SDSS-V
Local Volume Mapper

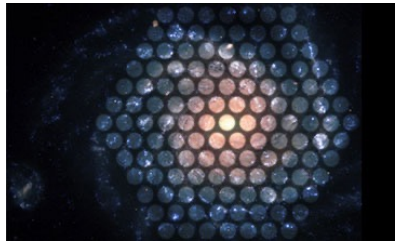
Ivan Katkov

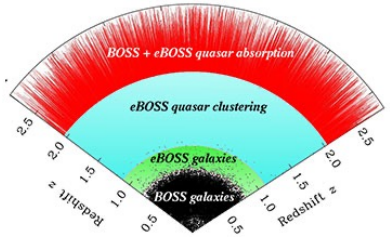
Volga seminar
March 3, 2025

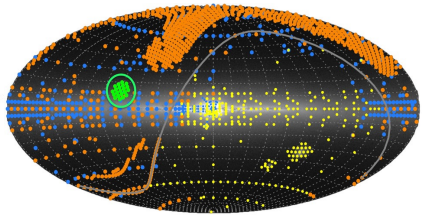
SDSS-V

SDSS IV (2014-2020)

- MaNGA, eBOSS, APOGEE-2

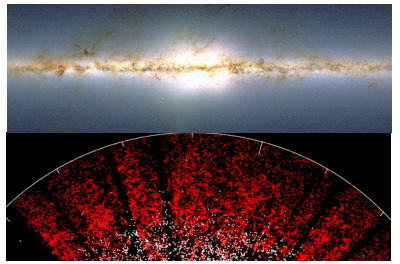






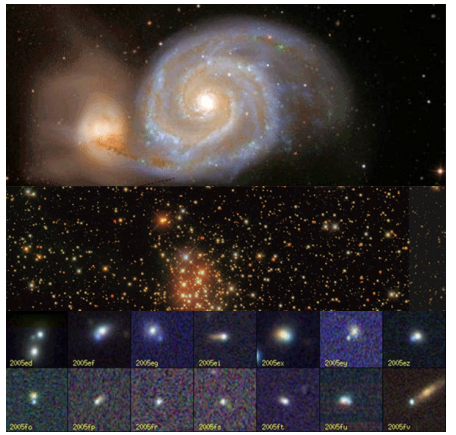
SDSS III (2008-2014)

- BOSS
  - 1000 fiber spectrograph, R~2000, 360-1000nm
- APOGEE
  - IR spectra 1.51-1.7μm, R~20,000, stellar params, chemical abundances
- MARVELS, SEGUE-2

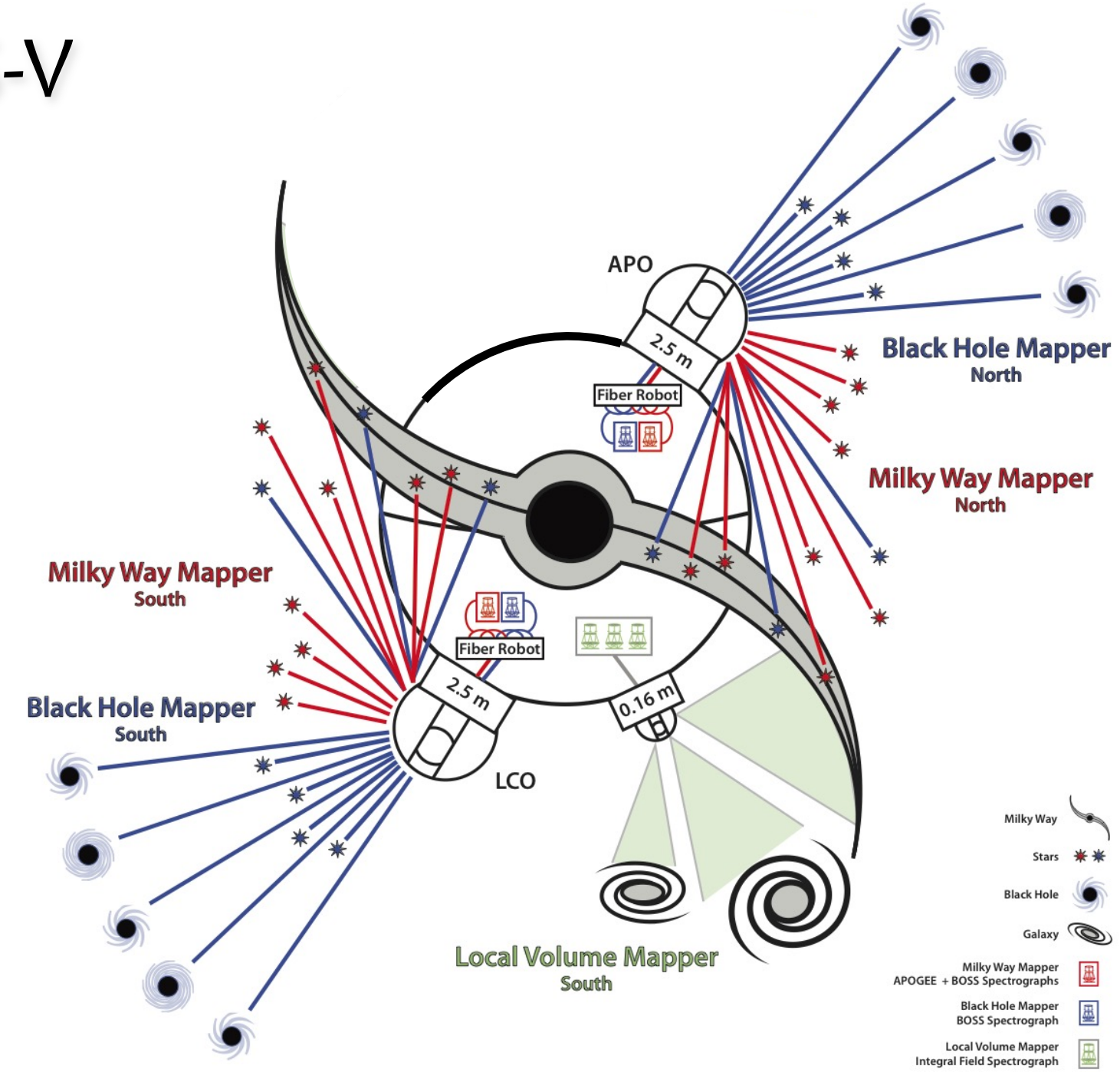


SDSS I/II (2000-2008)

- The Sloan Legacy Survey
  - Deep multi-color imaging of the half of the North sky
  - 230M celestial objects
  - Spectra for 930k galaxies, 120k quasars, 225k stars
- SEGUE
  - 3500 sq. deg and 240k spectra
- Supernova survey

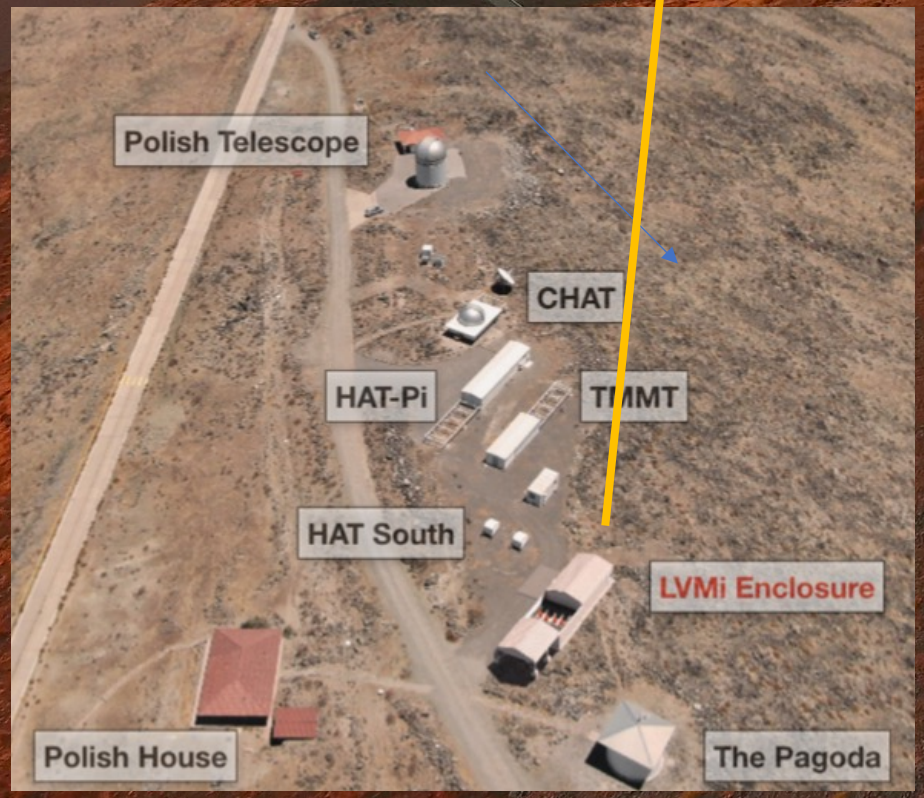


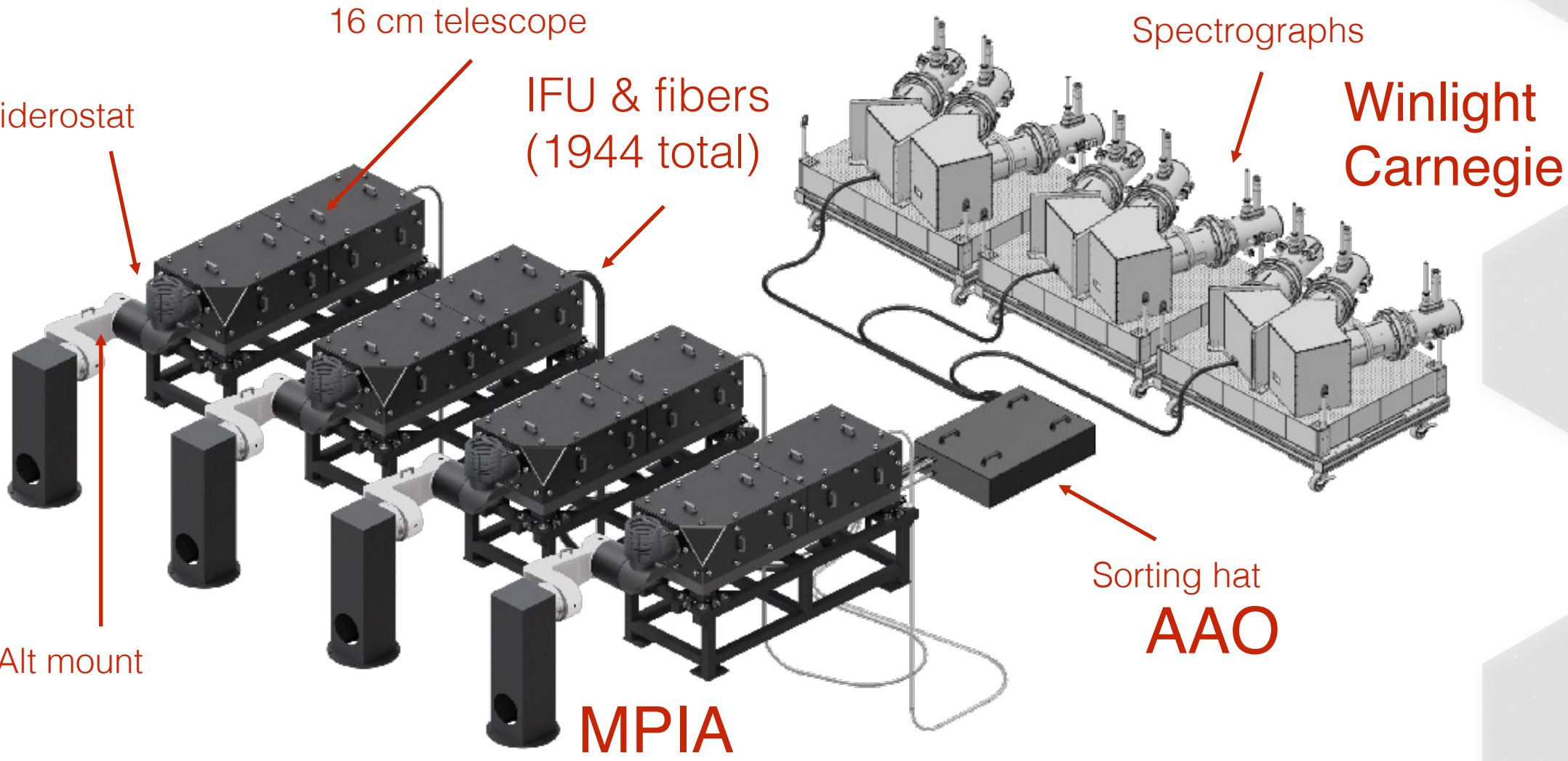
SDSS-V


APO
2.5 m
Fiber Robot
Black Hole Mapper
North
Milky Way Mapper
North
Milky Way Mapper
South
Fiber Robot
2.5 m
0.16 m
Black Hole Mapper
South
LCO
Local Volume Mapper
South
Milky Way
Stars
Black Hole
Galaxy
Milky Way Mapper
APOGEE + BOSS Spectrographs
Black Hole Mapper
BOSS Spectrograph
Local Volume Mapper
Integral Field Spectrograph

