

Visualisation in (spectral line) astronomy, a general perspective

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ExGal-Twin
Excellence in Galaxies · Twinning the IAC

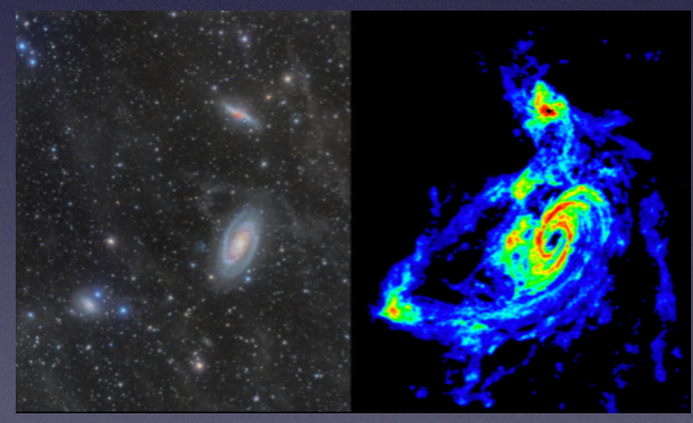
Visualisation: basic meaning

Any technique for creating images, diagrams, or animations to communicate a message.



- Historic examples:

  cave paintings, hieroglyphs, ancient graffiti

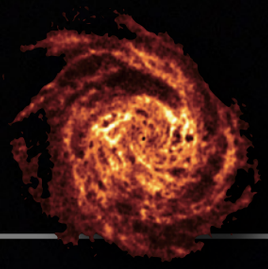


- Modern examples:

  drawings, photos, 3D rendered figures

- Modern visualisation:

