CLASS demonstration

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Data exploration: I. What does the file contain?

LAS90> file in demo
LAS90> find
LAS90> list

...  
8600; 4 B0355+508 12CO(1-0) 30M-V02-B100 +65.2 +60.0 Eq 9682. 2
8601; 4 B0355+508 12CO(1-0) 30M-V02-B100 +68.2 +60.0 Eq 9682. 2
8602; 4 B0355+508 12CO(1-0) 30M-V02-B100 +71.3 +60.0 Eq 9682. 2
8603; 4 B0355+508 12CO(1-0) 30M-V02-B100 +74.4 +60.0 Eq 9682. 2
8604; 4 B0355+508 12CO(1-0) 30M-V02-B100 +77.4 +60.0 Eq 9682. 2
8605; 4 B0355+508 12CO(1-0) 30M-V02-B100 +80.5 +60.0 Eq 9682. 2
8606; 4 B0355+508 12CO(1-0) 30M-V02-B100 +83.5 +60.0 Eq 9682. 2
8607; 4 B0355+508 12CO(1-0) 30M-V02-B100 +86.6 +60.0 Eq 9682. 2
8608; 4 B0355+508 12CO(1-0) 30M-V02-B100 +89.7 +60.0 Eq 9682. 2
8609; 4 B0355+508 12CO(1-0) 30M-V02-B100 +92.7 +60.0 Eq 9682. 2
8610; 4 B0355+508 12CO(1-0) 30M-V02-B100 +95.8 +60.0 Eq 9682. 2
8611; 4 B0355+508 12CO(1-0) 30M-V02-B100 +98.8 +60.0 Eq 9682. 2
8612; 4 B0355+508 12CO(1-0) 30M-V02-B100 +101.9 +60.0 Eq 9682. 2
8613; 4 B0355+508 12CO(1-0) 30M-V02-B100 +104.9 +60.0 Eq 9682. 2
8614; 4 B0355+508 12CO(1-0) 30M-V02-B100 +108.0 +60.0 Eq 9682. 2

⇒ Too many information.
Data exploration: I. What does the file contain?

LAS90> list /scan

...  
B0355+508  12CO(1-0)  30M-V02-B100  -108.5: +108.8  +70.0  Eq 9626 73
B0355+508  12CO(1-0)  30M-V01-A100  -108.5: +108.8  +80.0  Eq 9627 73
B0355+508  12CO(1-0)  30M-V02-B100  -108.5: +108.8  +80.0  Eq 9627 73
B0355+508  12CO(1-0)  30M-V01-A100  -109.4: +107.9  +90.0  Eq 9628 73
B0355+508  12CO(1-0)  30M-V02-B100  -109.4: +107.9  +90.0  Eq 9628 73
B0355+508  12CO(1-0)  30M-V01-A100  -109.6: +107.7  +100.0 Eq 9629 73
B0355+508  12CO(1-0)  30M-V02-B100  -109.6: +107.7  +100.0 Eq 9629 73
B0355+508  12CO(1-0)  30M-V01-A100  -100.0  -109.3: +108.0 Eq 9634 73
B0355+508  12CO(1-0)  30M-V02-B100  -100.0  -109.3: +108.0 Eq 9634 73
B0355+508  12CO(1-0)  30M-V01-A100  -90.0   -109.4: +107.9 Eq 9635 73
B0355+508  12CO(1-0)  30M-V02-B100  -90.0   -109.4: +107.9 Eq 9635 73
B0355+508  12CO(1-0)  30M-V01-A100  -80.0   -109.5: +107.8 Eq 9636 73
B0355+508  12CO(1-0)  30M-V02-B100  -80.0   -109.5: +107.8 Eq 9636 73
B0355+508  12CO(1-0)  30M-V01-A100  -70.0   -109.2: +108.1 Eq 9637 73

LAS90>

⇒ One line per scan and front-end/back-end combination
Data exploration: I. What does the file contain?

LAS90> list /scan /brief
Current index contains:
  9608: 146  9609: 146  9610: 146  9611: 146  9612: 146  9613: 146
  9614: 146  9615: 146  9616: 146  9617: 146  9619: 146  9620: 146
  9621: 146  9622: 146  9623: 146  9624: 146  9625: 146  9626: 146
  9627: 146  9628: 146  9629: 146  9634: 146  9635: 146  9636: 146
  9637: 146  9638: 146  9639: 146  9640: 146  9641: 146  9642: 146
  9643: 146  9645: 146  9646: 146  9647: 146  9648: 146  9649: 146
  9650: 146  9651: 146  9652: 146  9653: 146  9654: 146  9655: 146
  9665: 146  9666: 146  967: 146  9678: 146  967: 146  9680: 146
  9679: 146  968: 146  968: 146  9682: 146

⇒ Just the list of scans and the number of dumps per scans.
Data exploration: I. What does the file contain?