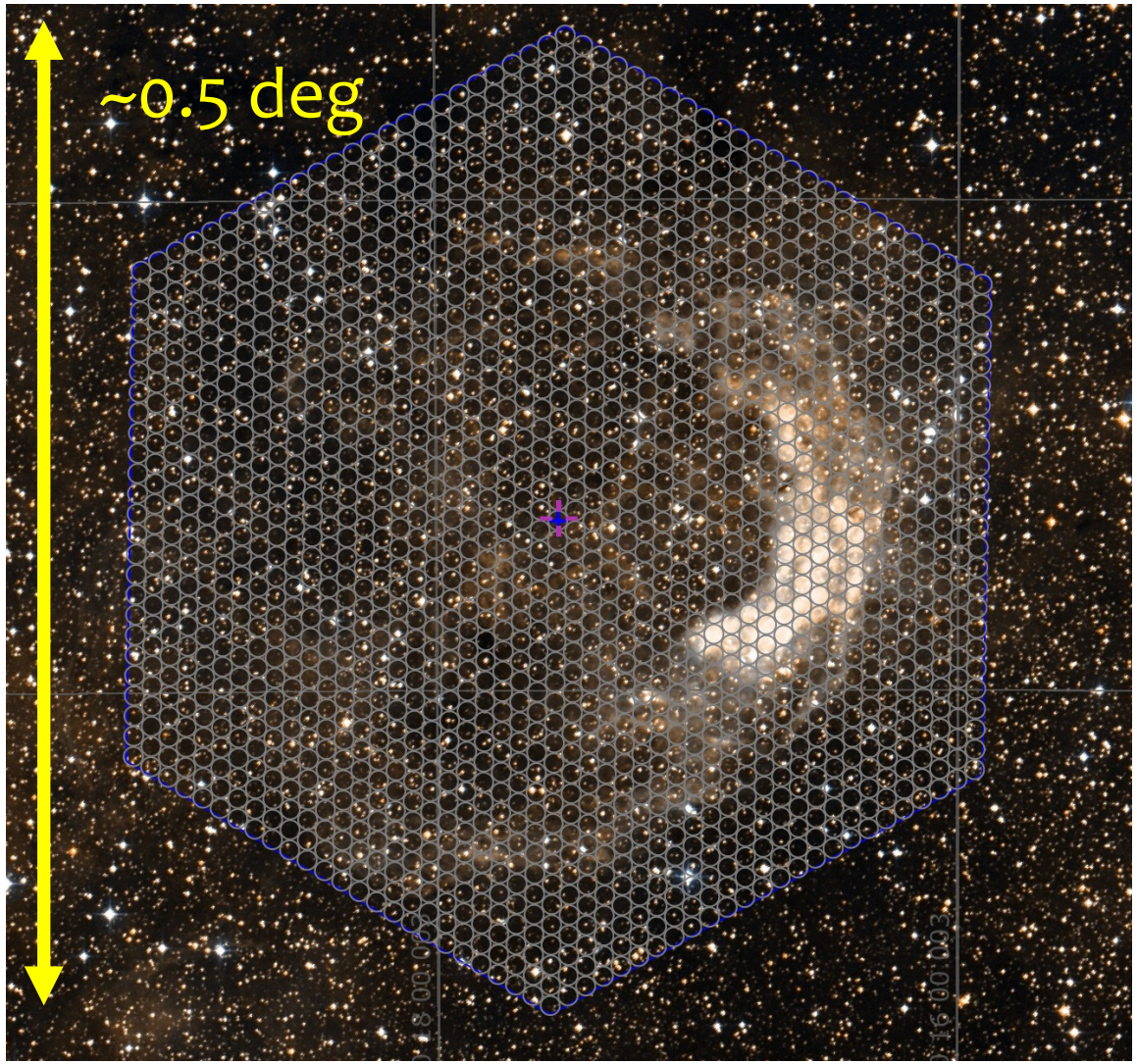
LVM Facility

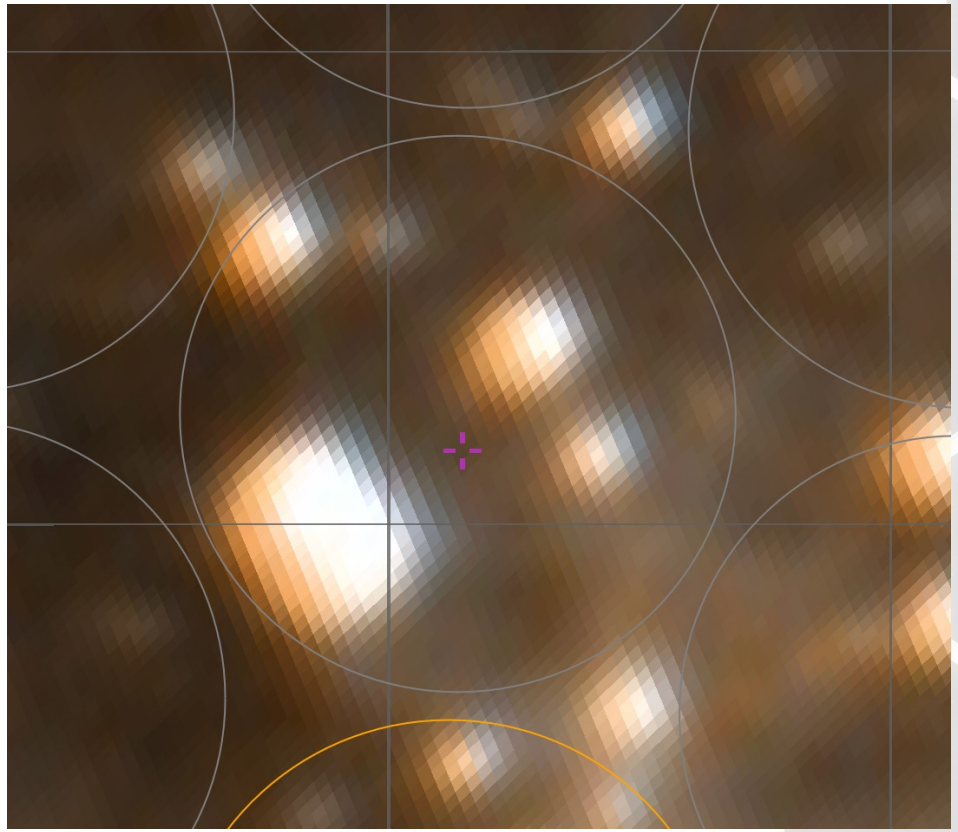
Las Campanas Observatory





Nick Konidaris, Tom Herbst et al.

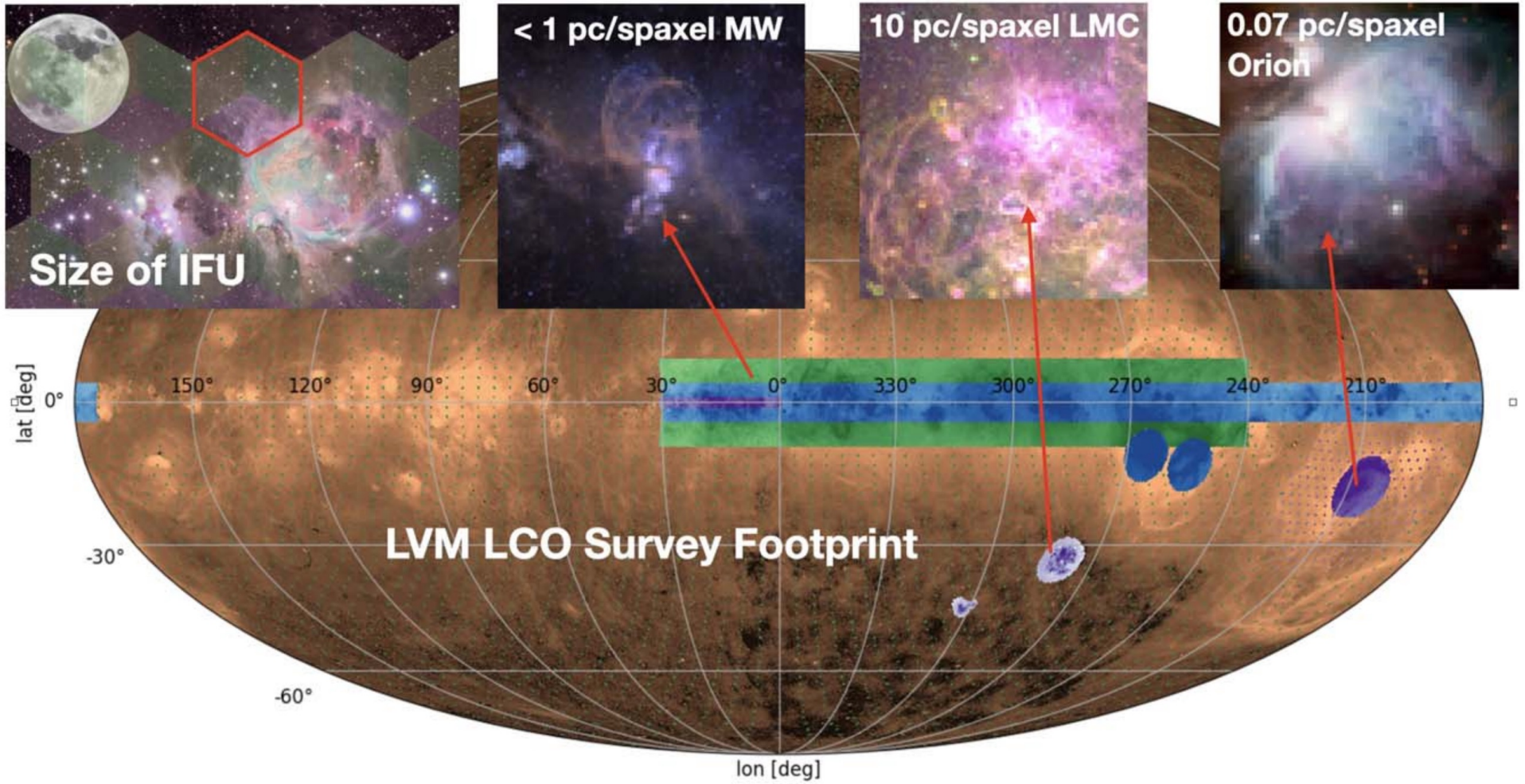

~0.5 deg




~0.5 de


Largest MaNGA 127-fiber bundle

Spatially Sampling the ISM



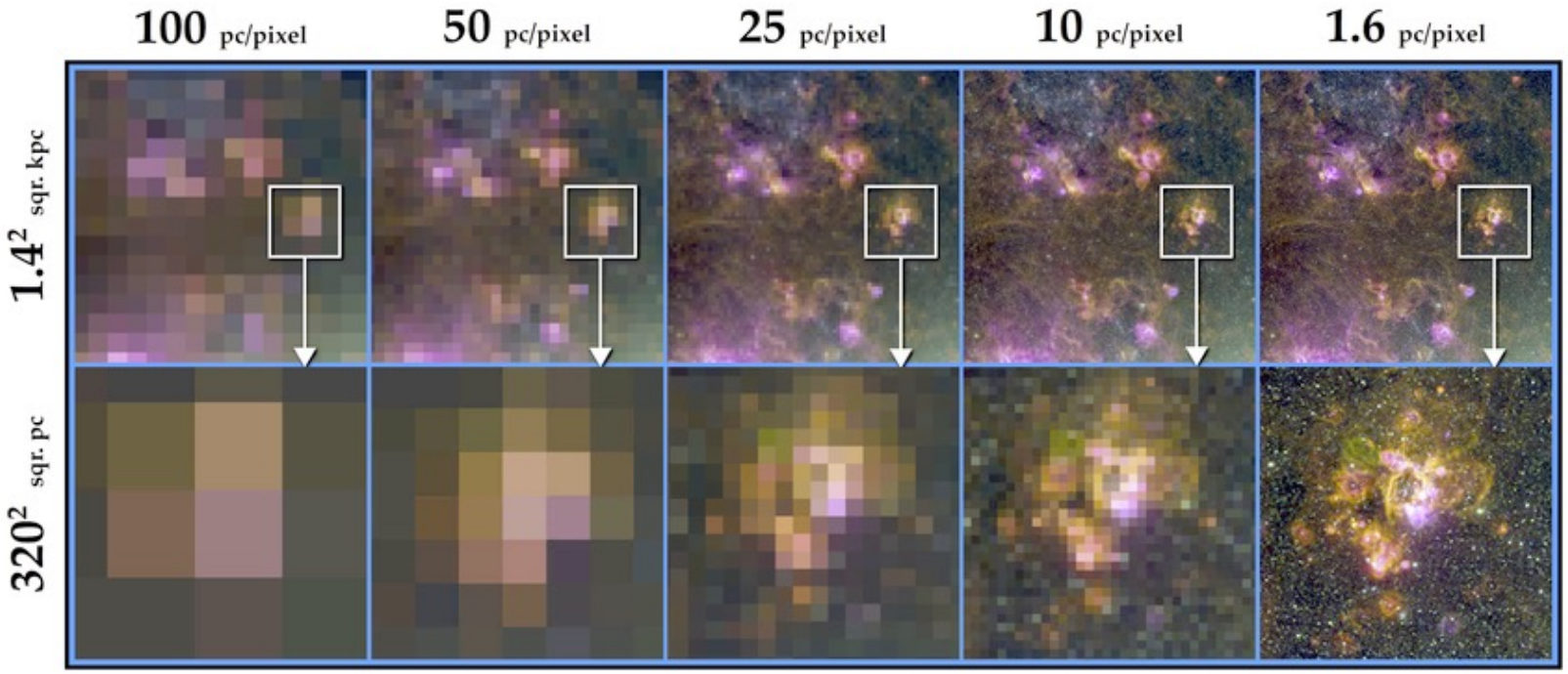
Drory, Blanc, Kreckel et al. AJ 168, 198D (2024)

Spatially Sampling the ISM

At <100 pc resolution we start separating individual SF regions

At <25 pc resolution we start resolving the the filamentary structure of the ISM

At <10 pc resolution we start resolving their inner structure

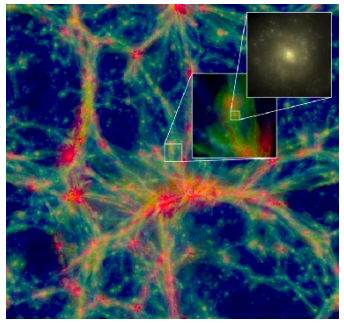


Typical resolution achieved by the best IFUs available today for nearby galaxies

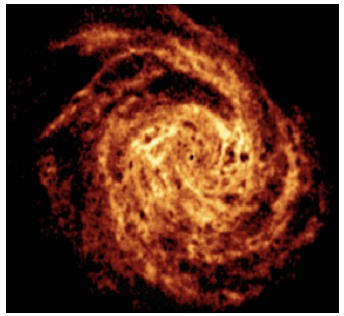
Typical resolution for individual sources