  full 3D, interactive, multi-data and multi-dimensional

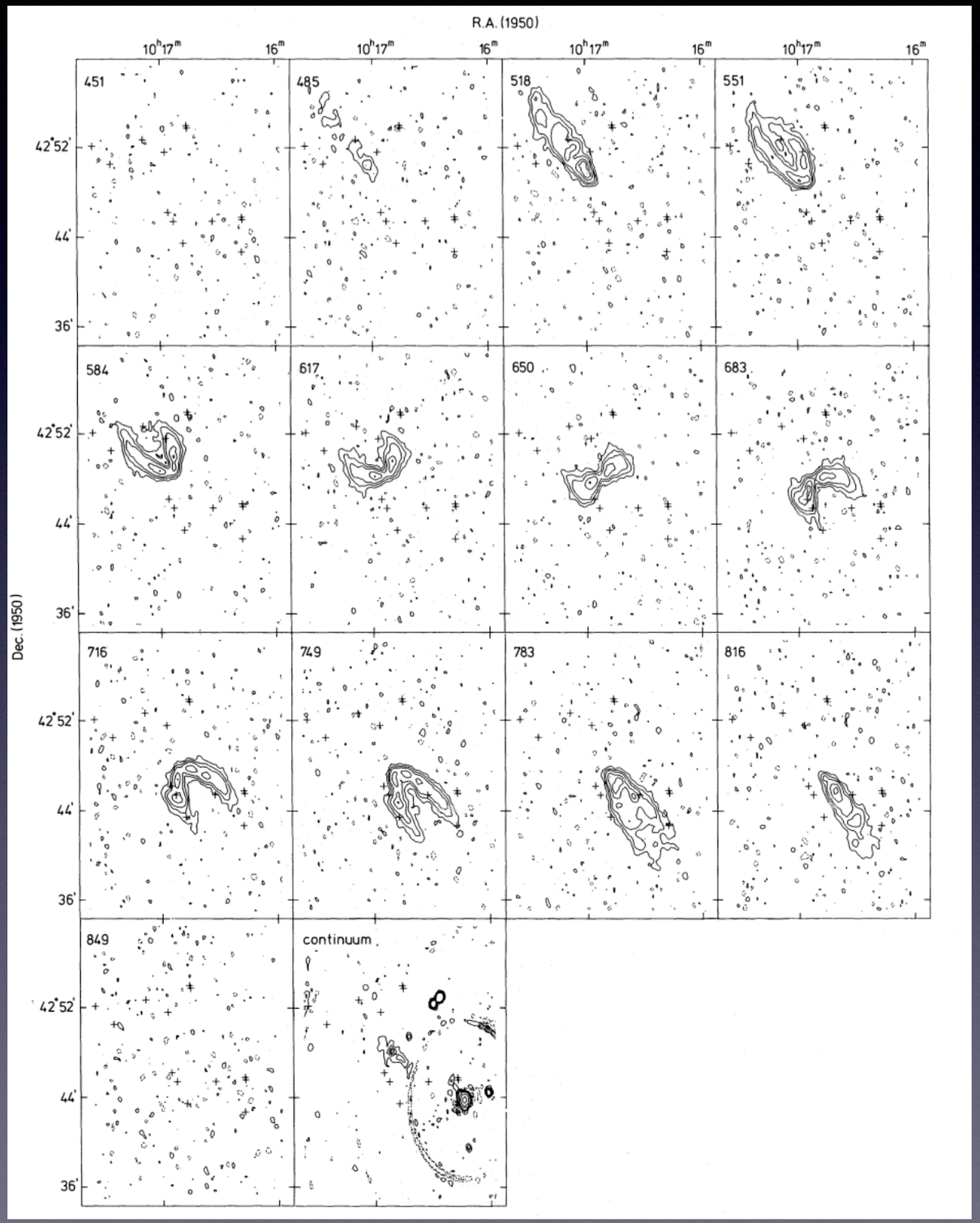


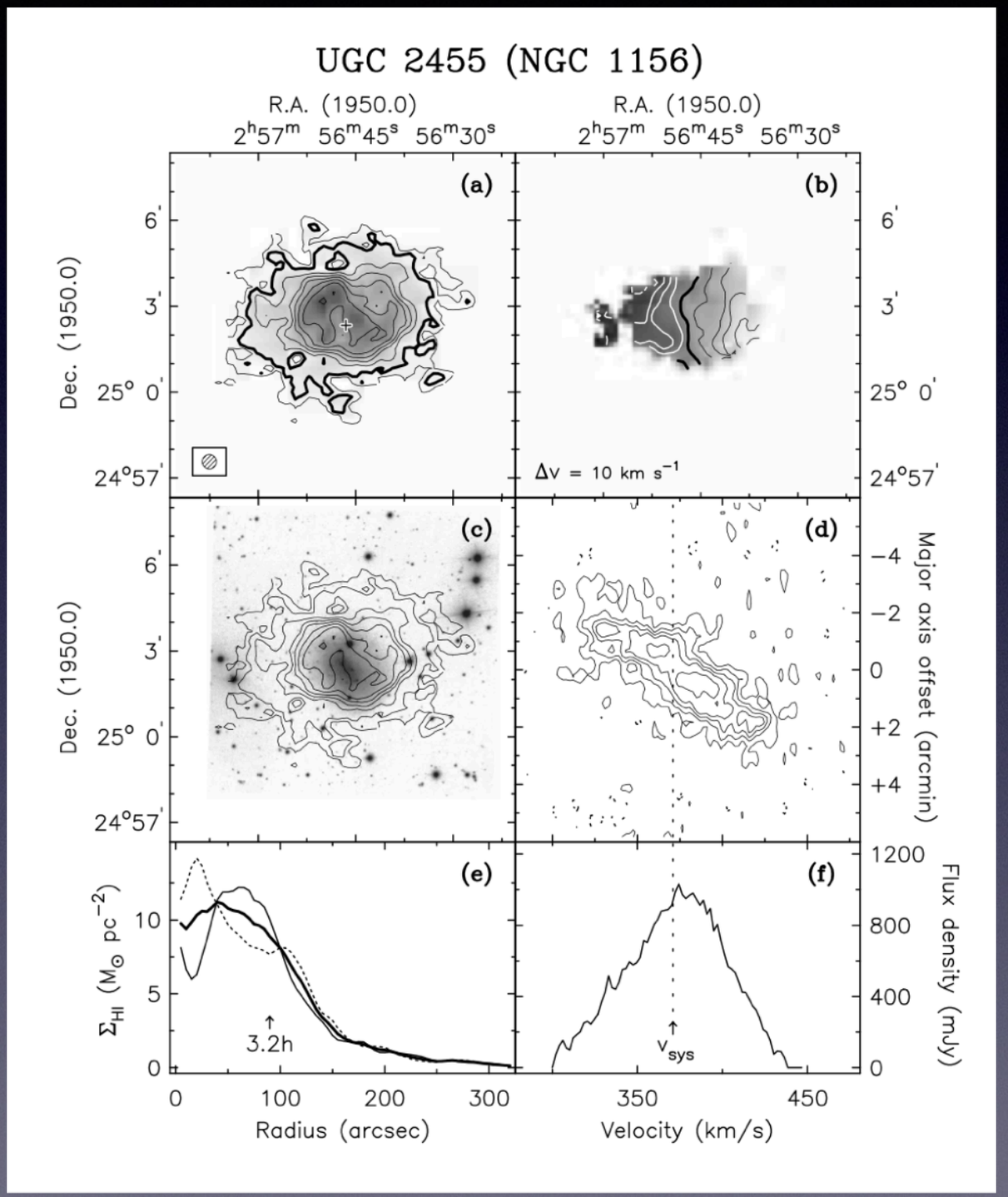
Visualisation: basic meaning

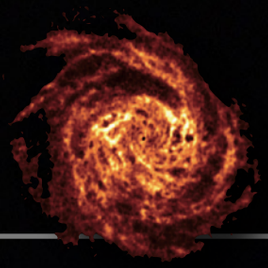
- To form a picture of someone or something in your mind, in order to imagine or remember him, her, or it
- Making a visible presentation of numerical data, particularly a graphical one
- Visualization is the process of representing abstract business or scientific data as images that can aid in understanding the meaning of the data

But here: presenting 1-D, 2-D, 3-D and n-D data in a comprehensive way and be able to interact with the data