LAS90> list /toc

equivalent to

LAS90> list /toc source line telescope
Current index contains:
Number of sources....... 1
   B0355+508          8614 (100.0%)
Number of lines........ 1
   12CO(1-0)          8614 (100.0%)
Number of backends..... 2
   30M-V01-A100      4307 ( 50.0%)
   30M-V02-B100      4307 ( 50.0%)
Number of setups....... 2
   B0355+508  12CO(1-0)  30M-V01-A100  4307 ( 50.0%)
   B0355+508  12CO(1-0)  30M-V02-B100  4307 ( 50.0%)
LAS90>

⇒ Default table of content.
Data exploration: I. What does the file contain?

LAS90> list /toc obs scan
Number of observation dates 1
  12-SEP-2005  8614 (100.0%)
Number of scans....... 59
  9608       146 ( 1.7%)
  9609       146 ( 1.7%)
  9610       146 ( 1.7%)
  9611       146 ( 1.7%)
  9612       146 ( 1.7%)
  9613       146 ( 1.7%)
  9614       146 ( 1.7%)
...
Number of setups....... 59
  12-SEP-2005  9608  146 ( 1.7%)
  12-SEP-2005  9609  146 ( 1.7%)
  12-SEP-2005  9610  146 ( 1.7%)
  12-SEP-2005  9611  146 ( 1.7%)
  12-SEP-2005  9612  146 ( 1.7%)
  12-SEP-2005  9613  146 ( 1.7%)
  12-SEP-2005  9614  146 ( 1.7%)
...

⇒ Customized table of content.
Data exploration: II. Is the data set in the current index consistent?

LAS90> consistency

I-CONSISTENCY,
I-CONSISTENCY, Checking Data type and regular x-axis sampling
I-CONSISTENCY, Checking Source Name
I-CONSISTENCY, Checking Position information
I-CONSISTENCY, Checking Line Name
I-CONSISTENCY, Checking Spectroscopic information
I-CONSISTENCY, Reference Source Name: B0355+508
I-CONSISTENCY, Reference Coordinate System: EQUATORIAL 2000.0
I-CONSISTENCY, Reference Projection Center: 1.044998, 0.889488
I-CONSISTENCY, Reference Line Name: 12CO(1-0)
I-CONSISTENCY, Reference freq. (MHz) rest: 115.271E+03, resol: 3.906E-02, offset: 0.000E+00, tole: 1.00E-06
I-CONSISTENCY, Reference vel (km/s) resol: -1.016E-01 offset: -1.000E+01, tole: 2.60E-06

W-CONSISTENCY, Obs # 74: Inconsistent reference channels: 1220.199951, 1476.199951
E-CONSISTENCY, Index is inconsistent

⇒ Inconsistent spectroscopic information in index.

LAS90> consistency

W-CONSISTENCY, Already checked Spectroscopic information: Inconsistent

⇒ Check not repeated (it avoids long waiting time)
Data exploration: II. Is the data set in the current index consistent?

LAS90> find /tel 30M-V01-A100
LAS90> consistency

I-CONSISTENCY, Checking Data type and regular x-axis sampling
I-CONSISTENCY, Checking Source Name
I-CONSISTENCY, Checking Position information
I-CONSISTENCY, Checking Line Name
I-CONSISTENCY, Checking Spectroscopic information
I-CONSISTENCY, Reference Source Name: B0355+508
I-CONSISTENCY, Reference Coordinate System: EQUATORIAL 2000.0
I-CONSISTENCY, Reference Projection Center: 1.044998, 0.889488
I-CONSISTENCY, Reference Line Name: 12CO(1-0)
I-CONSISTENCY, Reference freq. (MHz) rest: 115.271E+03 , resol: 3.906E-02, offset: 0.000E+00, tole: 1.00E-06
I-CONSISTENCY, Reference vel (km/s) resol: -1.016E-01 offset: -1.000E+01, tole: 2.60E-06
I-CONSISTENCY, Index is consistent

• find enforces a new consistency check from scratch.

• Selection of a data subset ⇒ Consistent index.
Data exploration: III. Where do we observe?

LAS90> go where

One point per spectrum
⇒ Lambda + Beta scanning
⇒ Mapping experiment
Data exploration: III. What does the data look like?