Typical resolution we expect to get in the MW and MCs

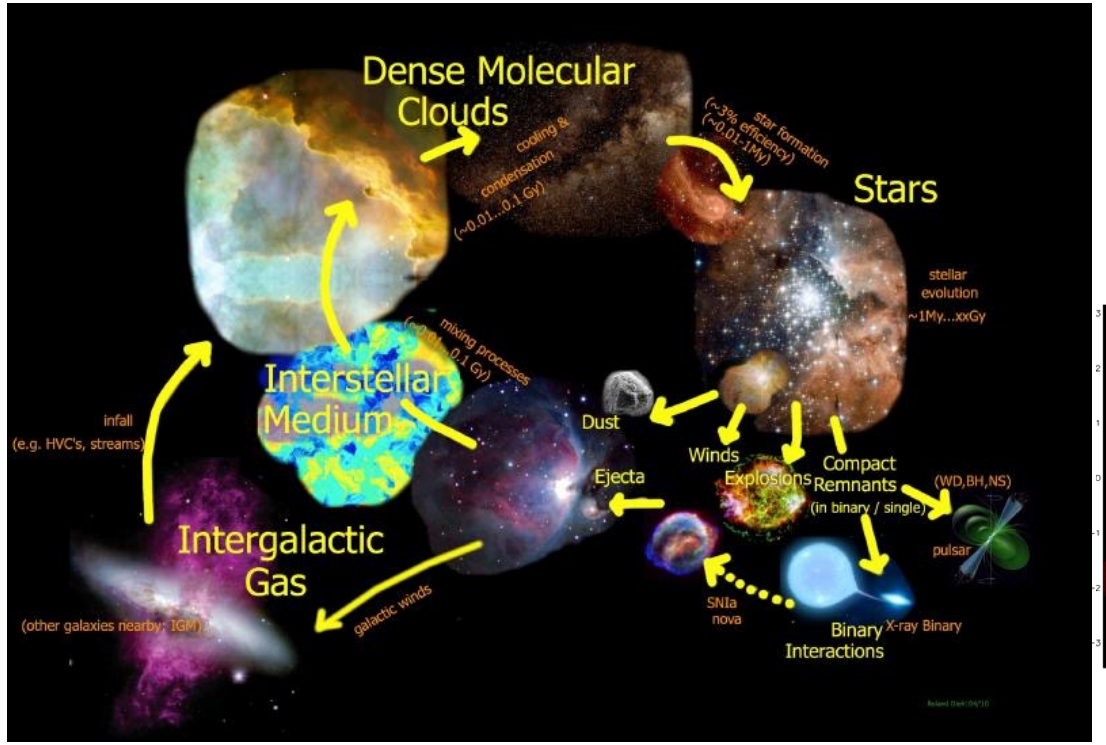
Star Formation

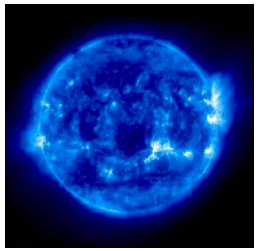


~ Mpc

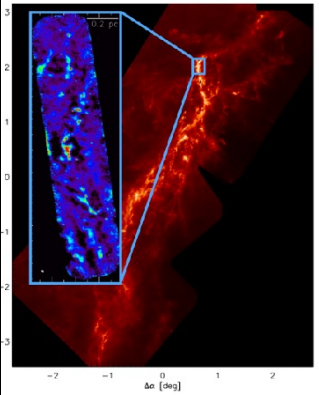


100 pc to kpc





~10^{-6} pc



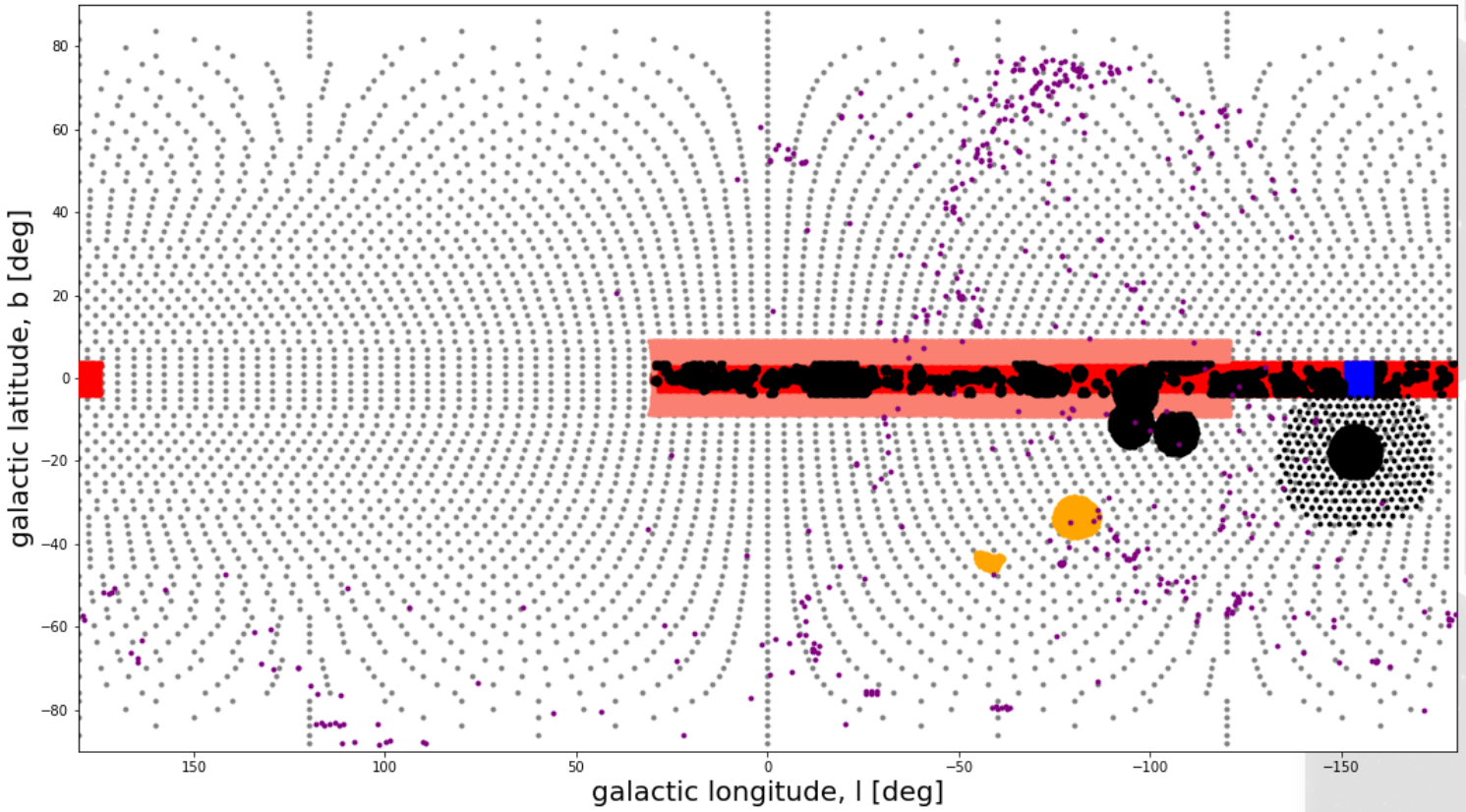
~ 0.1 pc

~ 10 pc

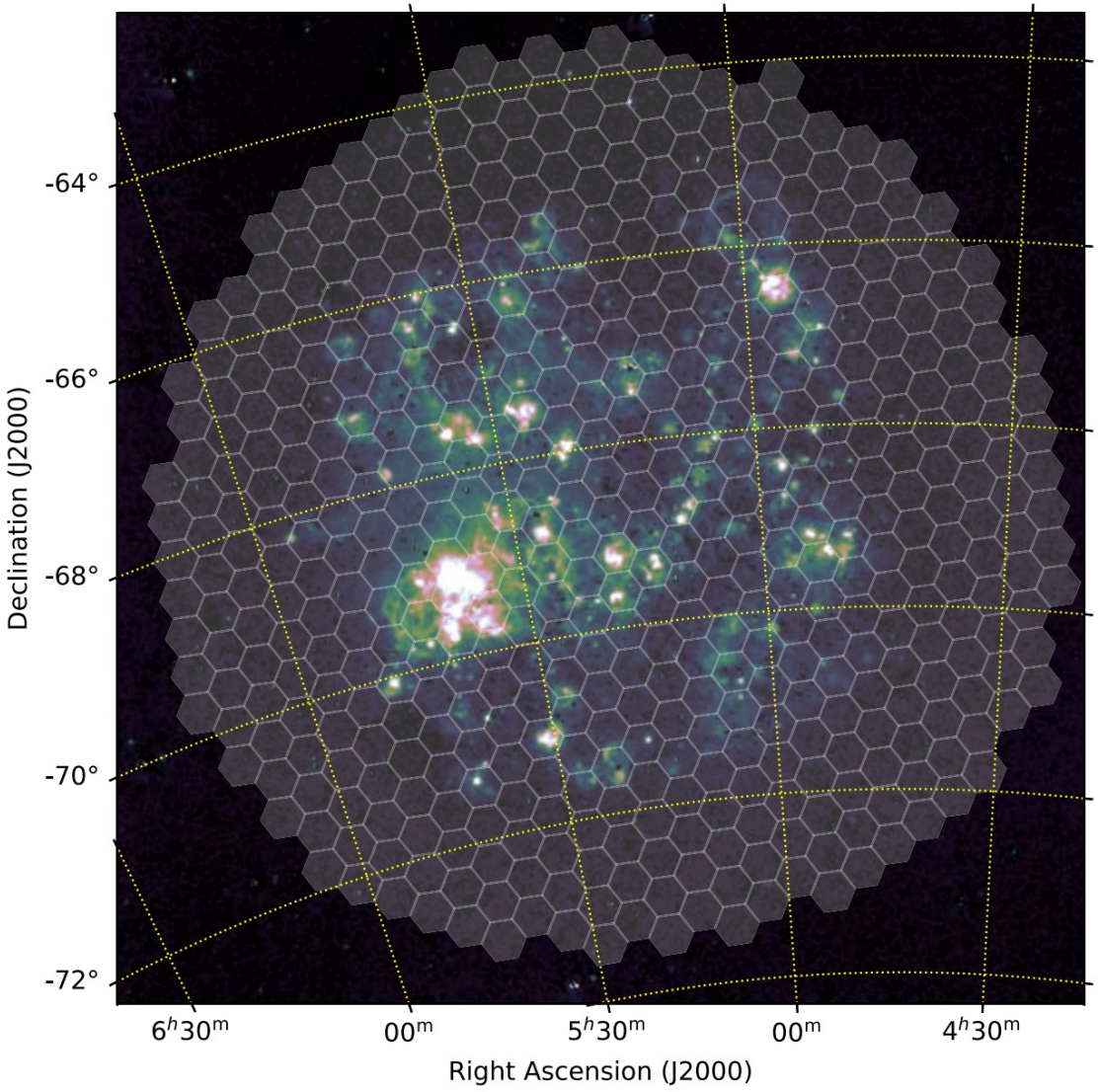
Star Formation is a multi-scale process ($\mathcal{O}$~10^{12}) that sets the thermodynamics, structure, and chemistry of the ISM, and regulates the growth of galaxies.

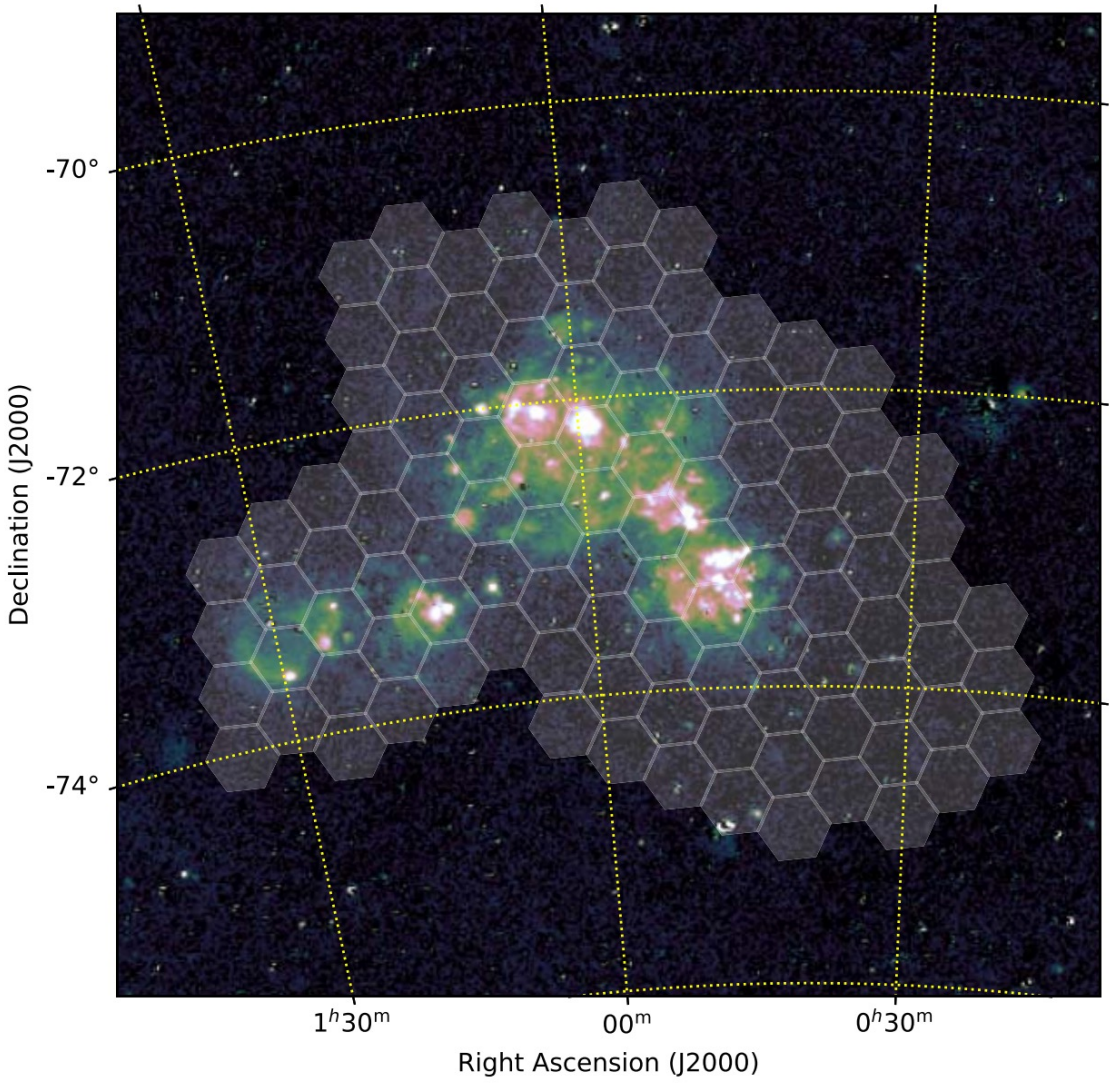
Survey Targets and Plan

- Core Survey
  - MW, LMC, SMC
- High Priority Regions (MW)
  - Orion, Gum, Vela
- Extended sample
  - Nearby Galaxies Survey
  - All Sky Grid

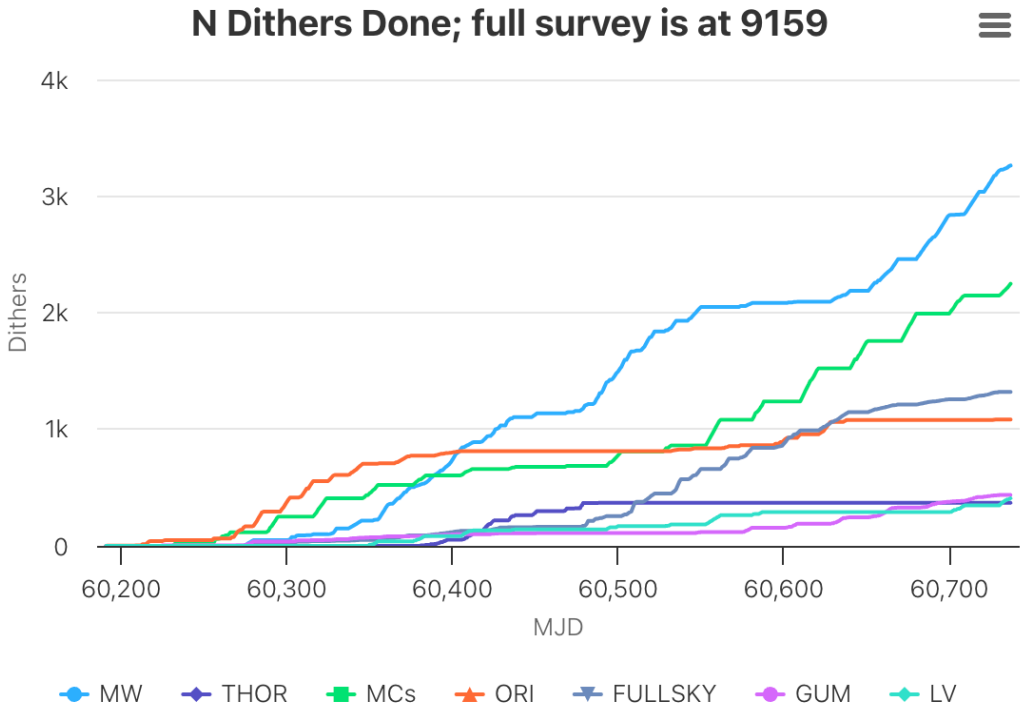


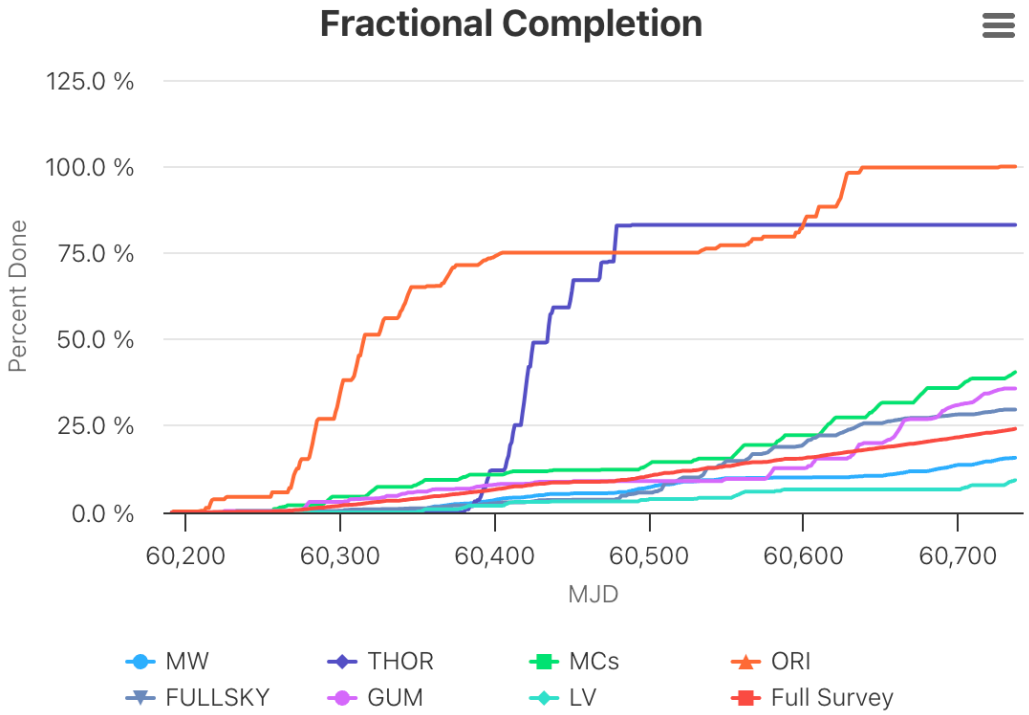
Magellanic Clouds





Current Survey Completion
(as of Mar 3, 2025)