Old School Visualisation





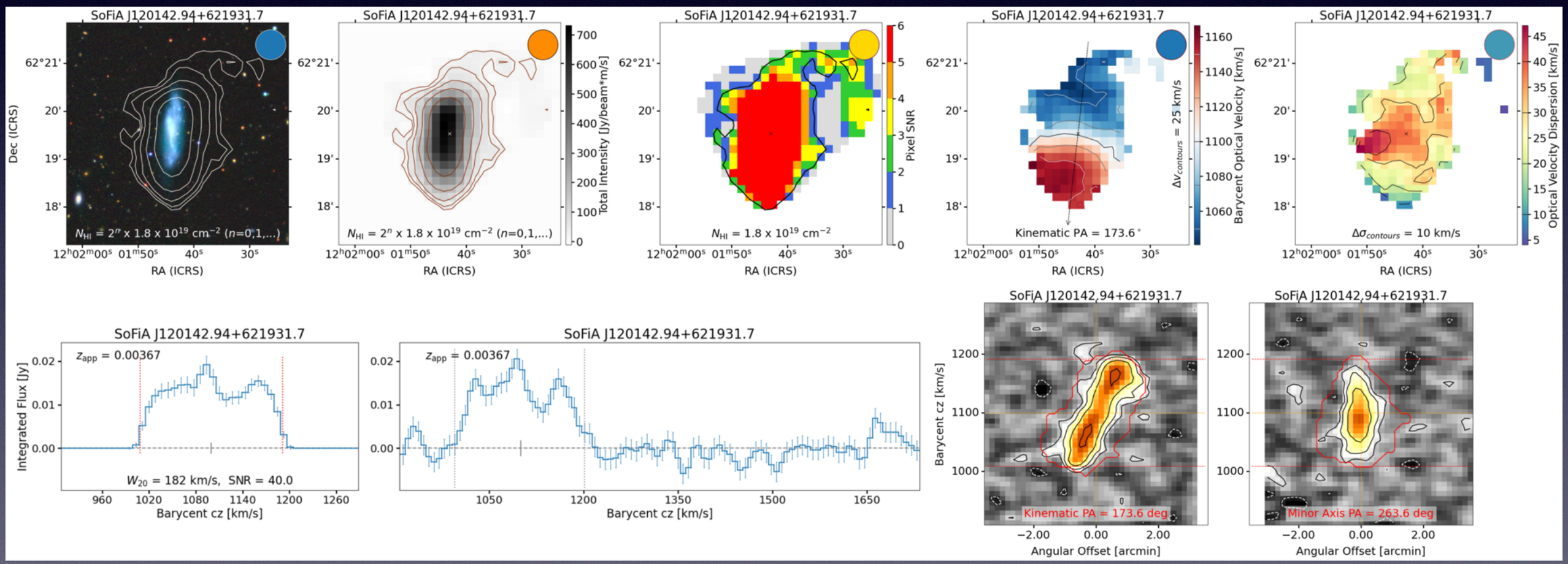


Modern Visualisation I

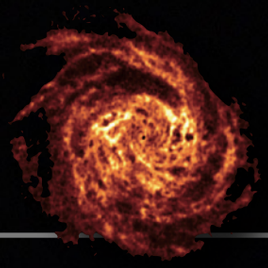
SoFiA Imaging Pipeline

https://github.com/kmhess/SoFiA-image-pipeline/

HI column density | S/N image | velocity field | v-dispersion



global profile | major and minor axis PV slice

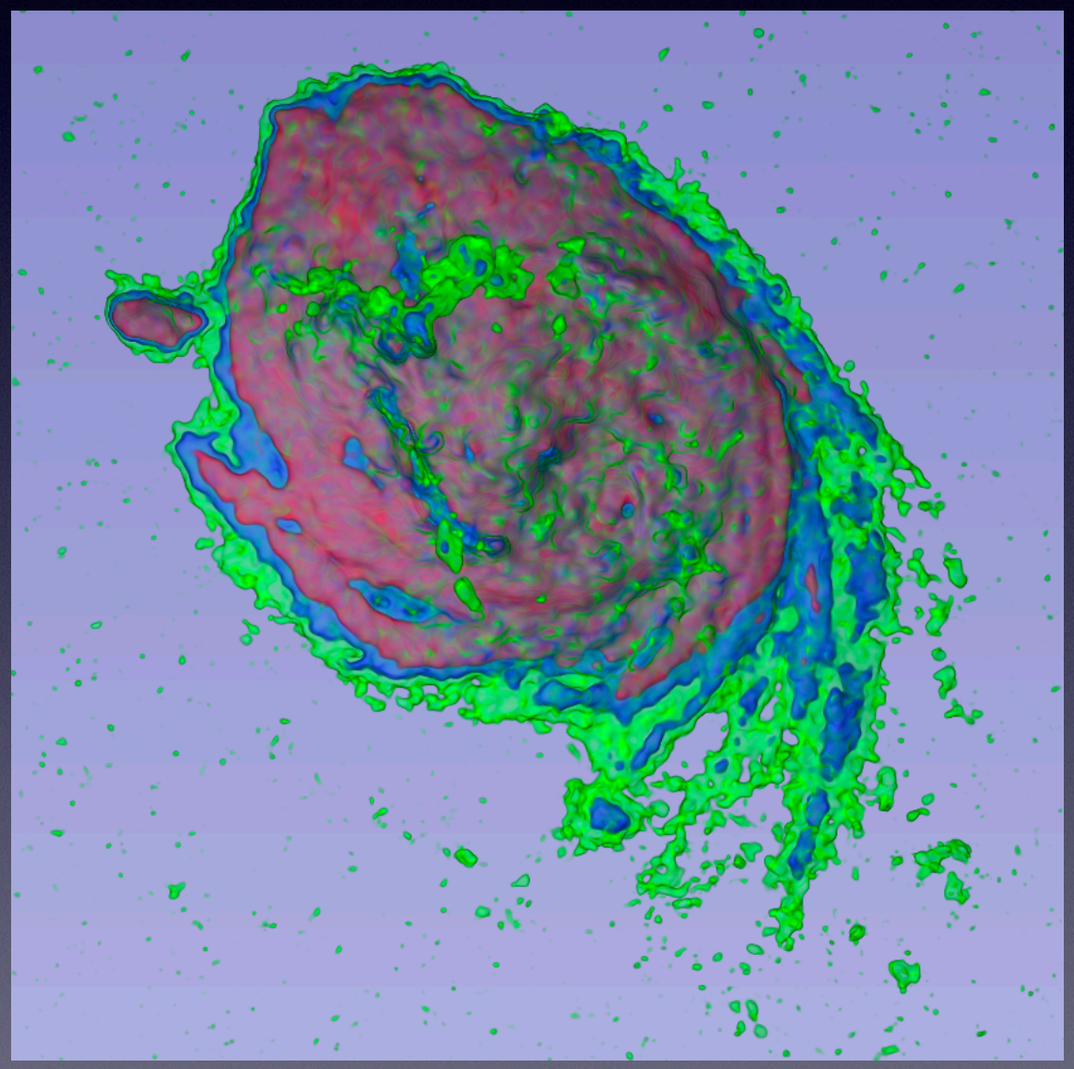


Modern Visualisation II

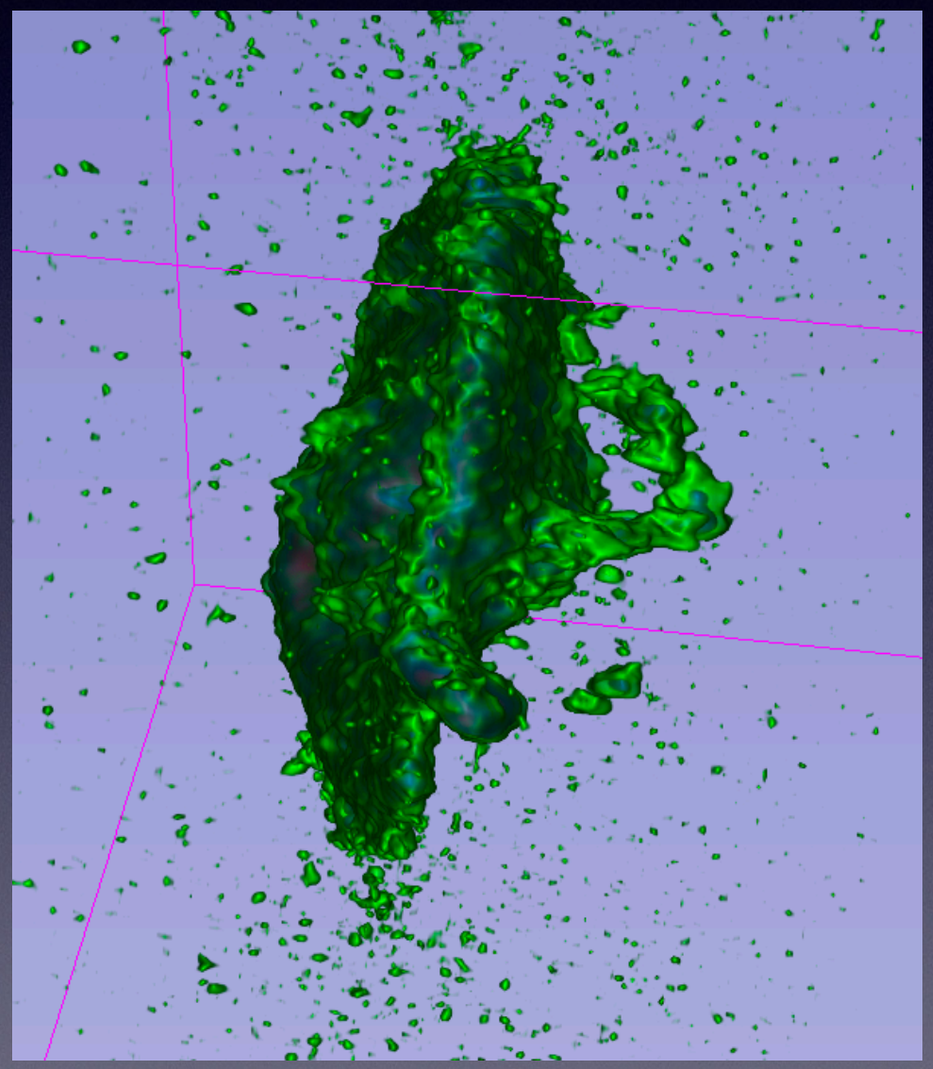
SlicerAstro

www.astro.rug.nl/~slicerastro/

M 101



front view



side view

Visualisation: available FITS viewers



Visualisation: available 3-D viewers

Karma (kvis, kpvslice, etc.)
Gipsy viewers (sliceview, visions)
DS9 (CfA)
QFitsView (MPE)
FITS3D
CARTA *cartavis.github.io*

VO: Alladin + HiPS (*Hierarchical Progressive Surveys*)
TopCat (for table data)

Volume rendering: Frelled (uses Blender)
VAA3D (hhmi Howard Hughes Medical Institute)
MayaVi
SlicerAstro *www.astro.rug.nl/~slicerastro/*
ViSL3D *https://github.com/ixakalabadie/ViSL3D*

Immersed VR: iDaVIE *https://github.com/idia-astro/iDaVIE/releases/tag/v1.0*

SAOImage ds9

File Edit View Frame Bin Zoom Scale Color Region WCS Analysis Help

File n5907h1.fits
Object NGC5907
Value
WCS
Physical X Y
Image X Y
Frame 1 x 1.000 0.000 °

file edit view frame bin zoom scale color region wcs help
linear log power square root squared asinh sinh histogram min max zscale

DS9

CARTA

File View Widgets Help

n5907h1.fits

Image: (450, 450); Value: −1.27473e−4 Jy/beam ; Apparent radial velocity (): 24.0000 ; Polarization: Stokes I

CARTA

X Profile: Cursor
Image Active Region Active
Data: (Image: 450 px, −1.27473e−4)

Y Profile: Cursor
Image Active Region Active
Data: (Image: 450 px, −1.27473e−4)

