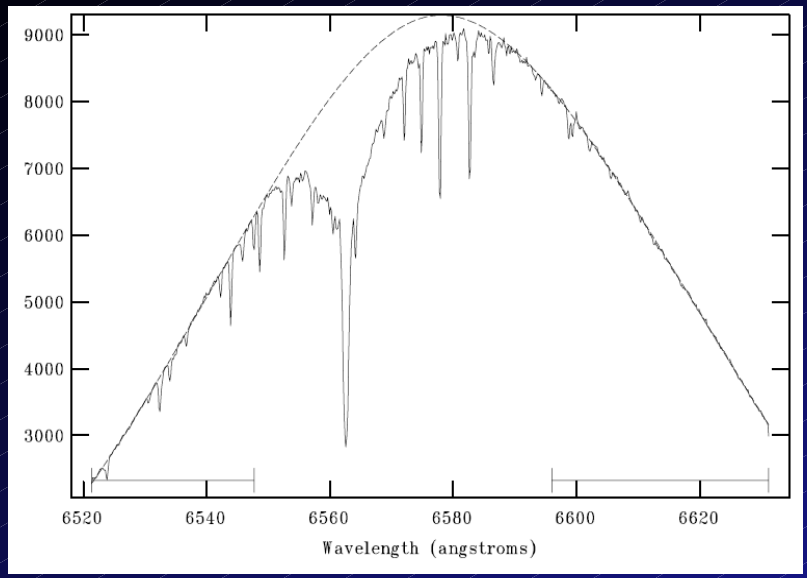


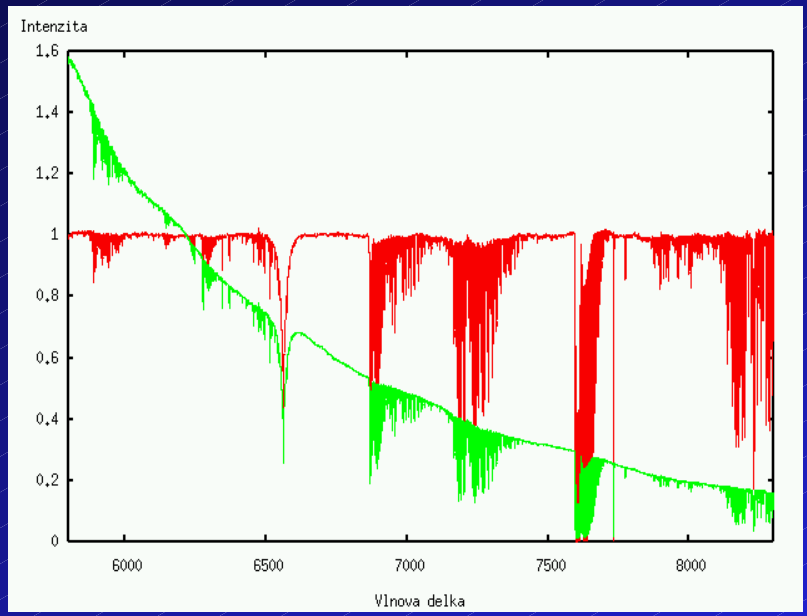
SDM and SSAP Isues

- NORMALIZED FluxCalib
- Handling the Continuum Tree
  - Like Background Tree, both are line fits
  - Background=fit from sides of COP as well
  - Methods of Continuum placement
    (math + physics – rather art and knowledge)
  - Crucial for trusted physical parameters
    (EW of shallow lines)
  - Challenge for echelles !
  - Continuum is a fit - function, not data points

Rectification (Normalization)