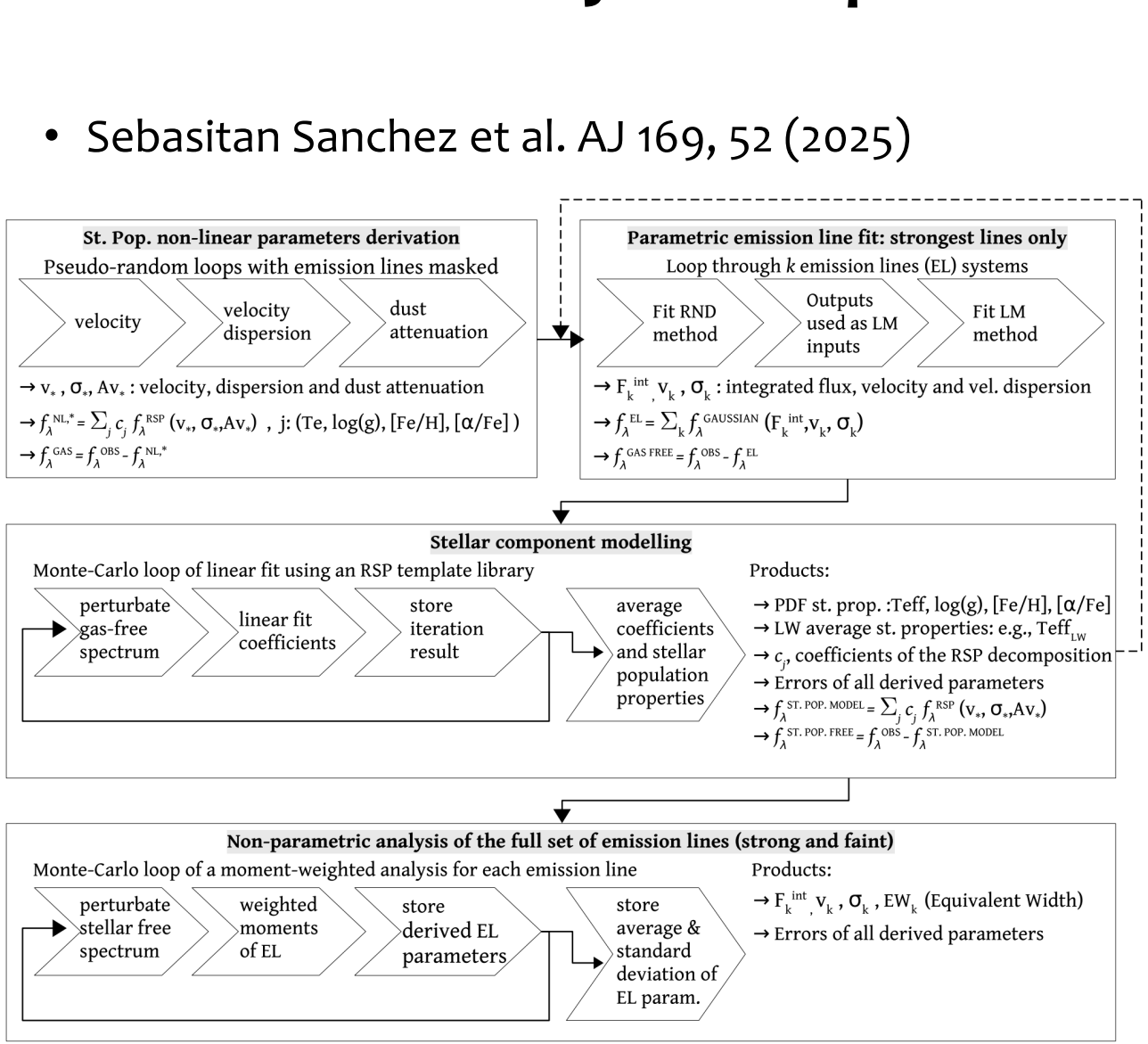
Data Reduction Pipeline

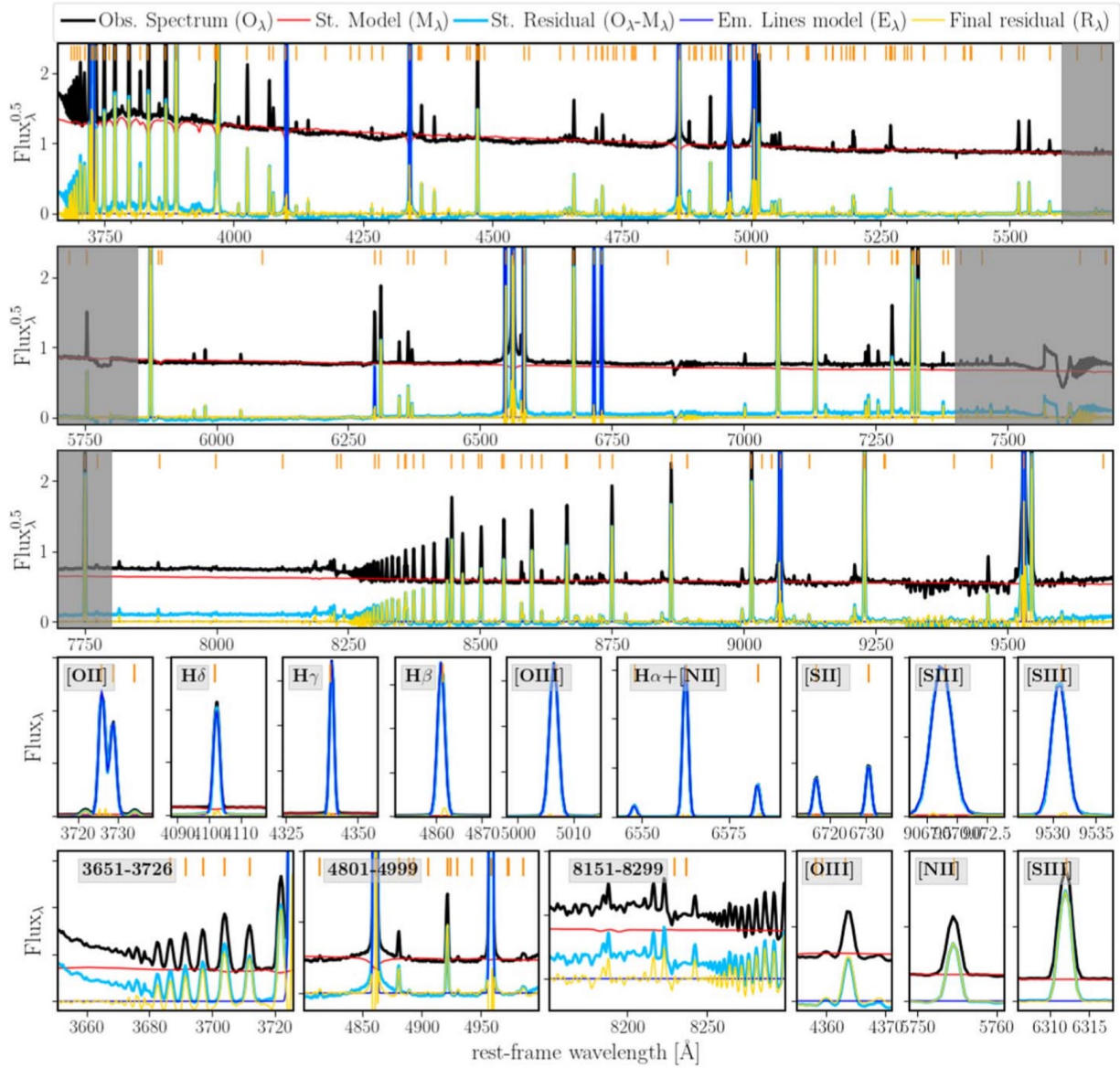
- SFrame is the final product
- RSS format, ~500Mb per exposure
- Still many issues
  - Variations on flat-field correction
  - Sky subtraction

```
f = ”/sas/sdsswork/lvm/spectro/redux/”+\
    “1.1.0/1028XX/1028028/60260/lvmSFrame-00007580.fits”

from astropy.io import fits
fits.info(f)

No.    Name      Ver    Type      Cards   Dimensions   Format
  0  PRIMARY       1 PrimaryHDU     436   ()
  1  FLUX          1 ImageHDU        22   (12401, 1944)   float32
  2  IVAR          1 ImageHDU        19   (12401, 1944)   float32
  3  MASK          1 ImageHDU        19   (12401, 1944)   uint8
  4  WAVE          1 ImageHDU        18   (12401,)   float64
  5  LSF           1 ImageHDU        19   (12401, 1944)   float32
  6  SKY           1 ImageHDU        19   (12401, 1944)   float32
  7  SKY_IVAR      1 ImageHDU        20   (12401, 1944)   float32
  8  SLITMAP       1 BinTableHDU     51   1944R x 21C   [K, K,
3A, K, 8A, 5A, K, 4A, D, D, D, 6A, 8A, K, 17A, K, K, K, K, D, D]
```

Data Analysis Pipeline

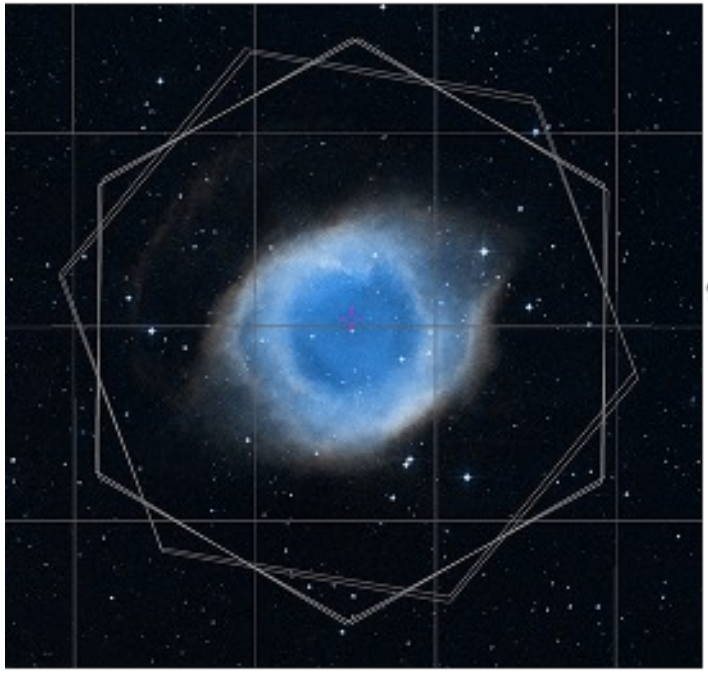
- Sebasitan Sanchez et al. AJ 169, 52 (2025)

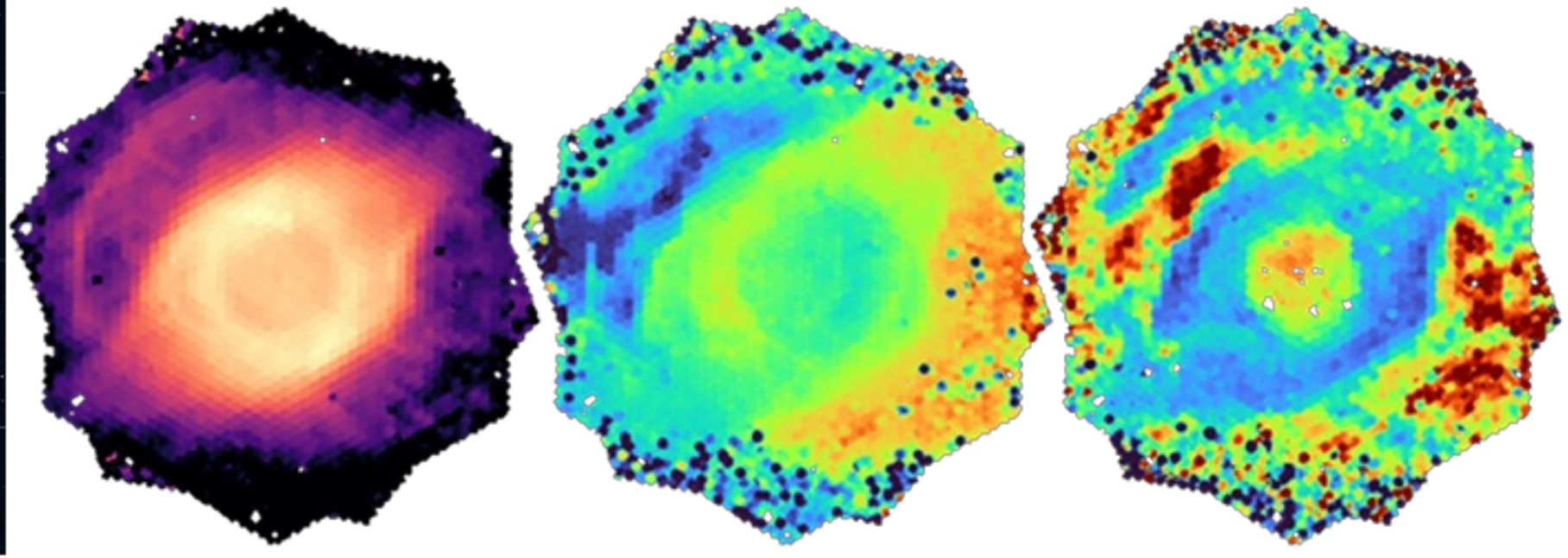




SDSS DR20 (2025)

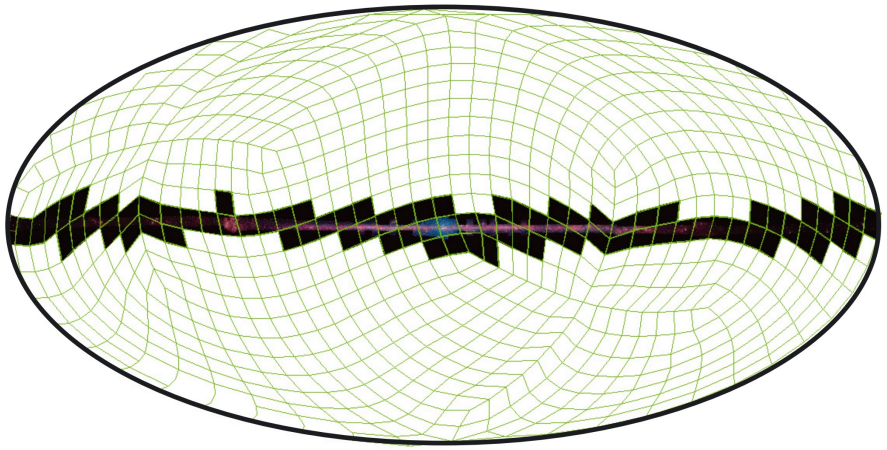
- DRP RSS for only one RSS of the Helix Nebula will be reseased

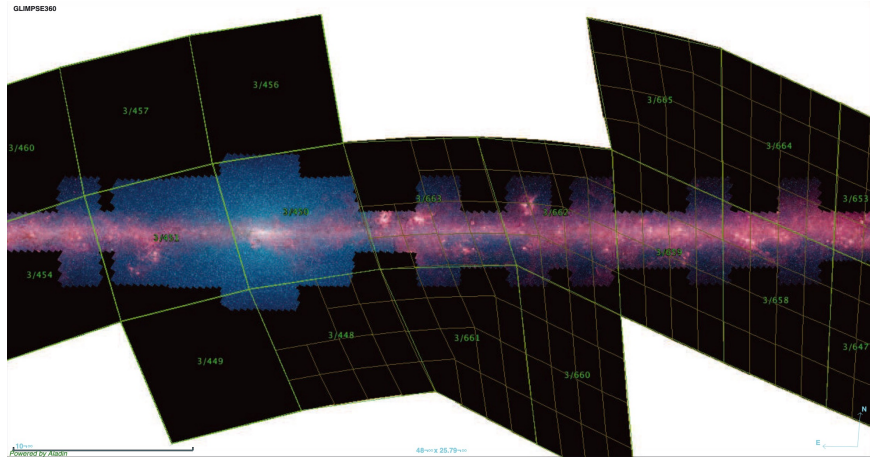




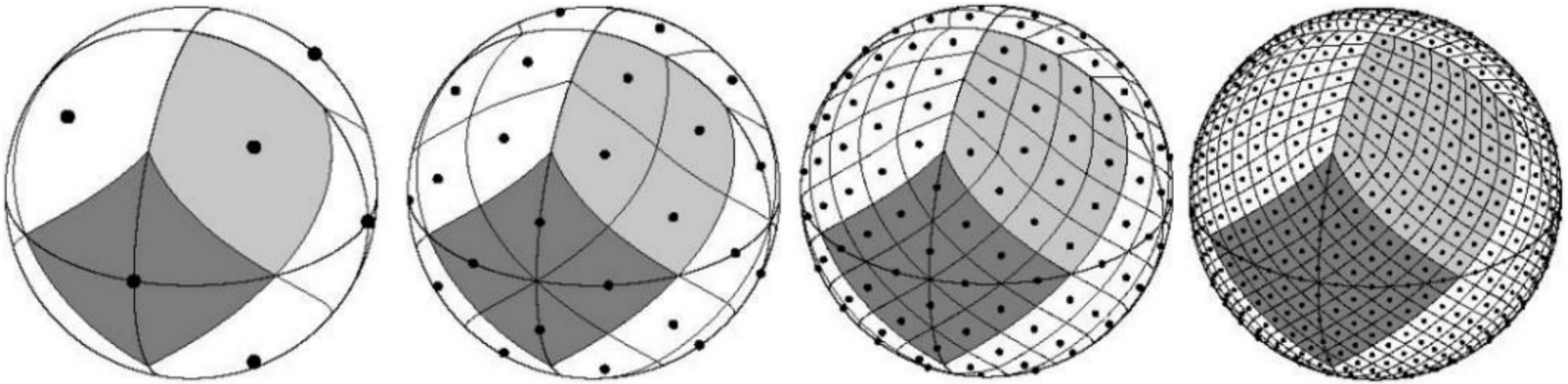
HiPS: Hierarchical **P**rogressive **S**urveys

- https://aladin.cds.unistra.fr/hips/
- IVOA Recommendation 1.0
  - https://www.ivoa.net/documents/HiPS/20170519/REC-HIPS-1.0-20170519.pdf
- Fernique et al. (2015) A&A 578, A114
- Approx. 1200 surveys are available in the HiPS list aggregator https://aladin.cds.unistra.fr/hips/list





HEALPix: Hierarchical **E**qual **A**rea iso**L**atitude **Pix**elization tessellation



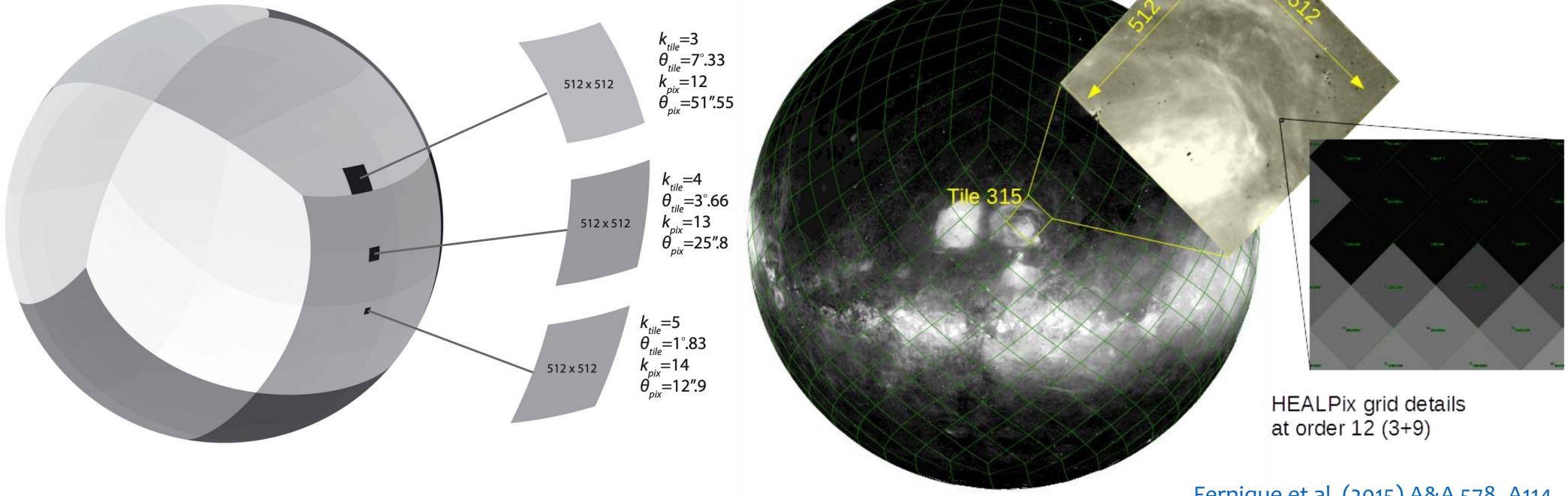
Order 0
12 cells

Order 1
48 cells

Order 2
192 cells

Order 3
768 cells

HEALPix: Hierarchical **E**qual **A**rea iso**L**atitude **Pix**elization tessellation