Image List Animator Region List
First Prev Play

Render Configuration
90% 95% 99% 99.5% 99.9% 99.95% 99.99%

QFitsView by Thomas Ott - buffer1 [/Users/vdhulst/Data/N5907/n5907h1.fits]

kvis v1.0.2/Karma v1.7.20 @JMs-MacBook-Pro.local:7070

Files Intensity Zoom Overlay Export View Edit New Quit

Velocity: 874.00 km/s
NGC5907 overlaid with NGC5907

KVIS

Declination (B1950)
Right Ascension (B1950)

Browser 1 of 1 for display window 1

Close Destroy Copy Active Show: all
Data: Arrays Advanced Make Data

IcMP n5907h1.fits

FB: 0 Dir: /Users/vdhulst/Data/N5907
Object: NGC5907
Format: unknown Unit: JY/BEAM
Size: 94 MiB Dim: 900*900*31 float
Min: -0.002170743421 Max: 0.02404103801

Histogram Clone Unload

Image: main Contour: map Movie: master
Low: 0.0008964331817 High: 0.003
Map Contour Levels: 0.002 0.004 0.008 0.016
-ve Cont. Width 0.0 +ve Cont. Width 0.0
-Colour: grey70 +Colour: red
Renzo Contour Levels: 80
Renzogram Channels: min:max+1
Profile: master Profile Colours:
Dark: black Light: white

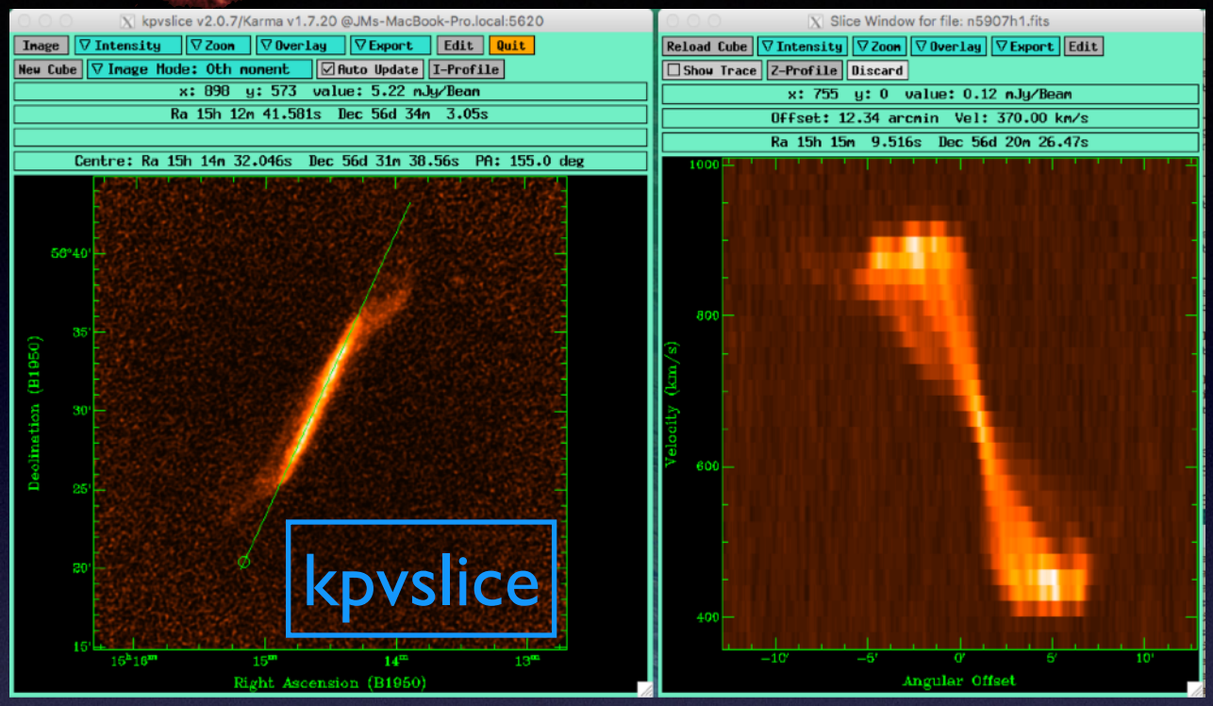
QFitsView

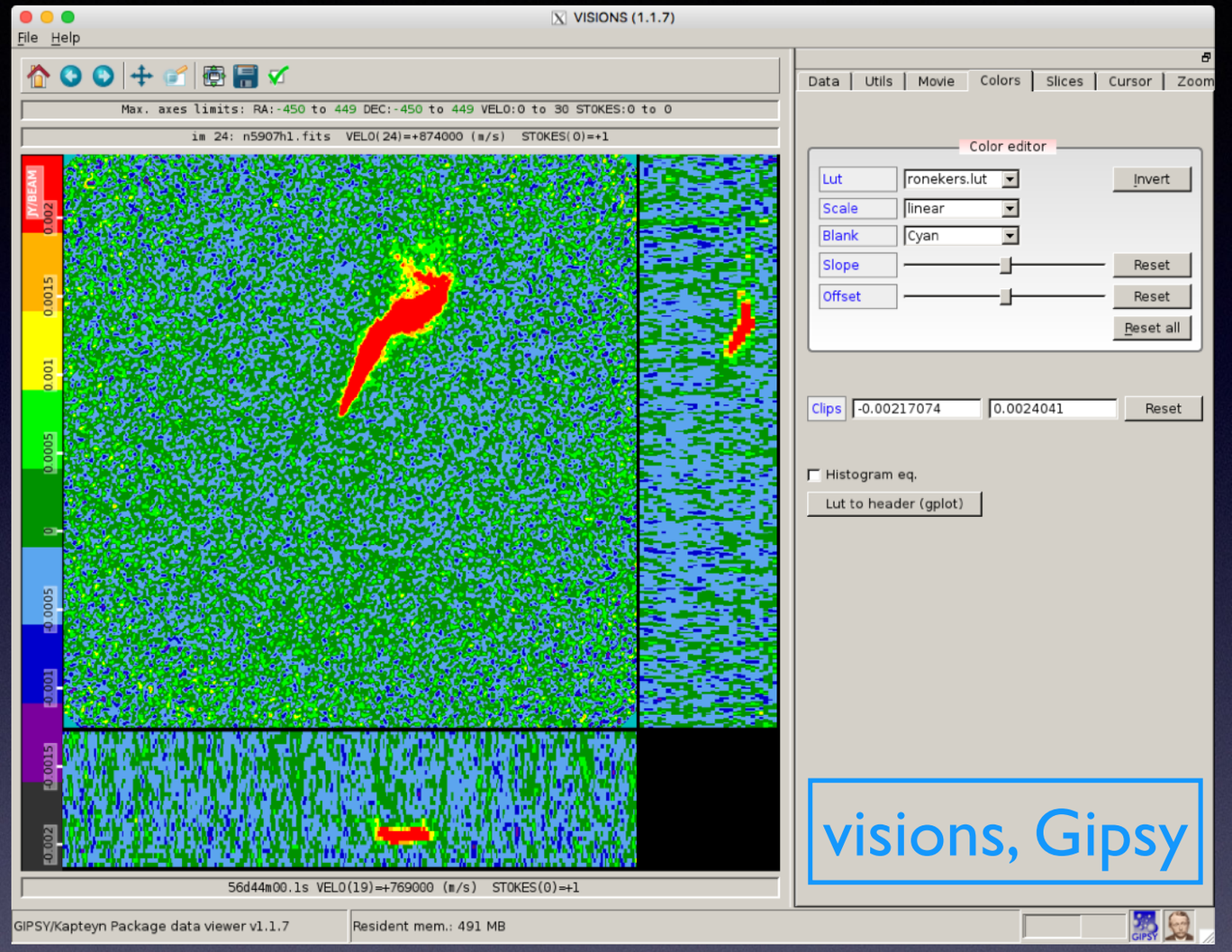
Minimum: 0 Maximum: 100 Auto Scale Single Pixel R1: 1 R2: 2