LAS90> set plot histogram ! => Spectrum will be plotted as an histogram
LAS90> set format long ! => Lot’s of information about the spectrum in the plot header
LAS90> set unit v f ! => Bottom axis in velocity, top axis in frequency
LAS90> get first ! Get first spectrum of index
LAS90> plot

16; 4 BO355+508 12CO(1−0) 30M−V01−A100 0:12−SEP−2005 R:23−AUG−2009
RA: 03:59:29.74 DEC: 50:57:50.1 Eq 2000.0 Offs: −65.6 −100.0
Unknown tau: 0.324 Tsys: 212. Time: 1.87E−02min El: 76.0
N: 2689 t0: 1220.20 V0: −10.00 Dv: −0.1016 LSR
F0: 115271.204 Df: 3.9063E−02 Fi: 118267.104

• Line + Spike visible.
• LAS90> get next
LAS90> plot
LAS90> get next
LAS90> plot...
8000 times ⇒ a bit long...
Data exploration: III. What does the data look like?

LAS90> quiet                      ! Shut off informational messages
LAS90> set nomatch                ! Disable check about position consistency
LAS90> set align f c              ! Toggle frequency resampling
LAS90> average                   ! Average all spectra in index
LAS90> verbose                   ! Shut on informational messages
LAS90> plot

Line + Spike + platforming visible.

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Data exploration: III. What does the data look like?

LAS90> set mode x 60 80 ! => Zoom on spike
LAS90> plot
LAS90> set mode x tot ! => Zoom back
LAS90> plot

1: 4 B0355+508 12CO(1-0) 30M-V01-A100 0:12-SEP-2005 R:23-AUG-2009
RA: 03:59:29.74 DEC: 50:57:50.1 Eq 2000.0 Offs: +108.0 +60.0
Unknown tau: 0.334 Tsys: 236. Time: 72. min EL: 51.8
N: 2689 Io: 1220.20 V0: -10.00 Dv: -0.1016 LSR
F0: 115271.204 Df: 3.9063E-02 Fr: 118267.104

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Data exploration: III. What does the data look like?

LAS90> find /tel 30M-V01-A100
LAS90> load ! Load the spectra in the current index as an image
LAS90> plot /index ! Plot the image

- Line + Spike visible.
- Variation of continuum level before baselining.
- 4000 spectra displayed at the same time.
- Possibility to quickly swap between average and image:
  LAS90> plot
  LAS90> plot /index
  LAS90> plot
Data exploration: III. What does the data look like?

- Line + Spike visible.
- Image saturation due to variation of the continuum level.
Data exploration: III. What does the data look like?

All previous possibilities integrated in an exploration tool

CLASS demonstration

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Data reduction: I. Windowing

LAS90> average
LAS90> plot
LAS90> set window -120 -105 -25 0 60 75  ! Define the windows
LAS90> draw window  ! Overplot the windows

• One window to avoid the signal
• two windows to avoid the spikes
Data reduction: II. Selecting baseline order

LAS90> pen 1 ! Change pen color
LAS90> base 0 /plot ! Fit 0-order baseline and overplot baseline polynomial
I-POLYNO, degree: 0 rms: 7.942E-02 area: 7.87 v0:-21.98 width: 0.000
LAS90> swap ! Get back averaged spectrum before baselining
LAS90> clear segment ! Clear overplotted baseline
LAS90> base 1 /plot ! Increase baseline polynomial order and check residual rms
I-POLYNO, degree: 1 rms: 3.559E-02 area: 7.58 v0:-26.01 width: 0.000
LAS90> swap; clear segment
LAS90> base 2 /plot ! Increase baseline polynomial order and check residual rms
I-POLYNO, degree: 2 rms: 2.292E-02 area: 7.02 v0:-25.84 width: 0.000
LAS90> pen 0 ! Reset pen color
LAS90> plot ! Plot baselined spectra

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Data reduction: III. Signal dependent window

LAS90> plot /index ! Plot the whole set of spectrum
LAS90> set window /poly 1 ! Define 1 polygon
Data reduction: IV. Baselining

LAS90>

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Data reduction: V. Baseline RMS

LAS90> clear plot
LAS90> g\limit /var idx%num idx%sig
LAS90> g\box
LAS90> g\set marker 4 3 0.15
LAS90> g\point idx%num idx%sig
LAS90> g\label "Observation number" /X
LAS90> g\label "rms [K]" /Y
Data reduction: VI. “Despiking”

LAS90> file out a100-fill single /over
LAS90> find
LAS90> for ient 1 to found
LAS90>   get next
LAS90>   fill -120 -100 60 75 /noise   ! File contaminated channels with Gaussian noise
LAS90>   write
LAS90> next ient

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Data reduction: VII.1 Platforming diagnostic

Platforming affects a single scan (#9621)
⇒ Copy all the 2nd receiver data in a file where correction will happen in-place.