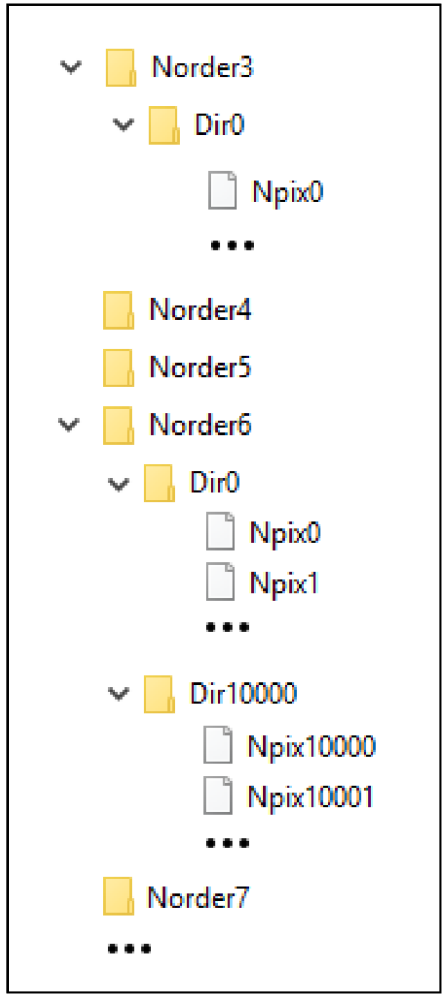


Fernique et al. (2015) A&A 578, A114

HiPS directory structure

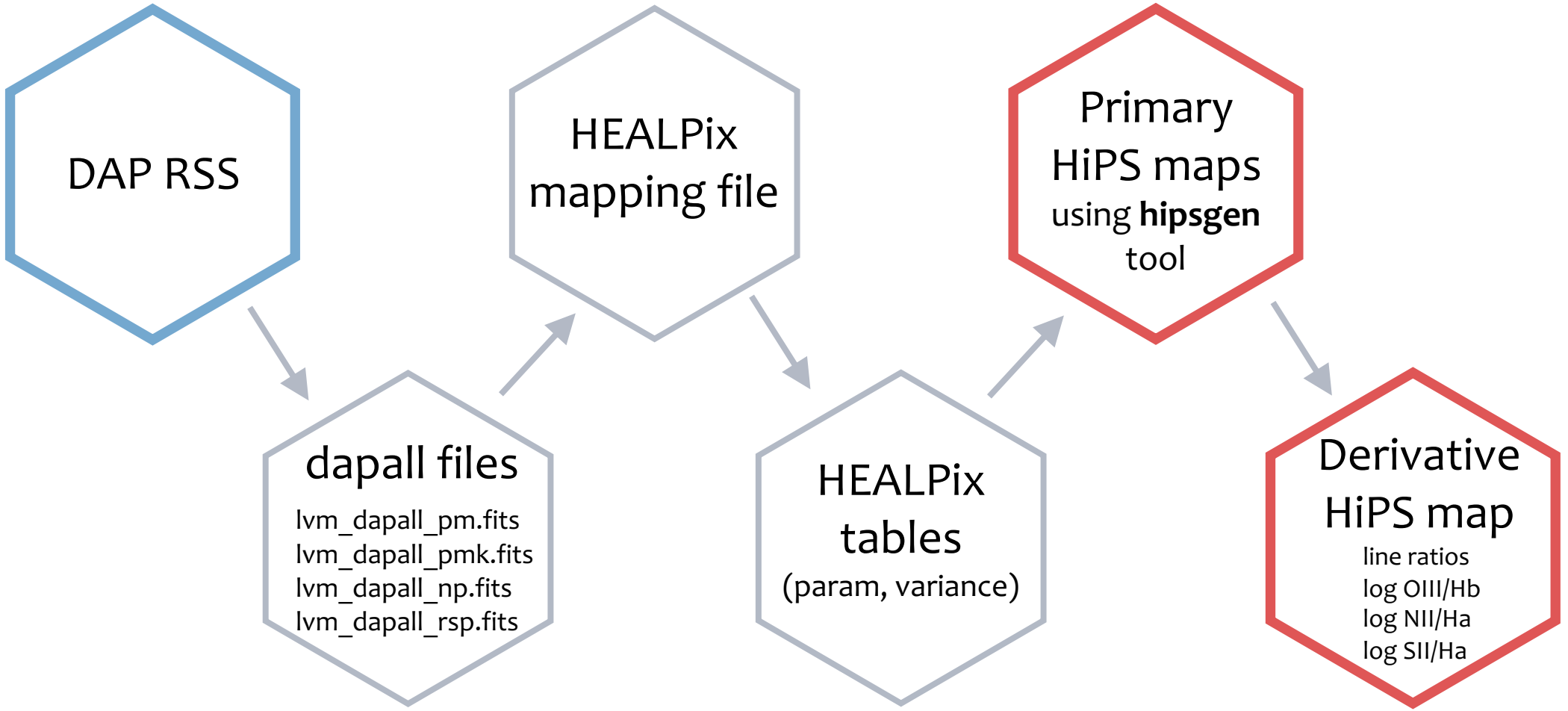
- Tile ***N*** in order ***K*** ⟶ Norder***K***/Dir***D***/Npix***N***{.ext}
  - ***N*** – HEALPix index
  - ***D***=(***N*** / 10000) x 10000 (integer division)
  - Extensions (ext): fits, jpeg, png

```
[u6058164@notchpeak20:lvm]$ ls -la 1.1.0/hips_flx_Halpha
-rw-rw----+  1 u6058164 sdss 25920 Nov 23 08:41 Moc.fits
drwxrwx---+  3 u6058164 sdss    25 Nov 23 08:41 Norder0
drwxrwx---+  3 u6058164 sdss    25 Nov 23 08:41 Norder1
drwxrwx---+  3 u6058164 sdss    25 Nov 23 08:41 Norder2
drwxrwx---+  3 u6058164 sdss    47 Nov 23 08:41 Norder3
drwxrwx---+  3 u6058164 sdss    25 Nov 23 08:41 Norder4
drwxrwx---+  4 u6058164 sdss    44 Nov 23 08:41 Norder5
drwxrwx---+  7 u6058164 sdss   101 Nov 23 08:41 Norder6
drwxrwx---+ 21 u6058164 sdss  4096 Nov 23 08:40 Norder7
-rw-rw----+  1 u6058164 sdss 70499 Nov 23 08:41 index.html
-rw-rw----+  1 u6058164 sdss   797 Nov 23 08:41 metadata.txt
-rw-rw----+  1 u6058164 sdss  3671 Nov 23 08:41 properties
```