Online documentation available at: http://www.mpe.mpg.de/~ott/dpuser
224 functions registered.
99 procedures registered.
126 pgplot procedures registered.
DPUSER> buffer1 = readfits("/Users/vdhulst/Data/N5907/n5907h1.fits")
DPUSER> buffer2 = longslit(buffer1, 519, 441, 0, 1)
DPUSER>

Mouse-left: change colormap; Keys: d=measure distances : g=Gaussfit : I=(un

Visualisation: commonly used 3-D viewers

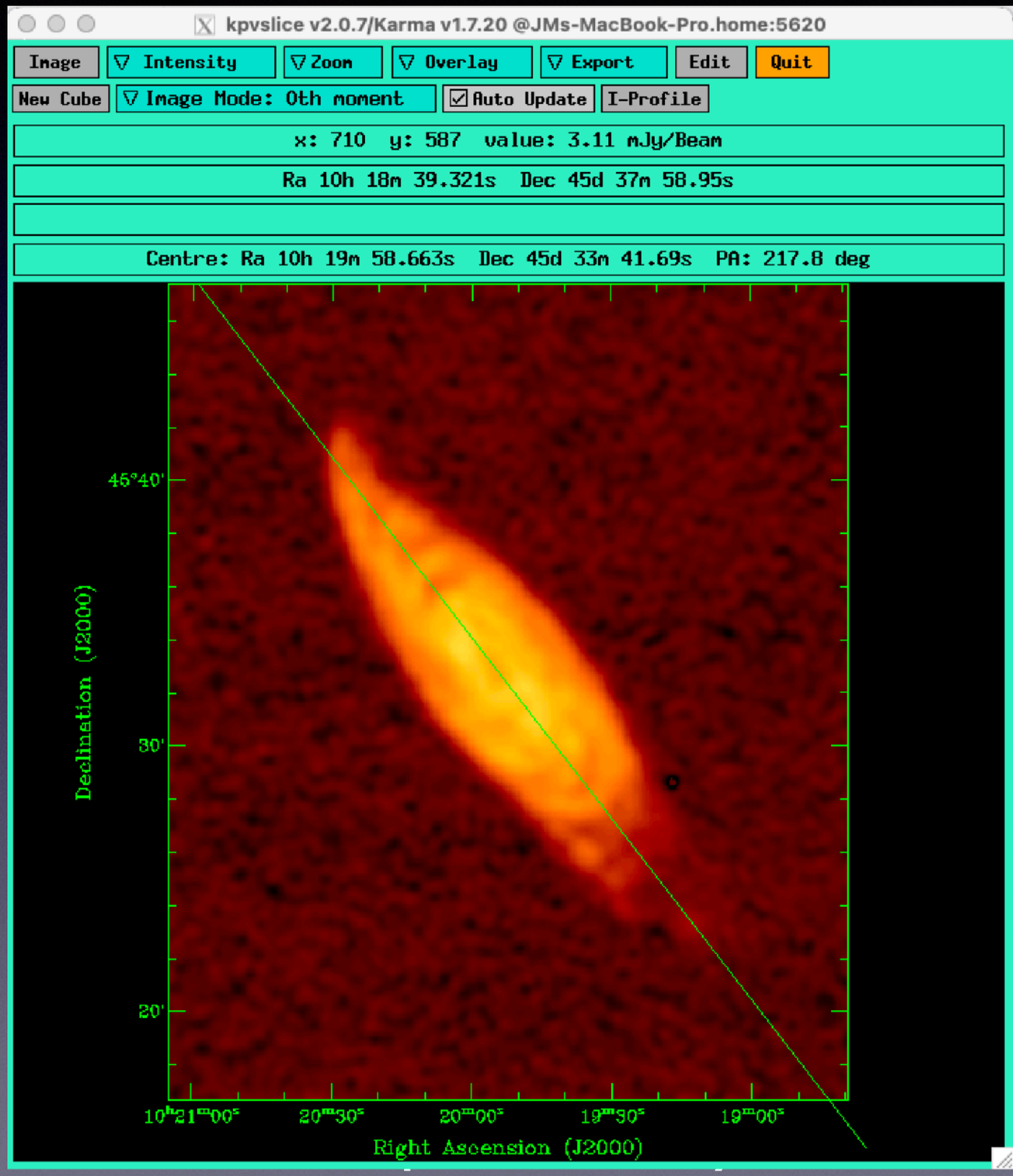


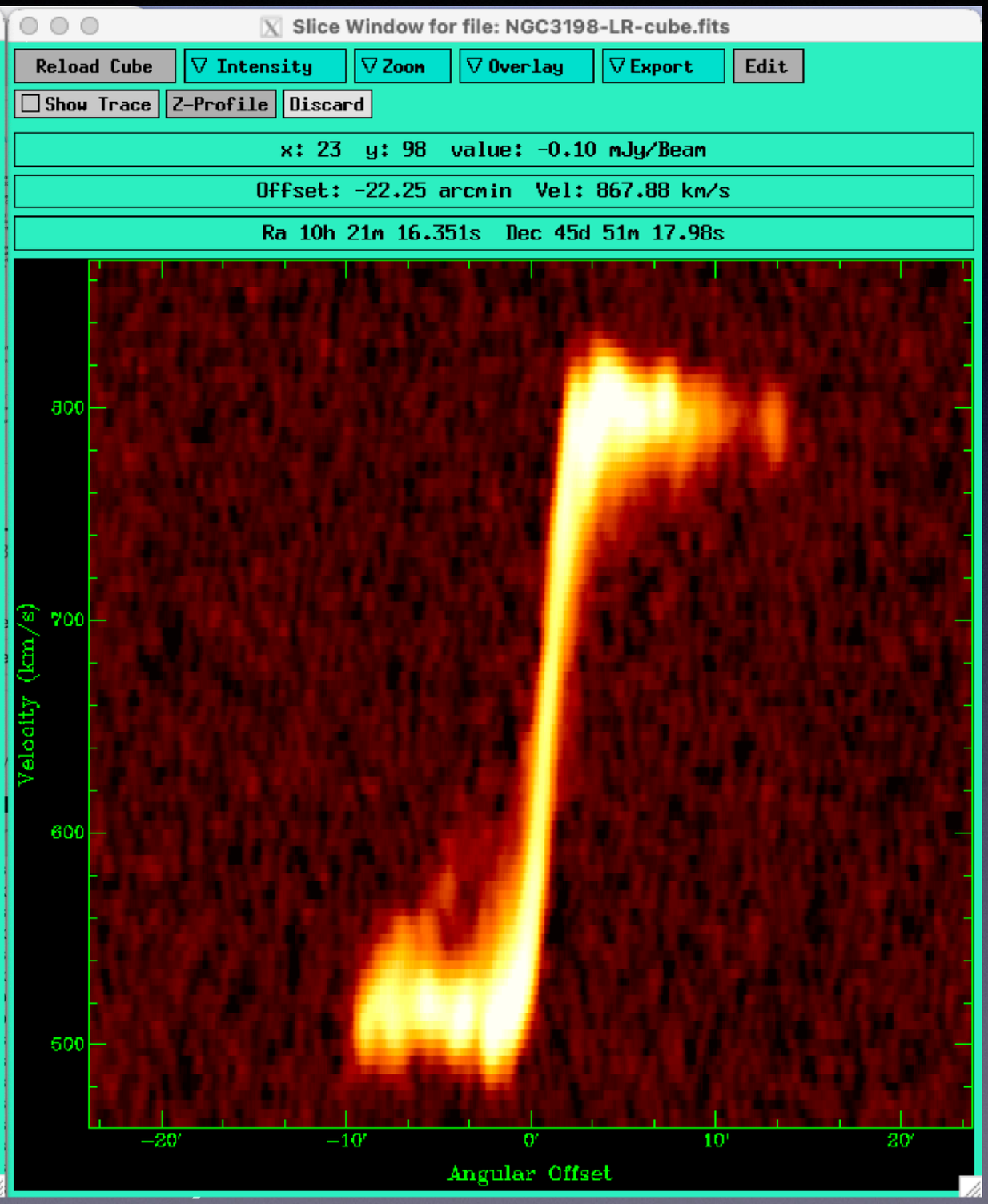


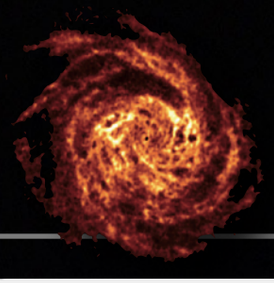
3-D Viewers:

- basic features present
- handling very diverse
- few can combine multiple data (kvis)
- few can display 3 dimensions at once (kpvslice, visions)
- few are coupled directly to the data analysis environment

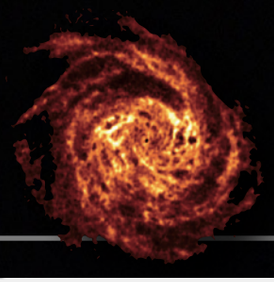
Visualisation: commonly used 3-D viewers







Visualisation: commonly used 3-D viewers



Visualisation: commonly used 3-D viewers

CARTA

File View Widgets Help

NGC3198-LR-cube.fits

Declination (FK5)

Right ascension (FK5)

X Profile: Cursor

Image Active Region Active

Value (Jy/beam)

X coordinate

Data: (WCS: 10:18:46.4, Image: 692 px, 1.95829e-4)

Y Profile: Cursor

Image Active Region Active

Value (Jy/beam)

Y coordinate

Data: (WCS: 45:25:39, Image: 402 px, 1.95829e-4)

Image List Animator Region List

First Prev Play Next Last Mode Frame rate 5

Channel

Apparent radial BARYCENT 484719.9993 m/s

Render Configuration

90% 95% 99% 99.5% 99.9% 99.95% 99.99% 100% Custom

Min Max

Value (Jy/beam)