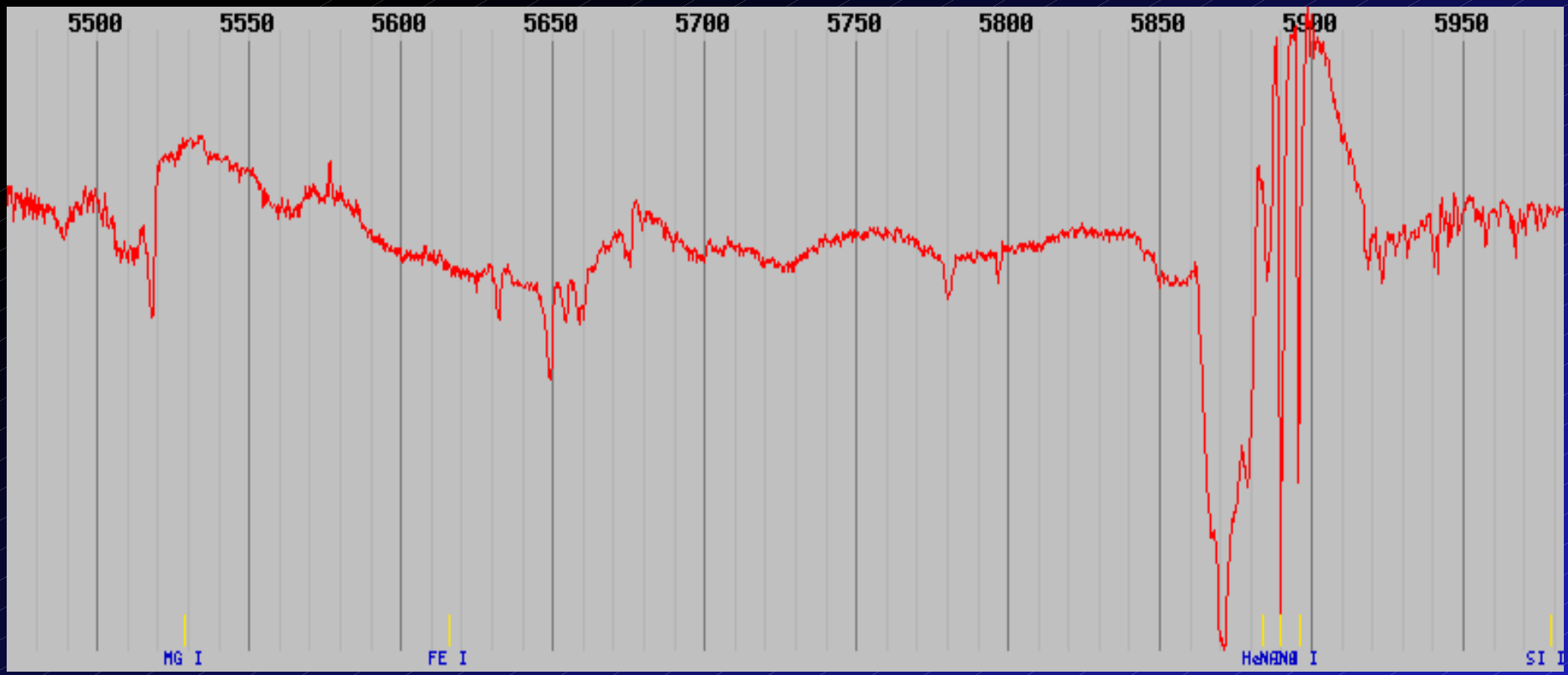




Echelle - tricky

Continuum ???

V 475 Sct =Nova Where is the continuum ? P Cyg profiles



NORMALIZED (Rectified)

- Data published in two versions
  - Raw counts (unrectified, but wavelength calib)
  - Normalized (1.0) – most of final reports (even artistic continuum – novae , molecular bands)
- Current tools (very few legacy) do not support both unrectified and rectified in one file (would be nice to switch on and off for check !!!)
- VO could help here (2 images, same metadata, different queries – joined in client)
- Curation metadata for description of reduction methods, algorithms, tools, comp arc linelist...

NORMALIZED vs. Absolute Flux Calib.

- Problems with ground (optical) absolute flux calibration
  - nothing special – the same art of fit using certain bins on standard star like continuum windows
  - Is again just a function NOT DATA !!
  - Mimics the reality – depends on distribution of bins
- Two products at the same time as above:
  - observed uncalibrated
  - after division by a sensitivity function
- In normalized and abs flux is useful to get the function itself by a separate query (arith.ratio*)

Data format problems

- Most ground based optical spectra consumed in 1D FITS – killer app = splot, spectool
  - Format of data reduction output
  - IRAF apall (doslit, echelle)
  - MIDAS echelle – bdf converted to FITS
  - Analysis in splot
  - IRAF WCS (WATn – polynomials for dispersion)
  - Common file – FITS with CRVAL1, CDELT1 , CRPIX=1 (?), CTYPE =??, units= A
  - Example: Conversion of bin tables *tprint* to ASCII – *rspectxt* -> 1D FITS because of *splot* !

Data format problems

- 1D FITS not flexible (errors, quality)
- Not precise (nonlinear disp. rebinning)
- But de facto standard (legacy app. – conserved for new SW)
- It is accepted by FITS WG – mime appl/fits
- Why not accept for VO ? - Not just propagate in FORMAT=NATIVE
- VO client should understand – transparent services – on-the-fly conversion to bintable ???
- Or accept as it is – M. Taylor: library VO client

Killer VO spectral applications

- Use VO to find all stars with emission in given line (EW<0) – find the time when it was in emission
- Use VO to get 1000 spectra of the given object cut out regions arround given lines, plot the lines, make a gray dynamic spectrum
- The same – search period, fold by period
- Get the unknown line ID of piece of spectra from SLAP overploted over SSA data
- Create Light and RV curve for given period from SSA data
- Fit the grid of models (Teff, log g) to many stars