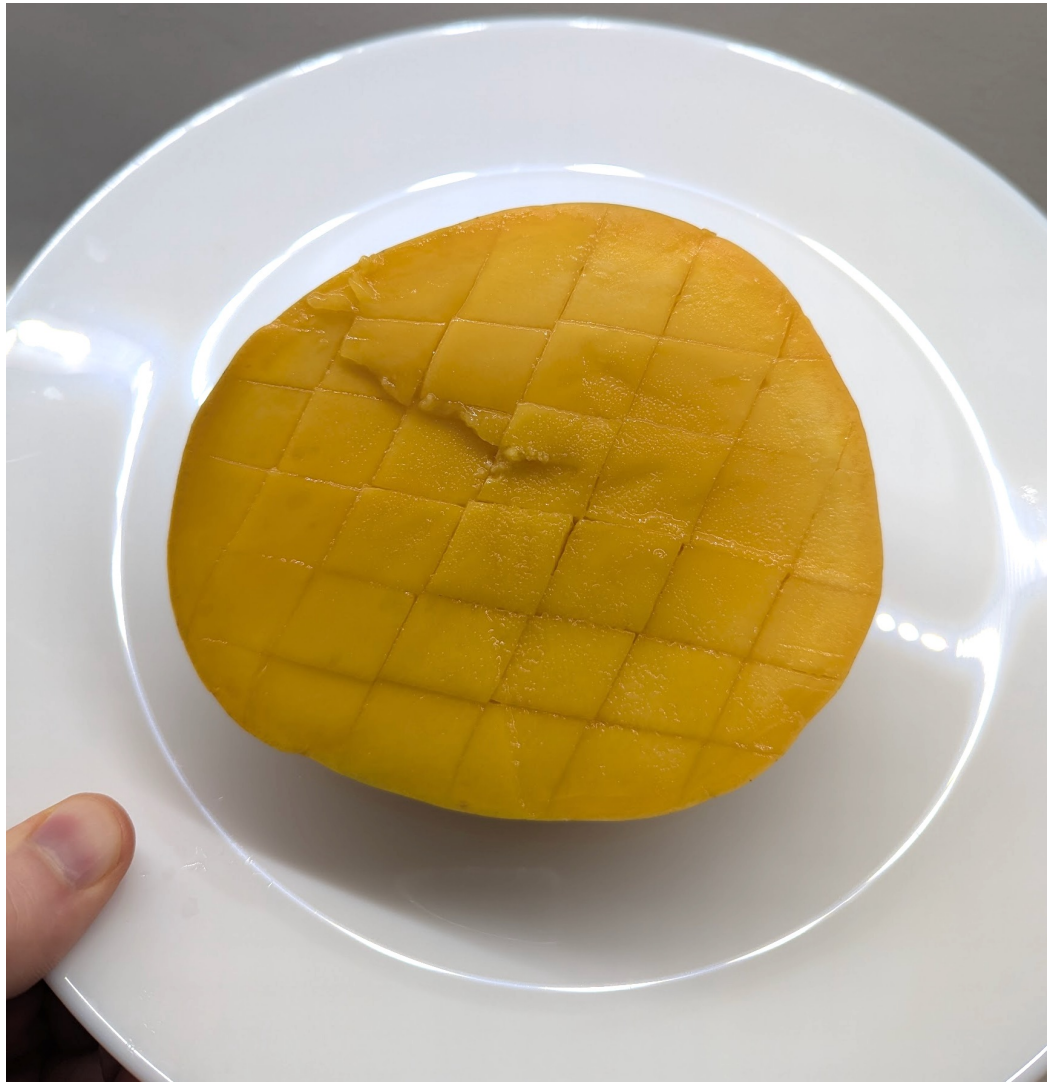
Fernique et al. (2015) A&A 578, A114

LVM HiPS maps

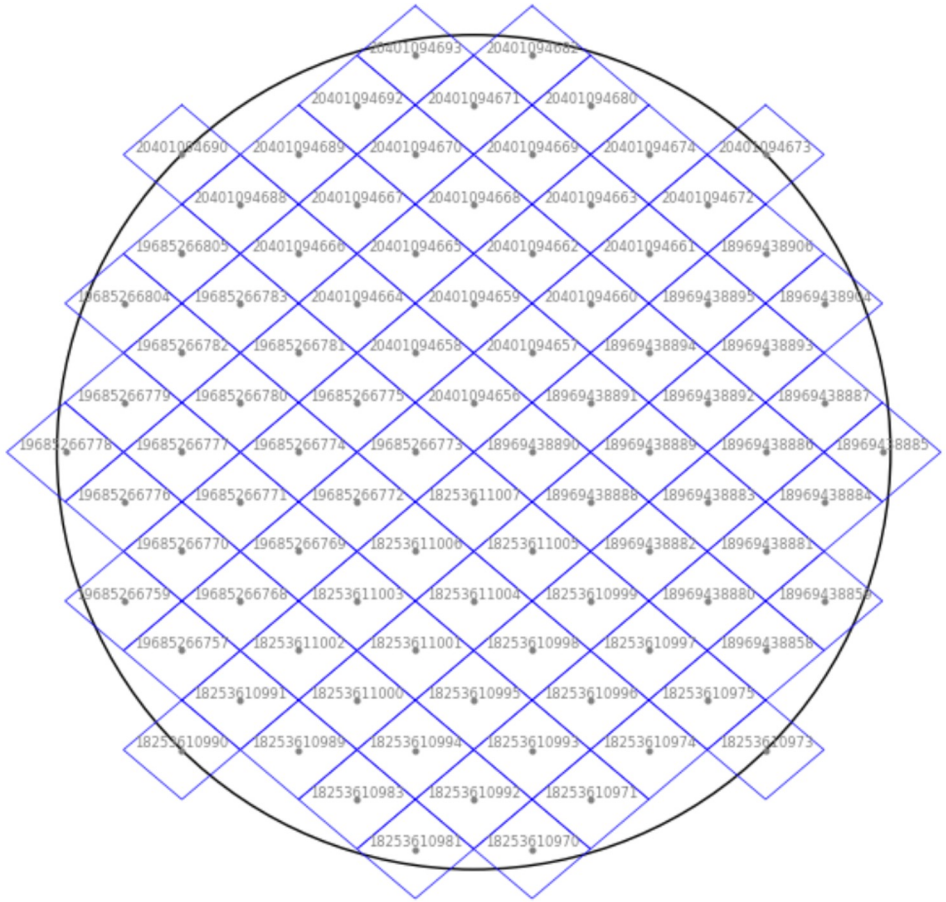


https://data.sdss5.org/sas/sdsswork/sandbox/data-viz/hips/sdsswork/lvm/1.1.1/

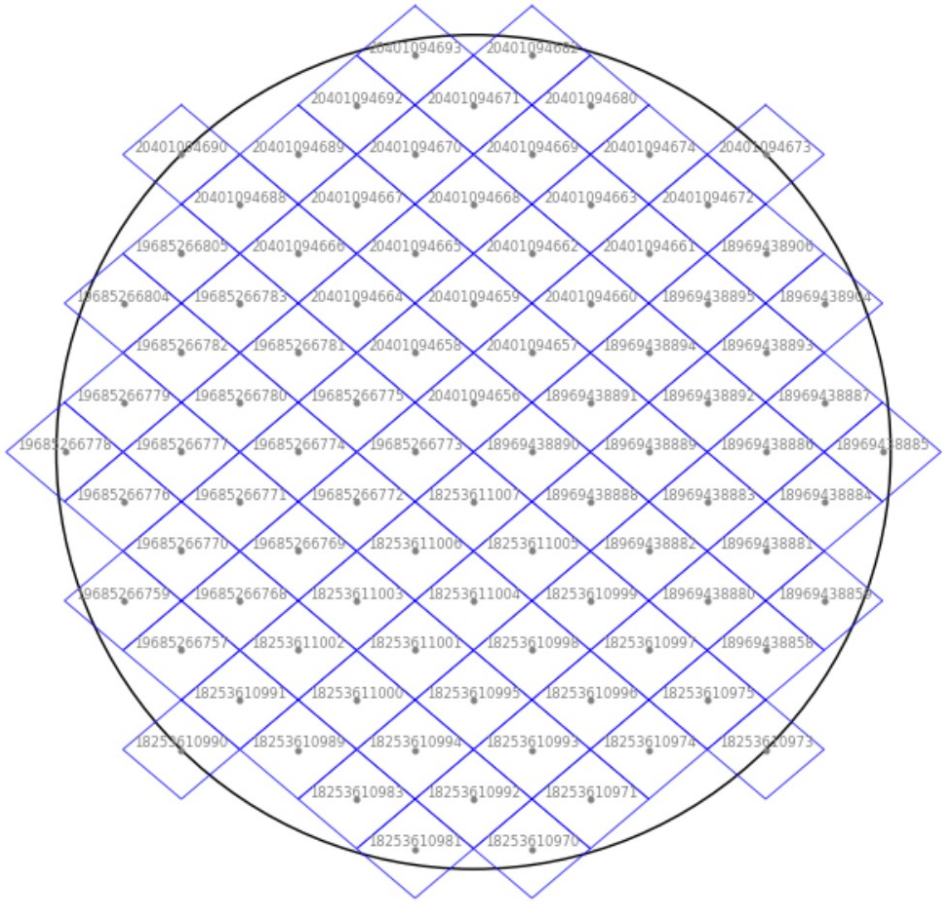
LVM HiPS maps



LVM HiPS maps



LVM HiPS maps

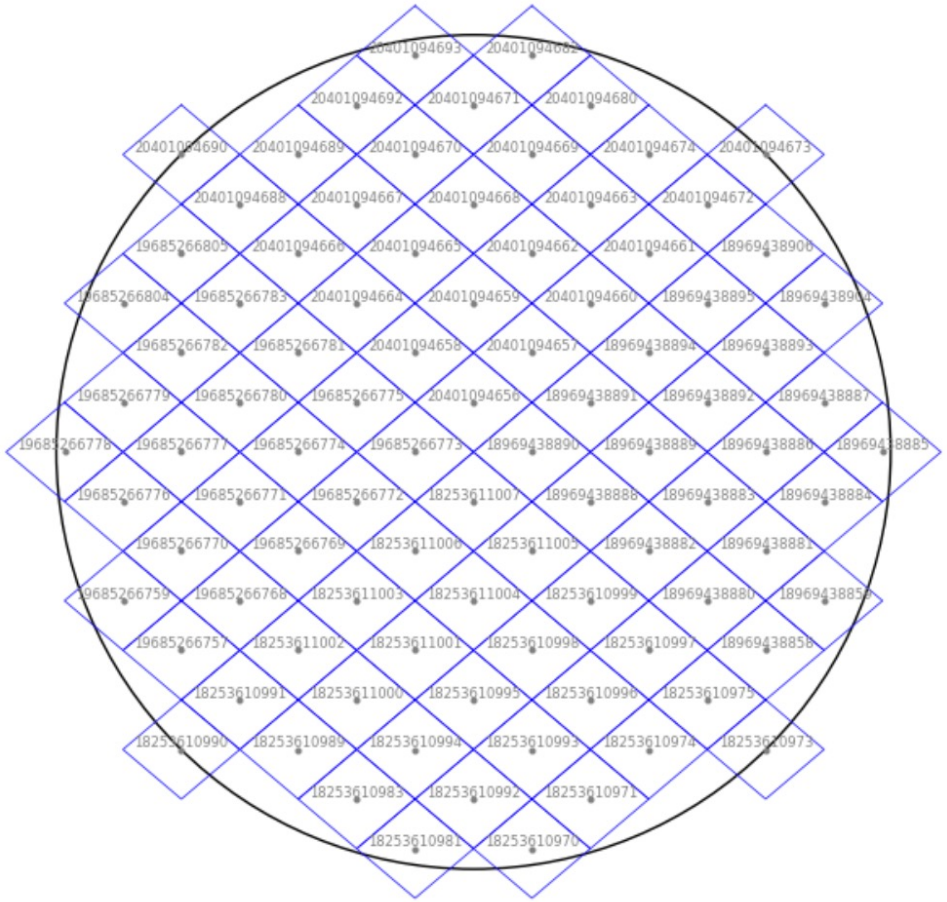


- 92 pixels per LVM fiber (R=35.3 arcsec)
- HEALPix size 3.22 arcsec

k	$N_{side} = 2^k$	N_{pix}	θ_{pix}	$k_{tile,512}$	$N_{tile,512}$	$\theta_{tile,512}$
6	64	49 152	55′.0			
7	128	196 608	27′.5			
8	256	786 432	13′.7			
9	512	3 145 728	6′.87	0	12	58′.6
10	1024	12 582 912	3′.44	1	48	29′.3
11	2048	50 331 648	1′.72	2	192	14′.7
12	4096	201 326 592	51″.5	3	768	7′.33
13	8192	805 306 368	25″.8	4	3072	3′.66
14	2^{14}	3.22×10^9	12″.9	5	12 288	1′.83
15	2^{15}	1.29×10^{10}	6″.44	6	49 152	55′.0
16	2^{16}	5.15×10^{10}	3″.22	7	196 608	27′.5
17	2^{17}	2.06×10^{11}	1″.61	8	786 432	13′.7
18	2^{18}	8.25×10^{11}	0″.81	9	3 145 728	6′.87

Fernique et al. (2015) A&A 578, A114

LVM HiPS maps

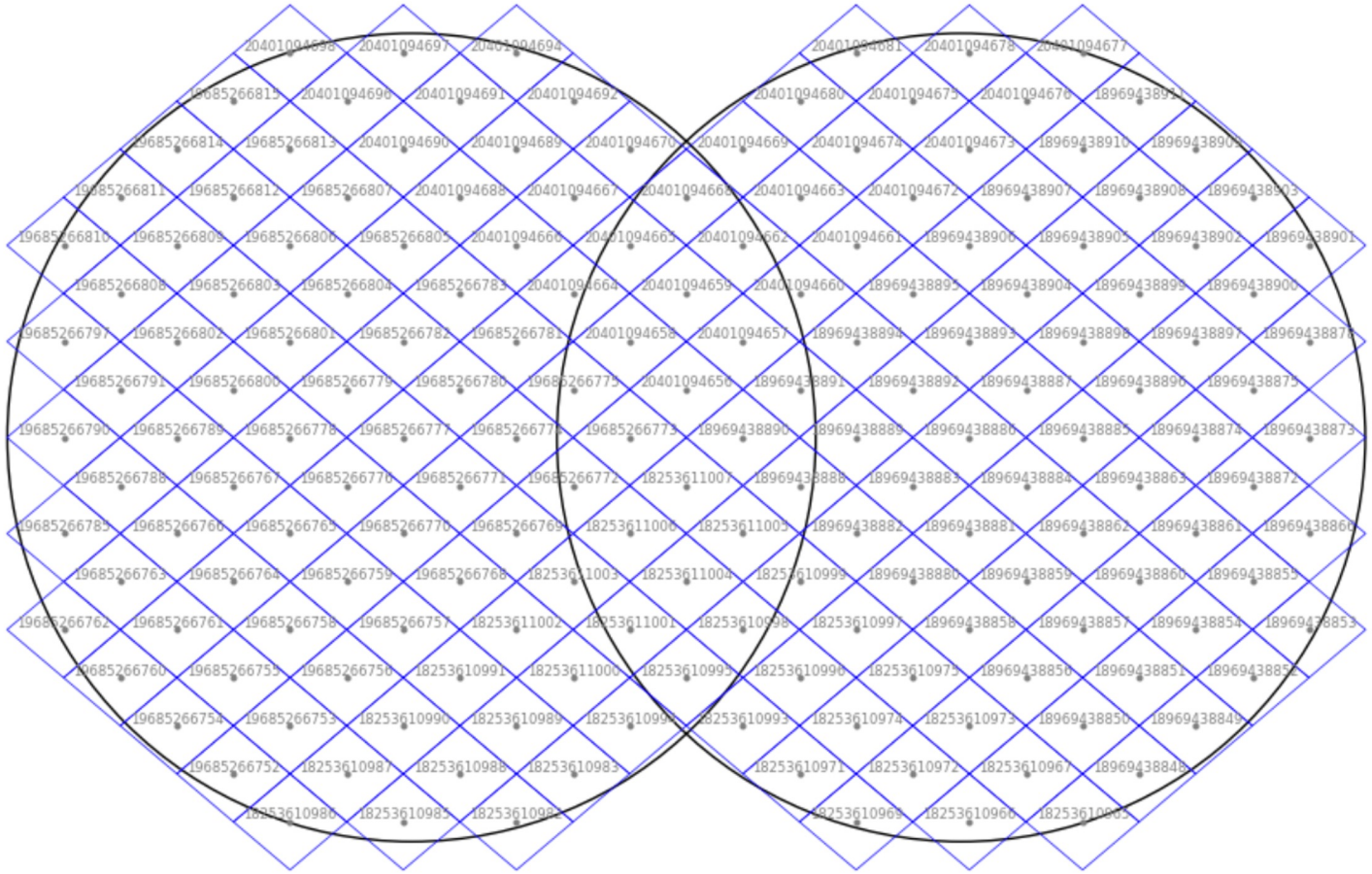


- 92 pixels per LVM fiber (R=35.3 arcsec)
- HEALPix size 3.22 arcsec

HEALPix ipix	Value
19685266779	0.26
19685266780	0.89
19685266781	0.05
19685266782	0.70
19685266783	0.31
19685266804	0.65
19685266805	0.85
20401094656	0.55
20401094657	0.17
20401094658	0.43
20401094659	0.30
20401094660	0.31
20401094661	0.58
20401094662	0.26
20401094663	0.68

LVM HiPS maps

- 92 pixels per LVM fiber (R=35.3 arcsec)
- HEALPix size 3.22 arcsec



HEALPix ipix	Value
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19685266780	0.89
19685266781	0.05
19685266782	0.70
19685266783	0.31
19685266804	0.65
19685266805	0.85
20401094656	**0.55**
20401094656	**0.45**
20401094657	0.17
20401094658	**0.43**
20401094658	**0.39**
20401094659	0.30
20401094660	**0.31**
20401094660	**0.30**
20401094661	0.58
20401094662	0.26
20401094663	0.68

LVM HiPS maps

- Group by with an aggregation function
- Pandas

```
df.groupby("ipix").median()
```

- Postgres DB

```
SELECT pixel,
       PERCENTILE_CONT(0.5) WITHIN GROUP (ORDER BY value_column)
       OVER (PARTITION BY pixel) AS median_value
FROM table;
```

- 92 pixels per LVM fiber (R=35.3 arcsec)
- HEALPix size 3.22 arcsec

HEALPix ipix	Value
19685266779	0.26
19685266780	0.89
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20401094658	**0.39**
20401094659	0.30
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```
SELECT pixel,
       PERCENTILE_CONT(0.5) WITHIN GROUP (ORDER BY value_column)
       OVER (PARTITION BY pixel) AS median_value
FROM table;
```

- **Most efficient way using Numpy**
  - Calculate once for DAP release

```
unique_keys, inverse_indices = np.unique(healpix, return_inverse=True)
```

  - Weighted average

```
sum_wgt = np.bincount(inverse_indices, weights=inv_var)
avg = np.bincount(inverse_indices, weights=value * inv_var) / sum_wgt
```

- 92 pixels per LVM fiber (R=35.3 arcsec)
- HEALPix size 3.22 arcsec

HEALPix ipix	Value
19685266779	0.26
19685266780	0.89
19685266781	0.05
19685266782	0.70
19685266783	0.31
19685266804	0.65
19685266805	0.85
20401094656	**0.55**
20401094656	**0.45**
20401094657	0.17
20401094658	**0.43**

$$avg = \frac{\sum_i w_i \cdot V_i}{\sum_i w_i}$$

$$w_i = 1/\delta V_i^2$$

LVM HiPS maps

```
TTYPE1  = 'pixel   '
TFORM1  = 'K       '
TTYPE2  = 'value   '
TFORM2  = 'D       '
EXTNAME = 'HEALPIX_MAP'        / name of this binary table extension
PIXTYPE = 'HEALPIX '           / HEALPIX pixelisation
ORDERING= 'NESTED  '
COORDSYS= 'C       '
NSIDE   =                65536 / Resolution parameter of HEALPIX
INDXSCHM= 'EXPLICIT'
OBJECT  = 'PARTIAL '
```

- 92 pixels per LVM fiber (R=35.3 arcsec)
- HEALPix size 3.22 arcsec

HEALPix ipix	Value
19685266779	0.26
19685266780	0.89
19685266781	0.05
19685266782	0.70
19685266783	0.31
19685266804	0.65
19685266805	0.85
20401094656	**0.55**
20401094656	**0.45**
20401094657	0.17
20401094658	**0.43**

- **Most efficient way using Numpy**
  - Calculate once for DAP release

```
unique_keys, inverse_indices = np.unique(healpix, return_inverse=True)
```

  - Weighted average

```
sum_wgt = np.bincount(inverse_indices, weights=inv_var)
avg = np.bincount(inverse_indices, weights=value * inv_var) / sum_wgt
```

$$avg = \frac{\sum_i w_i \cdot V_i}{\sum_i w_i}$$

$$w_i = 1/\delta V_i^2$$

LVM HiPS maps

- Generate HiPS using ***hipsgen*** tool
  - Software package developed by CDS
  - https://aladin.cds.unistra.fr/java/Hipsgen.jar

```
java –Xmx10g -jar /path/AladinBeta.jar –hipsgen \
    in=healpix_table.fits \
    out=hips_survey \
    id=SDSS/P/LVM_DAP_PARAM \
    -clean maxthread=10 MAPTILES
```

- One HiPS folder ~20Gb for DAP 1.1.1

Index of /sas/sdsswork/sandbox/data-viz/hips/sdsswork/lvm/1.1.1/

File Name ↓	File Size ↓	Date ↓
Parent directory/	-	-
hips_np_disp_Halpha/	-	2025-Jan-18 09:59
hips_np_disp_OIII5007/	-	2025-Jan-18 09:57
hips_np_flux_Halpha/	-	2025-Jan-18 09:55
hips_np_flux_Hbeta/	-	2025-Jan-18 09:38
hips_np_flux_NII6583/	-	2025-Jan-18 09:56
hips_np_flux_OI6300/	-	2025-Jan-18 09:39
hips_np_flux_OII3726/	-	2025-Jan-18 09:40
hips_np_flux_OII3726and29/	-	2025-Jan-18 14:46
hips_np_flux_OII3729/	-	2025-Jan-18 09:40
hips_np_flux_OIII5007/	-	2025-Jan-18 09:39
hips_np_flux_SII6717/	-	2025-Jan-18 09:58
hips_np_flux_SII6717and31/	-	2025-Jan-18 15:10
hips_np_flux_SII6731/	-	2025-Jan-18 09:59
hips_np_flux_SIII9069/	-	2025-Jan-18 09:57
hips_np_flux_SIII9531/	-	2025-Jan-18 09:56
hips_np_log_ratio_NII6583_Halpha/	-	2025-Jan-18 16:43
hips_np_log_ratio_OIII5007_Hbeta/	-	2025-Jan-18 16:22
hips_np_log_ratio_SII6717and31_Halpha/	-	2025-Jan-18 16:45
hips_np_ratio_Halpha_Hbeta/	-	2025-Jan-18 16:15
hips_np_ratio_OII3726_OII3729/	-	2025-Jan-18 15:04
hips_np_ratio_SII6717_SII6731/	-	2025-Jan-18 15:41
hips_np_vel_Halpha/	-	2025-Jan-18 09:57
hips_np_vel_OIII5007/	-	2025-Jan-18 09:59
hips_pm_disp_Halpha/	-	2025-Jan-18 09:37
hips_pm_disp_OIII5007/	-	2025-Jan-18 09:36
hips_pm_flux_Halpha/	-	2025-Jan-18 09:20
hips_pm_flux_Hbeta/	-	2025-Jan-18 09:21
hips_pm_flux_NII6583/	-	2025-Jan-18 09:16
hips_pm_flux_OI6300/	-	2025-Jan-18 09:20
hips_pm_flux_OII3726/	-	2025-Jan-18 09:18
hips_pm_flux_OII3726and29/	-	2025-Jan-18 14:30
hips_pm_flux_OII3729/	-	2025-Jan-18 09:20
hips_pm_flux_OIII5007/	-	2025-Jan-18 09:18
hips_pm_flux_SII6717/	-	2025-Jan-18 09:17
hips_pm_flux_SII6717and31/	-	2025-Jan-18 15:05
hips_pm_flux_SII6731/	-	2025-Jan-18 09:21
hips_pm_flux_SIII9069/	-	2025-Jan-18 09:17
hips_pm_flux_SIII9531/	-	2025-Jan-18 09:35
hips_pm_log_ratio_NII6583_Halpha/	-	2025-Jan-18 16:20
hips_pm_log_ratio_OIII5007_Hbeta/	-	2025-Jan-18 16:19

https://data.sdss5.org/sas/sdsswork/sandbox/data-viz/hips/sdsswork/lvm/1.1.1/

LVM HiPS maps

- Generate HiPS using ***hipsgen*** tool
  - Software package developed by CDS
  - https://aladin.cds.unistra.fr/java/Hipsgen.jar