Cursor: 0.07 Jy/beam

Scaling Log

Colormap

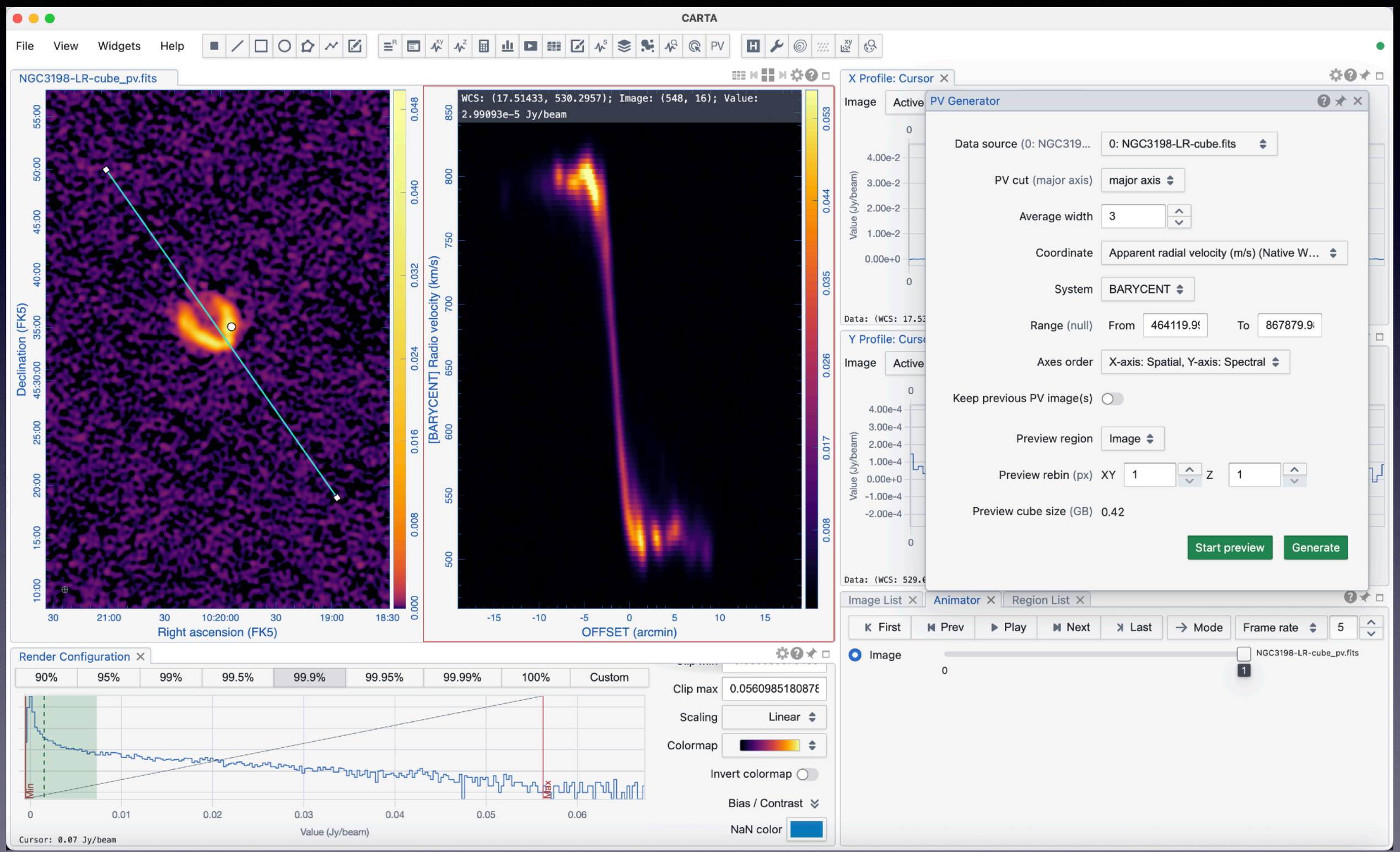
Invert colormap

Alpha 1000

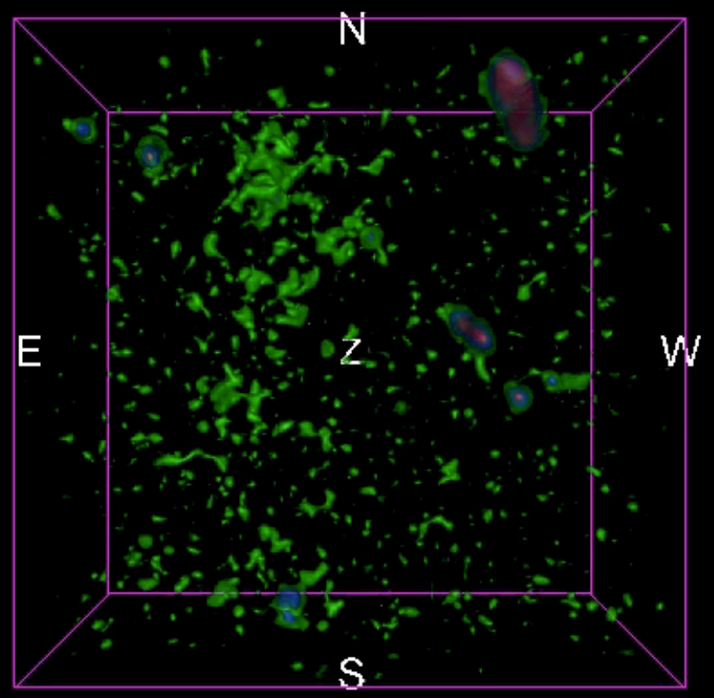
Bias / Contrast

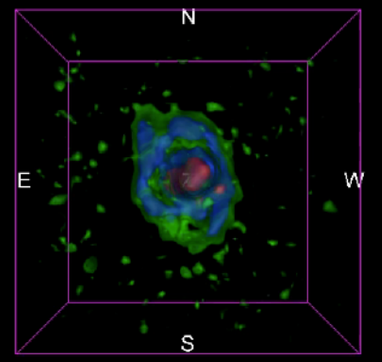
NaN color

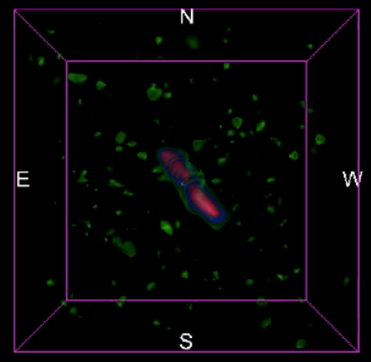
Visualisation: commonly used 3-D viewers