LAS90> set sort none
LAS90> file out b100-plat multiple /over ! Multiple occurences of one spectrum enabled
LAS90> copy

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Data reduction: VII.2 Platforming correction #1

LAS90> find /scan 9621
LAS90> get first
LAS90> define real ty /like ry ! Define an intermediate array of intensities
LAS90> find /scan 9621 ! Reset index counter to zero
LAS90> get next
LAS90> plot
LAS90> set window -200 -42.3 -22 0 90 100
LAS90> base 2 /pl
LAS90> let ty ry /where rx.gt.-42.3

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Data reduction: VII.3 Platforming correction #2

LAS90> set window -95 -75 -42.3 +200
LAS90> base 0 /pl
LAS90> let ry ty /where rx.gt.-42.3

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Data reduction: VII.4 After platforming correction

<table>
<thead>
<tr>
<th>RA</th>
<th>DEC</th>
<th>Epoch</th>
<th>Offset</th>
<th>RA</th>
<th>DEC</th>
<th>Epoch</th>
<th>Offset</th>
</tr>
</thead>
<tbody>
<tr>
<td>03:59:29.74</td>
<td>50:57:50.1</td>
<td>2000.0</td>
<td>107.8</td>
<td>03:59:29.74</td>
<td>50:57:50.1</td>
<td>2000.0</td>
<td>107.8</td>
</tr>
</tbody>
</table>

Position: 73
Offset ranges: (-109.5, +107.8) (420.0, +20.0)

Instrument: 12C0(1-0)

Detected: 3 points

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Data reduction: VIII. Merging reduced data sets

LAS90> set tel *
LAS90> file out reduced single /over
LAS90> file in a100-fill
LAS90> quiet
LAS90> find
LAS90> list /toc
LAS90> copy
LAS90> file in b100-base
LAS90> find
LAS90> list /toc
LAS90> copy
LAS90> verbose
LAS90> file in reduced
LAS90> find
LAS90> list /toc
Data gridding

LAS90> table 12co10 new /range -30 10 v
LAS90> xy_map 12co10
LAS90> let name 12co10
LAS90> let type lmv
LAS90> go view
Visualization: I. GO VIEW

LAS90> let name 12co10
LAS90> let type lmv
LAS90> go view

Source: B0355+508  Line: 12CO(1−0)  Freq: 115.271204 GHz  Beam: 22.5 x 22.5 PA 0°

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Visualization: II. GO BIT

LAS90> let name 12co10
LAS90> let type lmv
LAS90> go bit
LAS90> input bit

12co10.lmv
Source: B0355+508
Line: 12C0(1–0)
Frequency: 115.271204 GHz
Beam: 22.5 x 22.5 PA 0°
Level step: 1 K (T_{A*})

Box marking: VELOCITY
Channels: [0,0]

04–SEP–2009 16:02:33
Visualization: III. GO SPECTRUM

LAS90> let name 12co10
LAS90> let type lmv
LAS90> go spectrum

Source: B0.355+508
Line: 12CO(1-0)
Frequency: 115.271204 GHz
Beam: 22.5 x 22.5 PA 0°
Level step: 1 K (T_A^*)

Box marking: DEC Offset
Channels: [0,0]

pety@visior13
04-SEP-2009 16:11:53
Visualization: IV. GO ROT

LAS90> let name 12co10
LAS90> let type lmv
LAS90> let angle 45
LAS90> go rot
LAS90> go view

Source: B0355+508  Line: 12CO(1−0)  Freq: 115.271204 GHz  Beam: 22.5 x 22.5 PA 45°

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Visualization: V. GO 3VIEW

LAS90> let name 12co10-rot45deg
LAS90> let type lmv
LAS90> go 3view
Analysis: Noise Estimation with MEAN

LAS90> let name 12co10
LAS90> let type lmv
LAS90> let first 1
LAS90> let last 1
LAS90> go bit
LAS90> poly
LAS90> mean
I-MEAN, Found 288 non-blanked pixels, of area: 7.7075E-07 Radians squared
I-MEAN, Integrated intensity: -1.678452E-08 (Map Units * Radians squared)
I-MEAN, Mean value: -2.17770E-02, r.m.s.: 0.16625