```
java -Xmx10g -jar /path/AladinBeta.jar -hipsgen \
    in=healpix_table.fits \
    out=hips_survey \
    id=SDSS/P/LVM_DAP_PARAM \
    -clean maxthread=10 MAPTILES
```

- One HiPS folder ~20Gb for DAP 1.1.1

- **Pros:** Correct error propagation
- **Cons:** Sensitive for outliers

Index of /sas/sdsswork/sandbox/data-viz/hips/sdsswork/lvm/1.1.1/

File Name ↓	File Size ↓	Date ↓
Parent directory/	-	-
hips_np_disp_Halpha/	-	2025-Jan-18 09:59
hips_np_disp_OIII5007/	-	2025-Jan-18 09:57
hips_np_flux_Halpha/	-	2025-Jan-18 09:55
hips_np_flux_Hbeta/	-	2025-Jan-18 09:38
hips_np_flux_NII6583/	-	2025-Jan-18 09:56
hips_np_flux_OI6300/	-	2025-Jan-18 09:39
hips_np_flux_OII3726/	-	2025-Jan-18 09:40
hips_np_flux_OII3726and29/	-	2025-Jan-18 14:46
hips_np_flux_OII3729/	-	2025-Jan-18 09:40
hips_np_flux_OIII5007/	-	2025-Jan-18 09:39
hips_np_flux_SII6717/	-	2025-Jan-18 09:58
hips_np_flux_SII6717and31/	-	2025-Jan-18 15:10
hips_np_flux_SII6731/	-	2025-Jan-18 09:59
hips_np_flux_SIII9069/	-	2025-Jan-18 09:57
hips_np_flux_SIII9531/	-	2025-Jan-18 09:56
hips_np_log_ratio_NII6583_Halpha/	-	2025-Jan-18 16:43
hips_np_log_ratio_OIII5007_Hbeta/	-	2025-Jan-18 16:22
hips_np_log_ratio_SII6717and31_Halpha/	-	2025-Jan-18 16:45
hips_np_ratio_Halpha_Hbeta/	-	2025-Jan-18 16:15
hips_np_ratio_OII3726_OII3729/	-	2025-Jan-18 15:04
hips_np_ratio_SII6717_SII6731/	-	2025-Jan-18 15:41
hips_np_vel_Halpha/	-	2025-Jan-18 09:57
hips_np_vel_OIII5007/	-	2025-Jan-18 09:59
hips_pm_disp_Halpha/	-	2025-Jan-18 09:37
hips_pm_disp_OIII5007/	-	2025-Jan-18 09:36
hips_pm_flux_Halpha/	-	2025-Jan-18 09:20
hips_pm_flux_Hbeta/	-	2025-Jan-18 09:21
hips_pm_flux_NII6583/	-	2025-Jan-18 09:16
hips_pm_flux_OI6300/	-	2025-Jan-18 09:20
hips_pm_flux_OII3726/	-	2025-Jan-18 09:18
hips_pm_flux_OII3726and29/	-	2025-Jan-18 14:30
hips_pm_flux_OII3729/	-	2025-Jan-18 09:20
hips_pm_flux_OIII5007/	-	2025-Jan-18 09:18
hips_pm_flux_SII6717/	-	2025-Jan-18 09:17
hips_pm_flux_SII6717and31/	-	2025-Jan-18 15:05
hips_pm_flux_SII6731/	-	2025-Jan-18 09:21
hips_pm_flux_SIII9069/	-	2025-Jan-18 09:17
hips_pm_flux_SIII9531/	-	2025-Jan-18 09:35
hips_pm_log_ratio_NII6583_Halpha/	-	2025-Jan-18 16:20
hips_pm_log_ratio_OIII5007_Hbeta/	-	2025-Jan-18 16:19

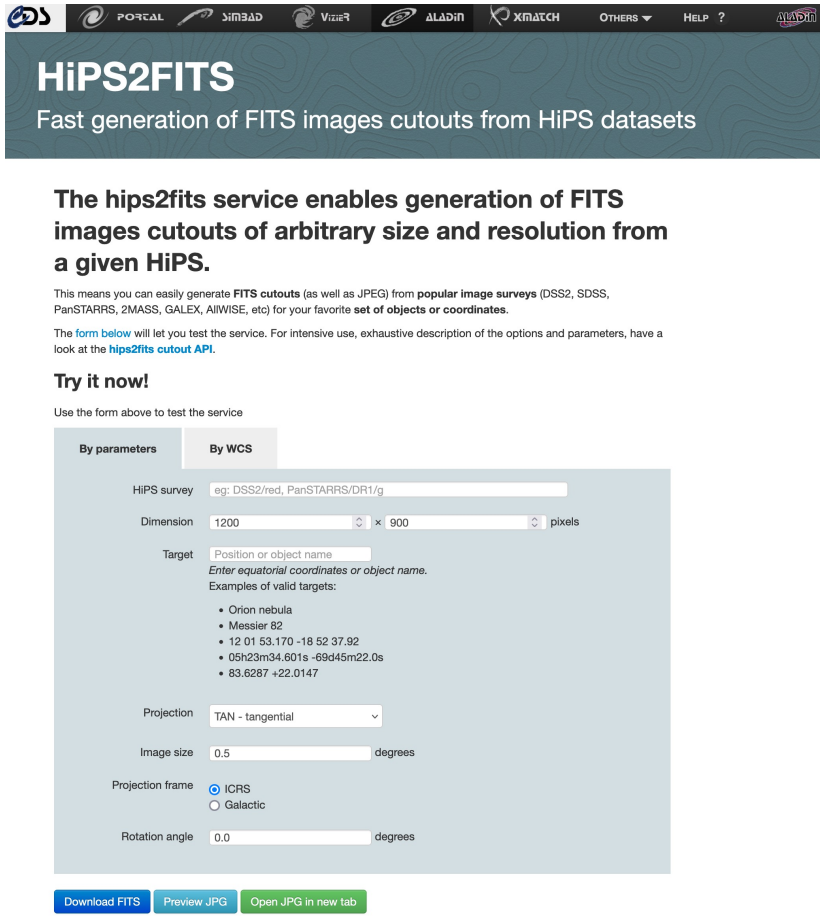
https://data.sdss5.org/sas/sdsswork/sandbox/data-viz/hips/sdsswork/lvm/1.1.1/

HiPS2FITS Image Cutout service

- Can be used for any HiPS from the list https://aladin.cds.unistra.fr/hips/list which includes approx. 1200 surveys

https://alasky.cds.unistra.fr/hips-image-services/hips2fits?hips=CDS/P/DECaLS/DR5/g&width=1200&height=900&fov=0.1&projection=TAN&object=UGC10041&format=png

https://alasky.cds.unistra.fr/hips-image-services/hips2fits

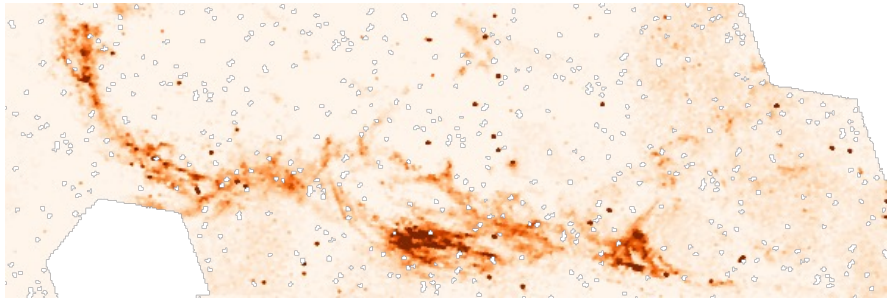


LVM Image Cutout service

- Based on ***hips2fits*** script by CDS https://github.com/cds-astro/hips2fits-cutout
- Bi-linear interpolation from the nearest HEALPix tile matching the output resolution of output image
- Documentation of Image Cutout endpoint
  - https://data.sdss5.org/valis-lvmvis-api/docs#/lvm/get_image_lvm_cutout_image__version___hips__get

- Halpha flux

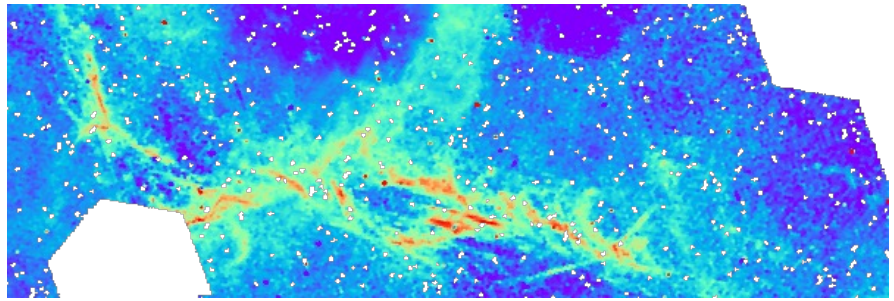
https://data.sdss5.org/valis-lvmvis-api/lvm/cutout/image/1.1.0/hips_disp_Halpha?ra=133.4&dec=-44.2&fov=2.5&width=200&height=600&stretch=linear&cmap=Oranges&min=0.7&max=1.1



Vela SN remnant

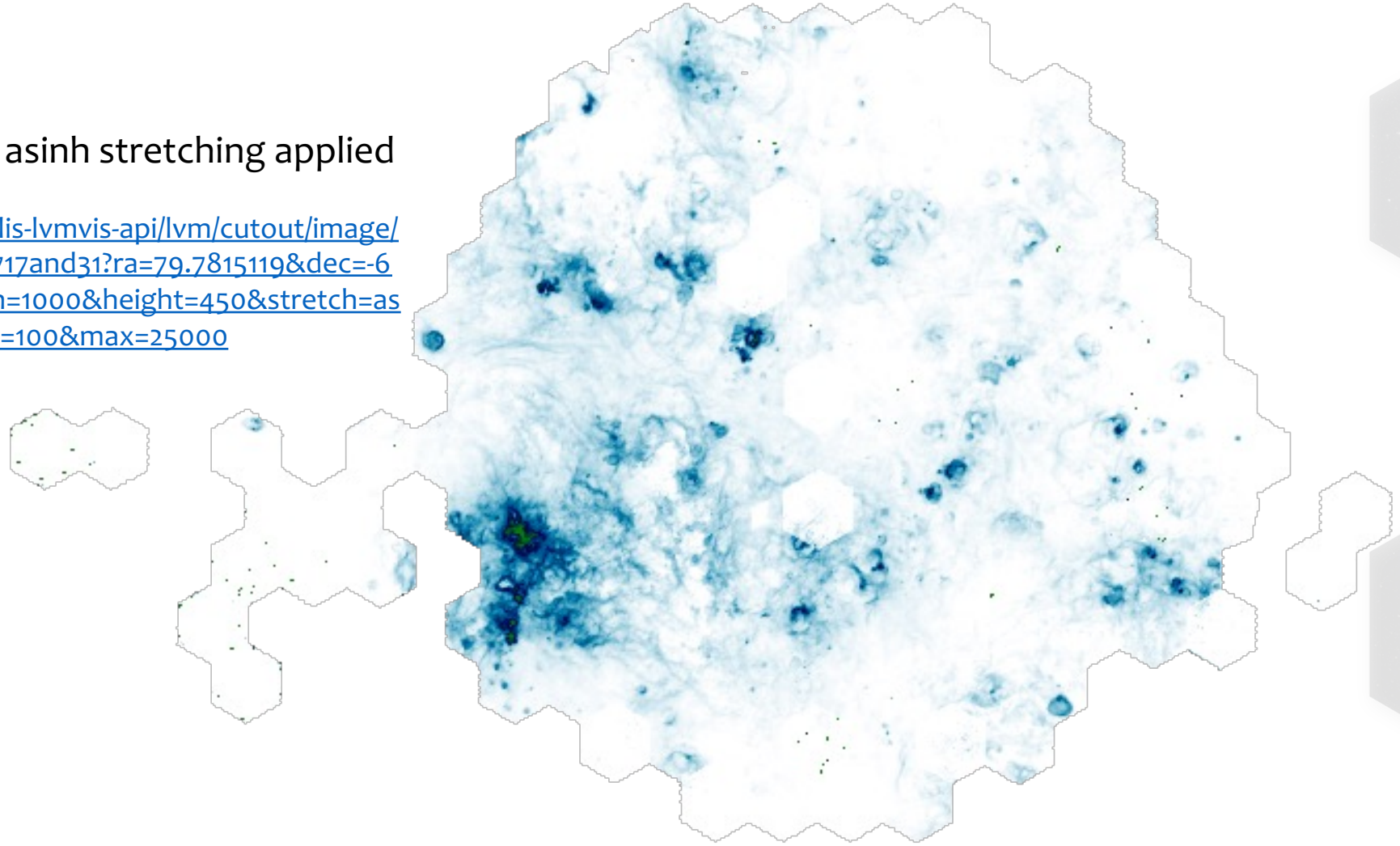
- log [NII]6583 / Ha (right)

https://data.sdss5.org/valis-lvmvis-api/lvm/cutout/image/1.1.0/hips_ratio_log_NII6583_Ha?ra=133.4&dec=-44.2&fov=2.5&width=600&height=200&stretch=linear&cmap=rainbow&min=-0.6&max=-0.1&pa=90



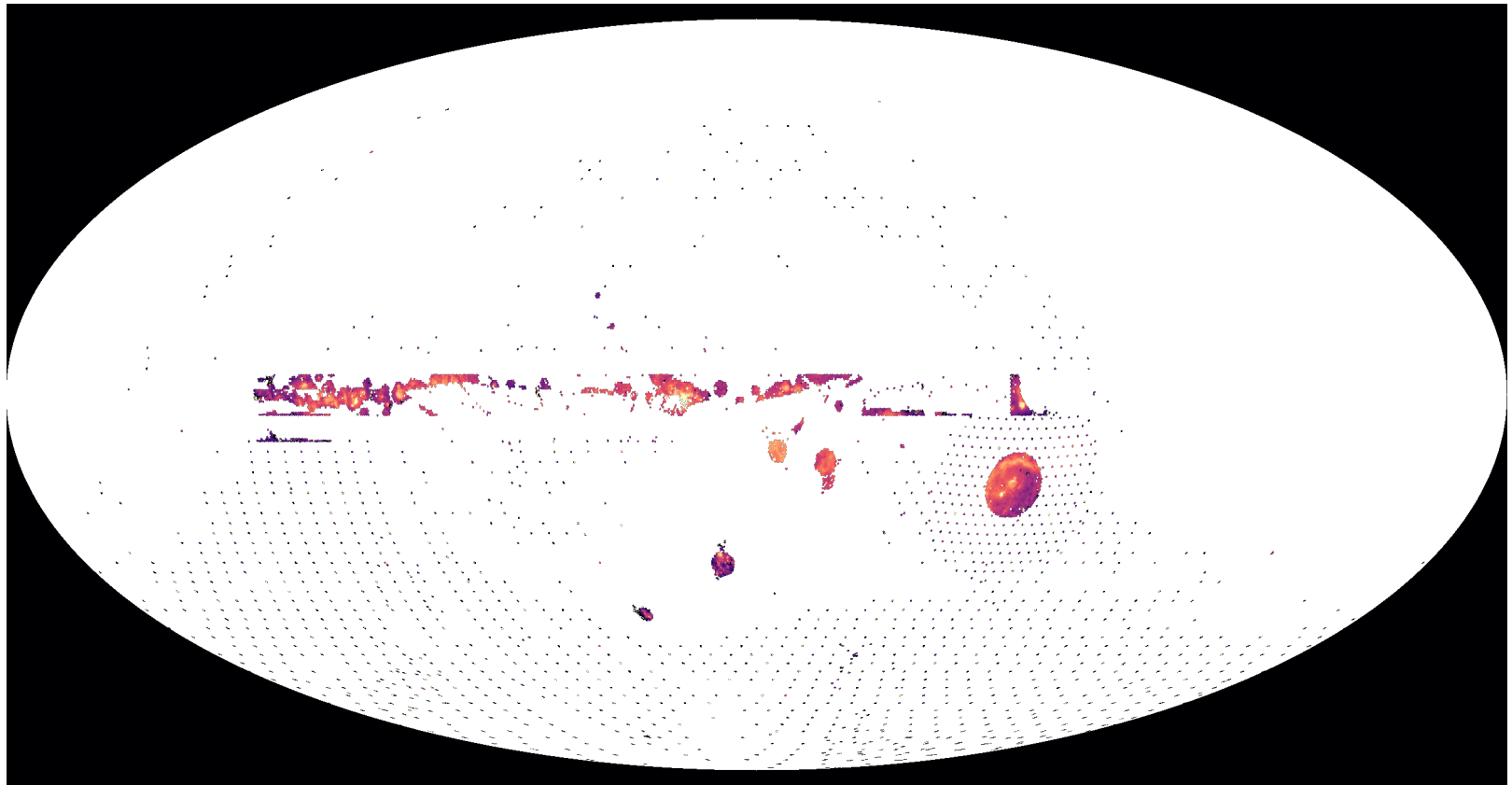
LVM Image Cutout service

- [SII]6717+6731 flux, asinh stretching applied
- https://data.sdss5.org/valis-lvmvis-api/lvm/cutout/image/1.1.1/hips_pmk_flux_SII6717and31?ra=79.7815119&dec=-68.6698211&fov=13&width=1000&height=450&stretch=asinh&cmap=ocean_r&min=100&max=25000



LVM Image Cutout service

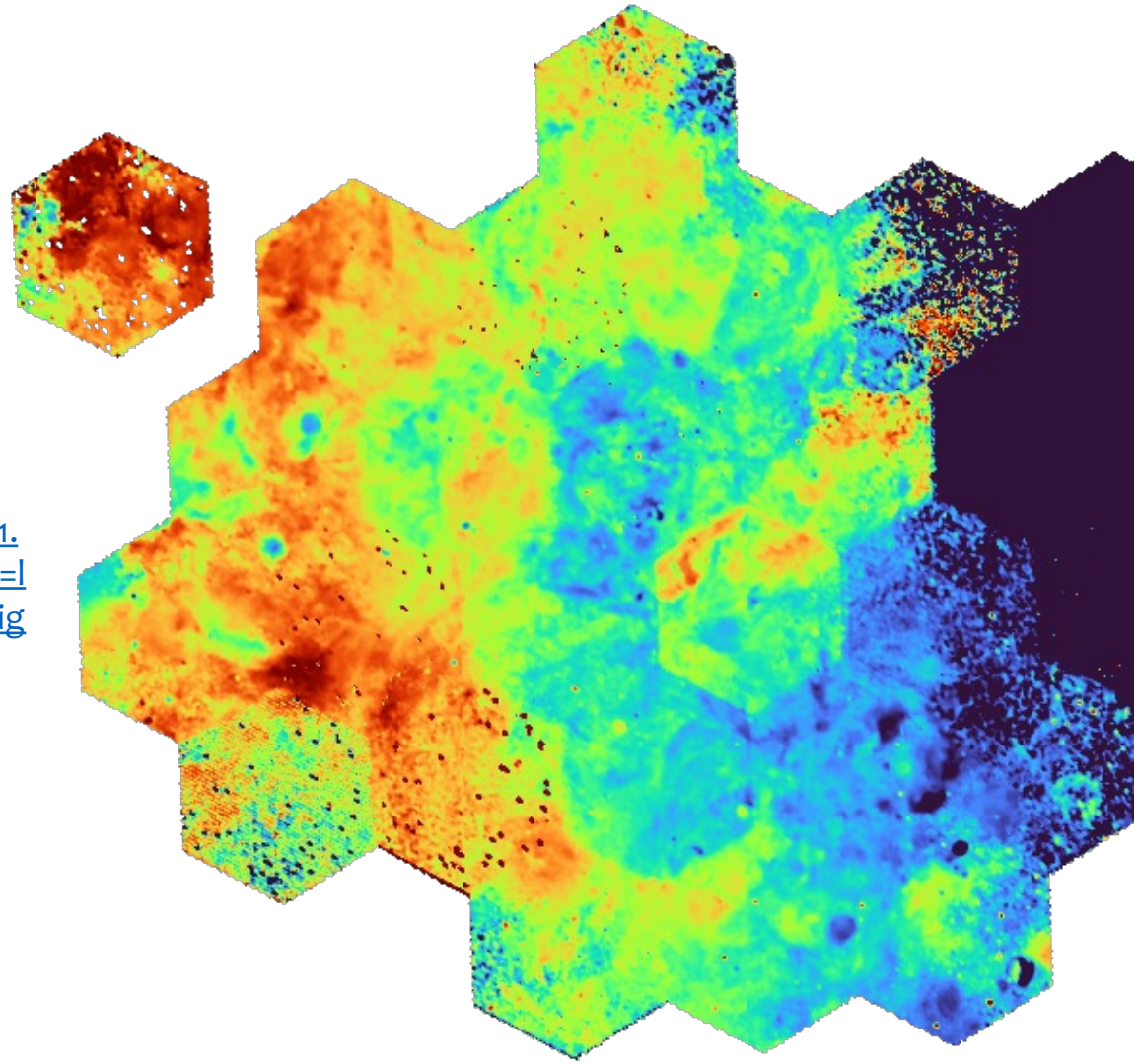
- All sky Halpha flux for 1.1.1 version
- MOL – Molweide projection
- https://data.sdss5.org/valis-lvmvis-api/lvm/cutout/image/1.1.0/hips_flx_Halpha?ra=270&dec=0&format=png&stretch=log&fov=360&coordsys=galactic&min=0&max=30000&projection=MOL&width=2500&height=1300&pa=0



LVM Image Cutout service

- SMC Halpha velocity field
- V range of 120-200 km/s

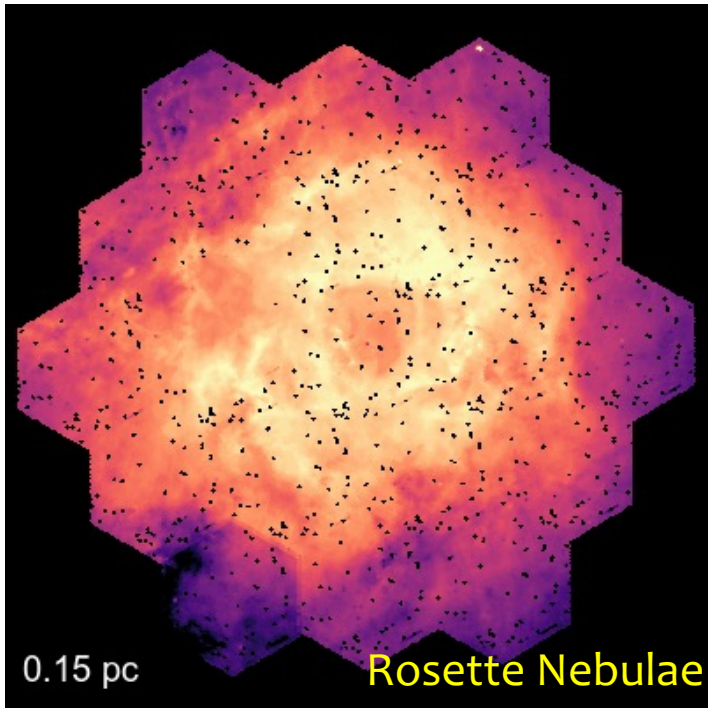
- https://data.sdss5.org/valis-lvmvis-api/lvm/cutout/image/1.1.0/hips_vel_Halpha?ra=13.8&dec=-72.7&fov=2.5&stretch=linear&cmap=turbo&min=120&max=200&width=600&height=600

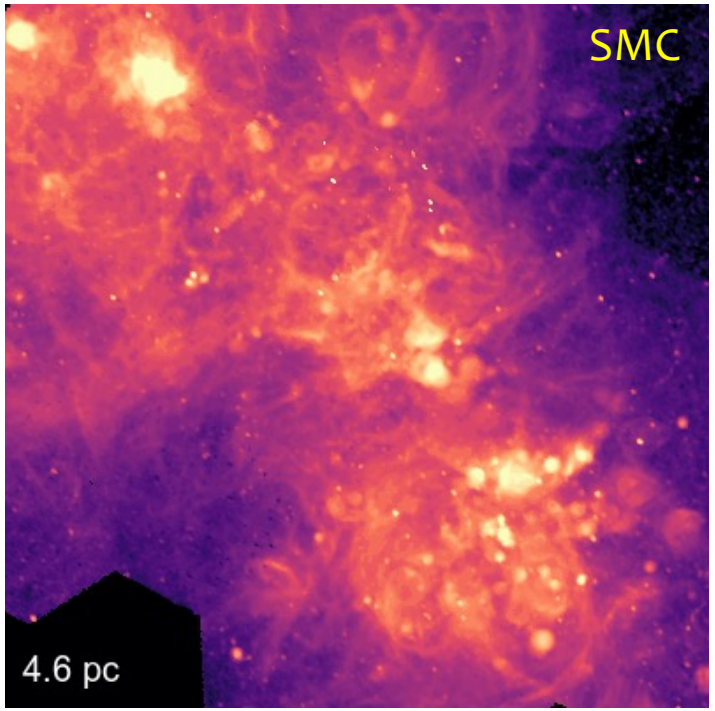


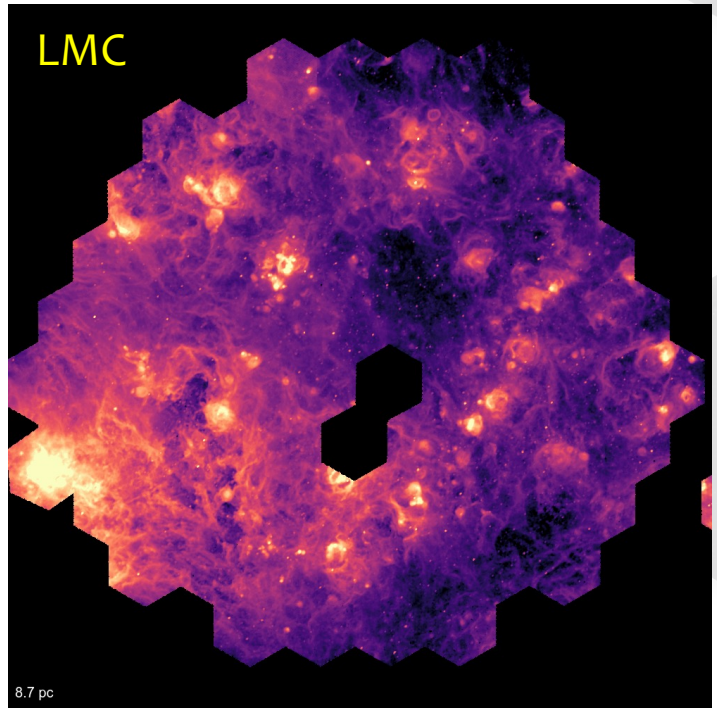
LVM Image Cutout service