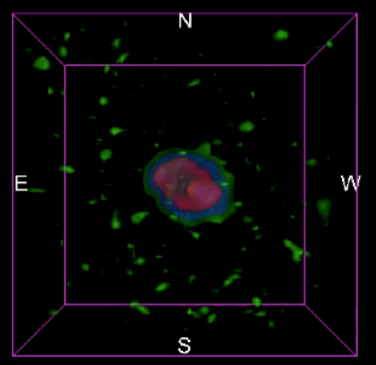


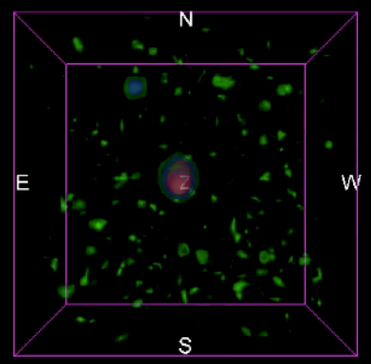
Galaxies in the Ursa Major cluster

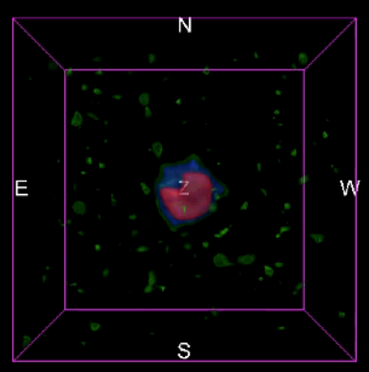


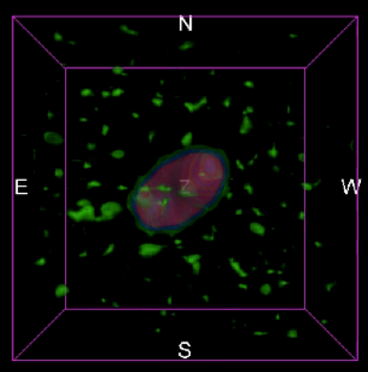


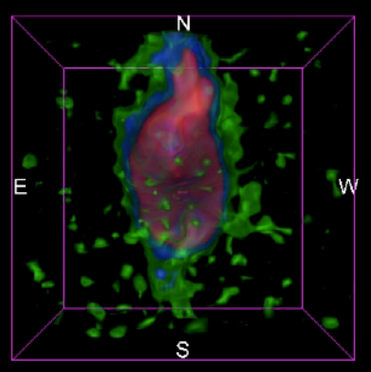


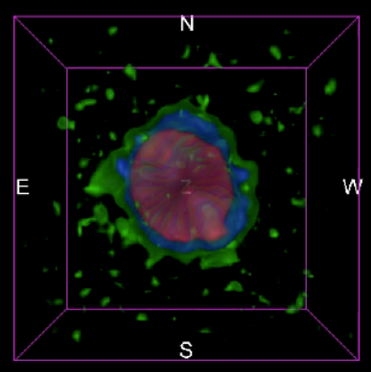