```
n=1; for ((w=400, h=400; w>=20 && h>=20; w=w*95/100, h=h*95/100)); do printf -v order "%03d" $n; echo wget -O "cutout_${order}_${w}x${h}.png" "'https://data.sdss5.org/valis-lvmvis-api/lvm/cutout/image/1.1.0/hips_flx_Halpha?ra=13.25&dec=-72.85&format=png&stretch=log&fov=1.7&width=${w}&height=${h}'"; ((n++)); done | sh
```

```
mkdir temp_frames; for file in $(ls cutout_*.png | sort -t'_' -k2,2n); do size=$(identify -format "%wx%h" "$file"); width=${size%x*}; pixel_size=$(awk "BEGIN {printf \"%.1f\", 62.44 * 1000 * 3.14 / 180 * (1.7 / $width) }"); magick "$file" -filter point -resize 400x400\! -background black -gravity southwest -extent 400x400 -fill white -pointsize 20 -annotate +10+10 "${pixel_size} pc" "temp_frames/$(basename "$file")"; done && magick temp_frames/*.png -set delay 50 -duplicate 1,-2-1 -loop 0 SMC_ra13.25_dec=-72.85_fov1.7_400_to_20.gif && rm -r temp_frames
```







LVM Image Cutout service

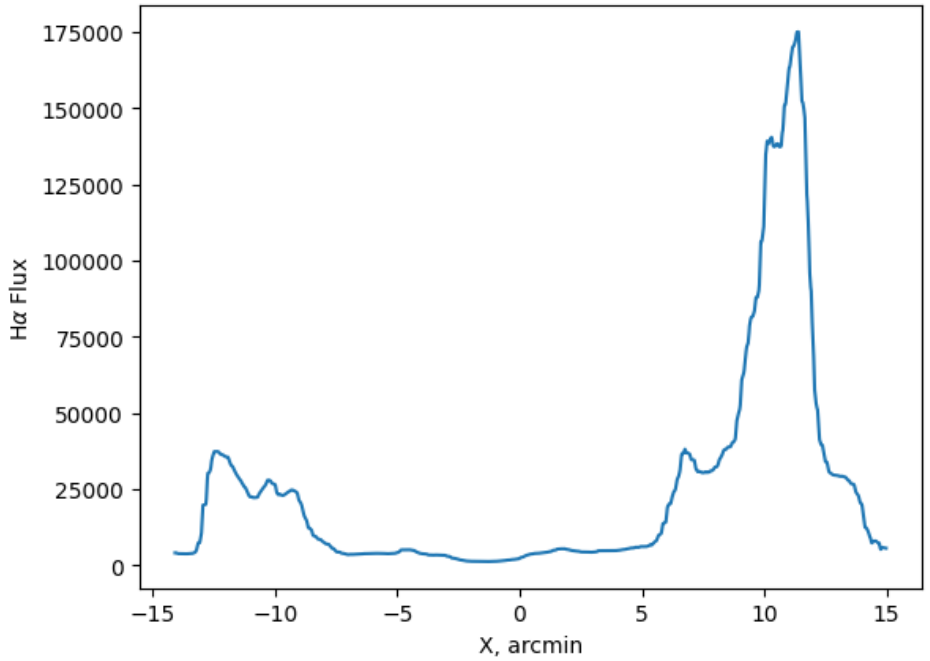
https://data.sdss5.org/valis-lvmvis-api/lvm/cutout/image/1.1.0/hips_flx_Halpha?ra=15.3223912&dec=-72.1175533&fov=0.5&width=1500&**height=200**&stretch=linear&cmap=inferno&min=0&max=30000&pa=18

Pseudo-slit imitation

https://data.sdss5.org/valis-lvmvis-api/lvm/cutout/image/1.1.0/hips_flx_Halpha?ra=15.3223912&dec=-72.1175533&fov=0.5&width=1500&**height=3**&stretch=linear&cmap=inferno&min=0&max=30000&pa=18

LVM Image Cutout service

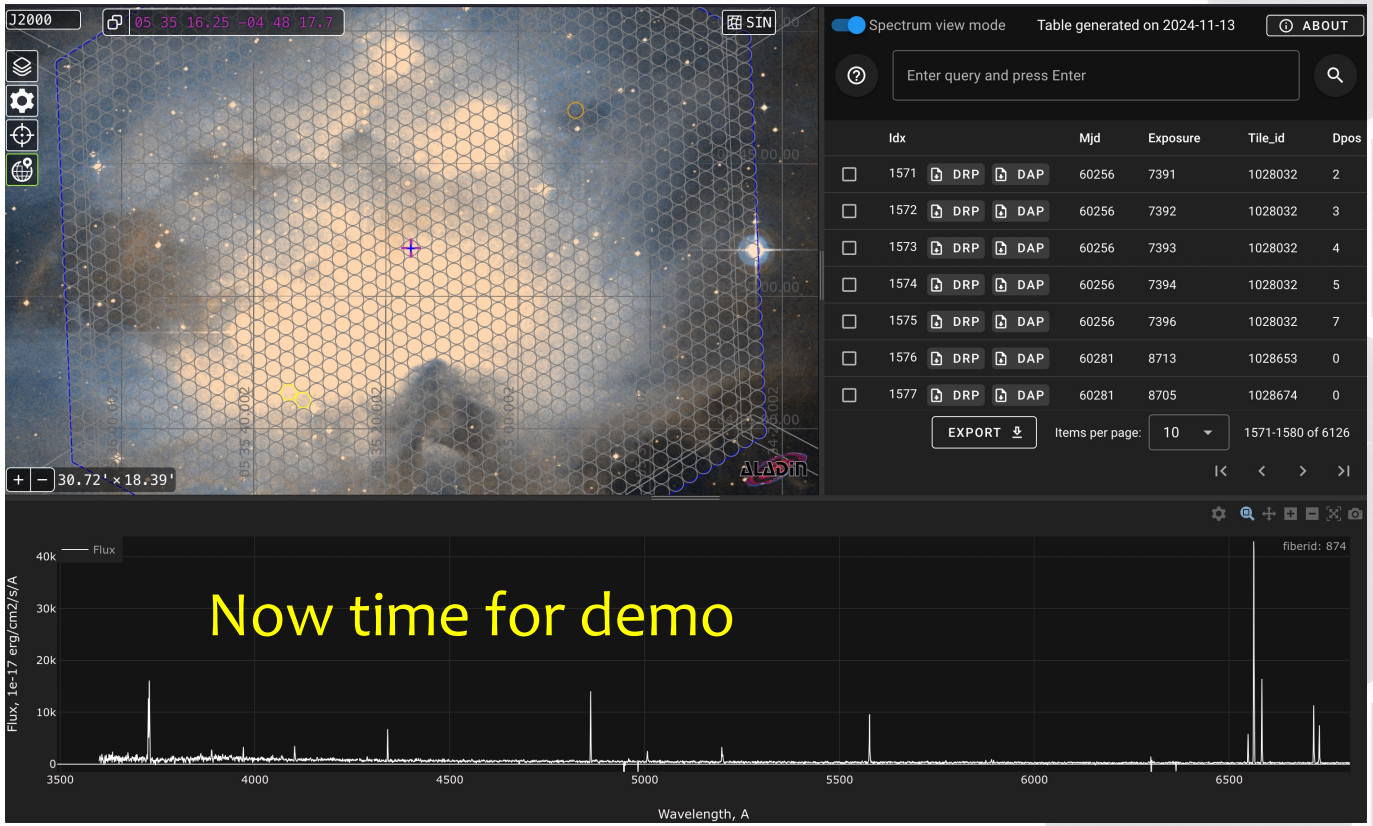
```
import requests
from astropy.io import fits
from astropy.wcs import WCS, utils
from io import BytesIO
from matplotlib import pyplot as plt

url = "https://data.sdss5.org/valis-lvmvis-
api/lvm/cutout/image/1.1.0/hips_flx_Halpha?ra=15.3223912&dec=-
72.1175533&fov=0.5&width=1500&height=3&stretch=linear&cmap=inferno&min=0
&max=30000&pa=18&format=fits"

response = requests.get(url, auth=("sdss5", "XXXXXXXXXX"))

if response.status_code == 200:
    # Open the FITS file from the response content
    with fits.open(BytesIO(response.content)) as hdul:
        data = hdul[0].data
        header = hdul[0].header
    print("FITS file loaded successfully!")
else:
    print(f"Failed to download FITS file. Status code:
{response.status_code}")

pixel_scales = utils.proj_plane_pixel_scales( WCS(header) )

profile = np.nanmean(data, axis=0)
x_arcmin = (np.arange(profile.size) - profile.size / 2) *
pixel_scales[1] * 60

plt.plot(x_arcsec, profile)
plt.xlabel("X, arcmin")
plt.ylabel(r"H$\alpha$ Flux")
```



LVM Data Visualizer (lvmvis)

- Interactive Single Page Application
- JavaScript frameworks
  - Vue3.js
  - Vuetify
- Aladin-lite client
- FastAPI backend

- Hosted at the SDSS-V headquarters data center at the University of Utah



Thank you!