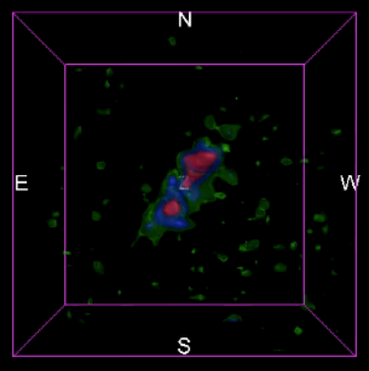


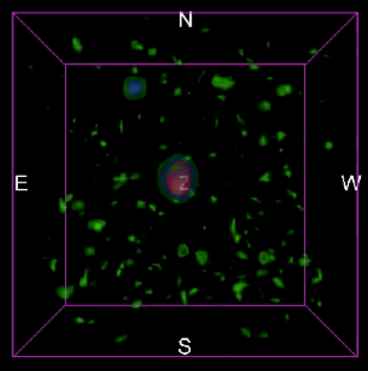


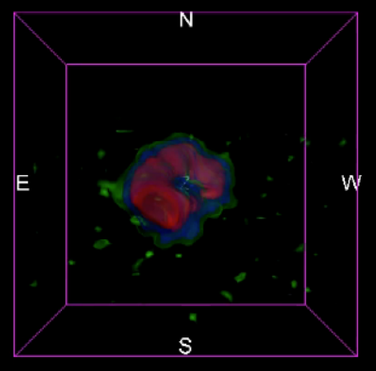


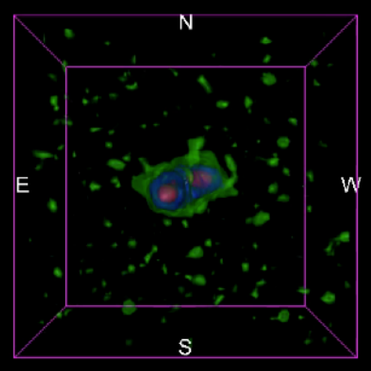








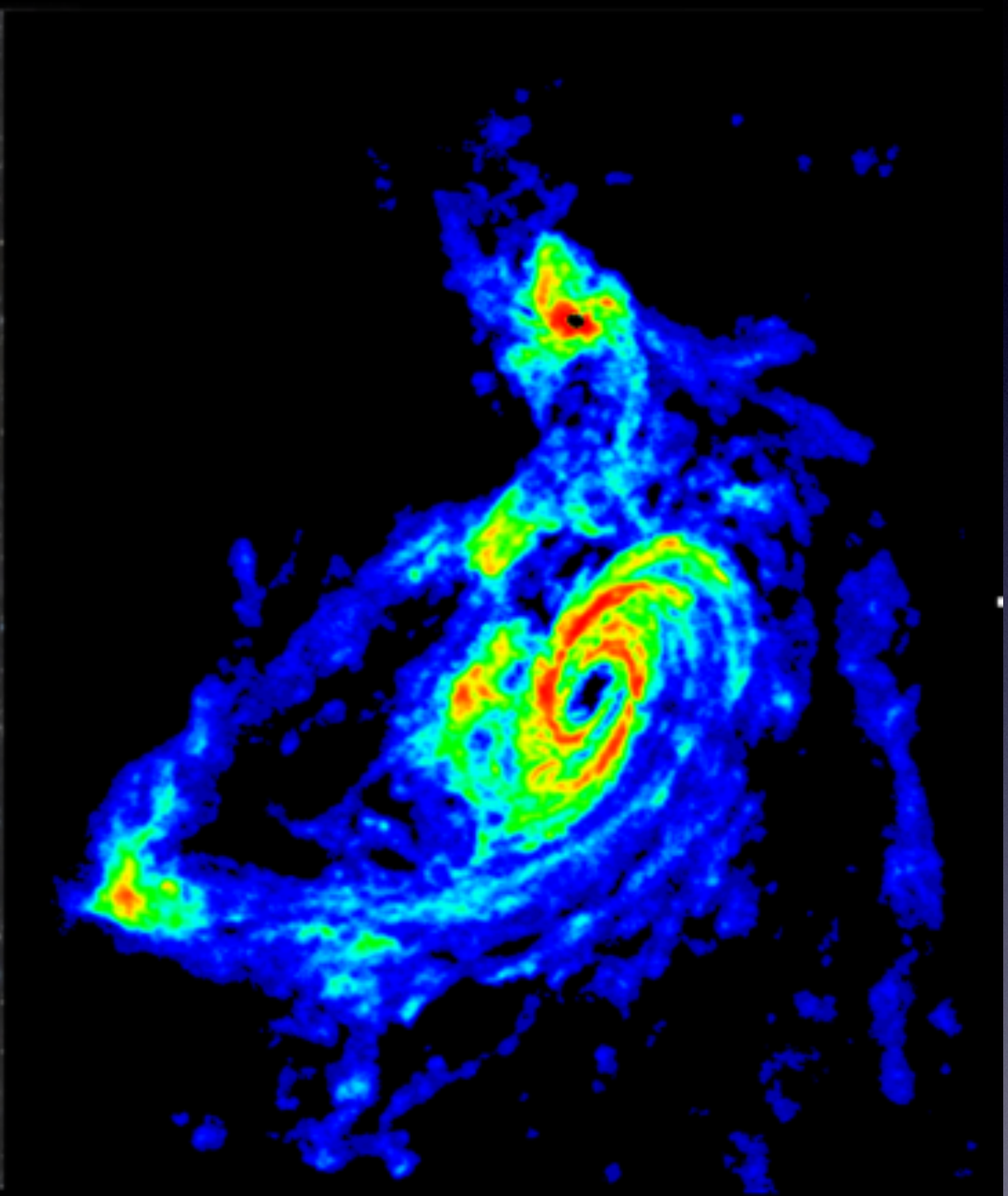


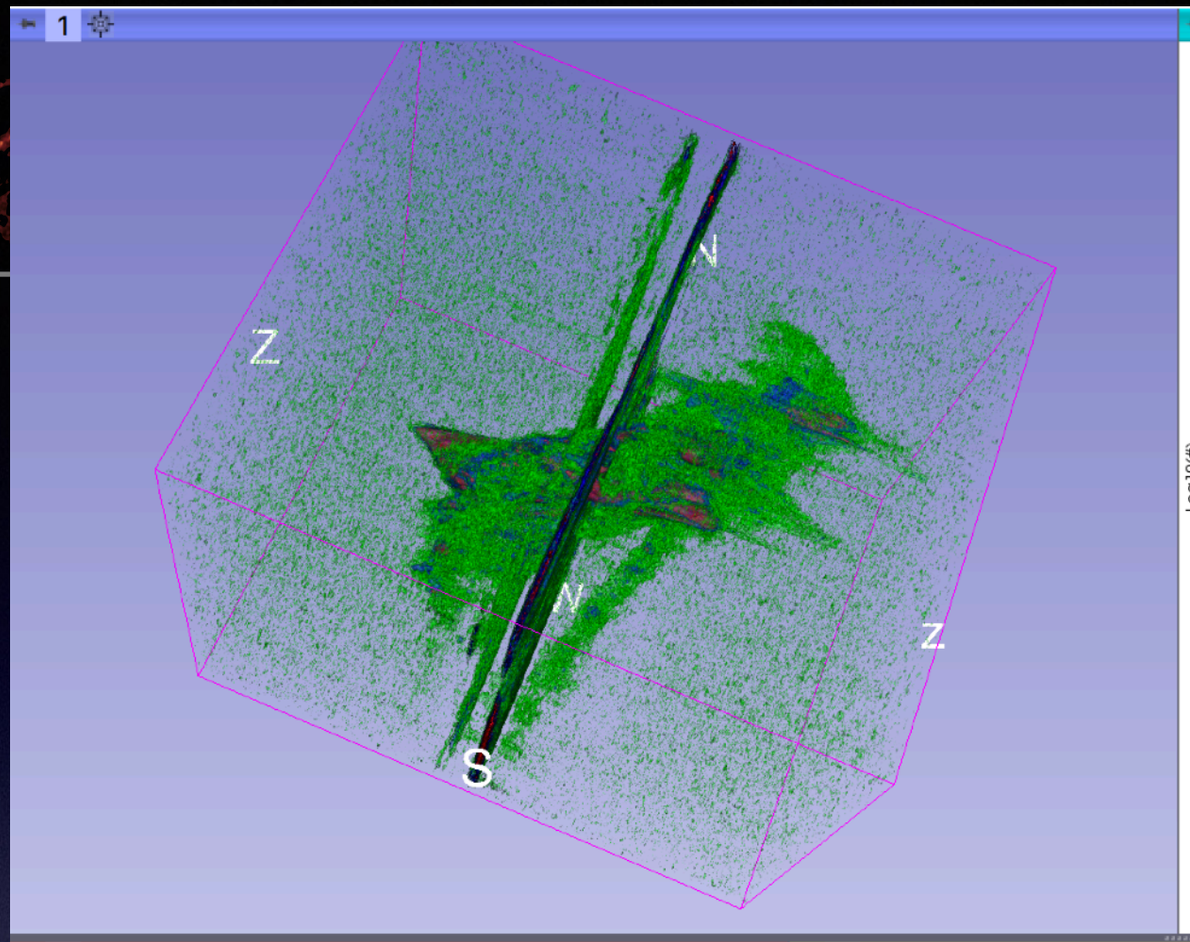


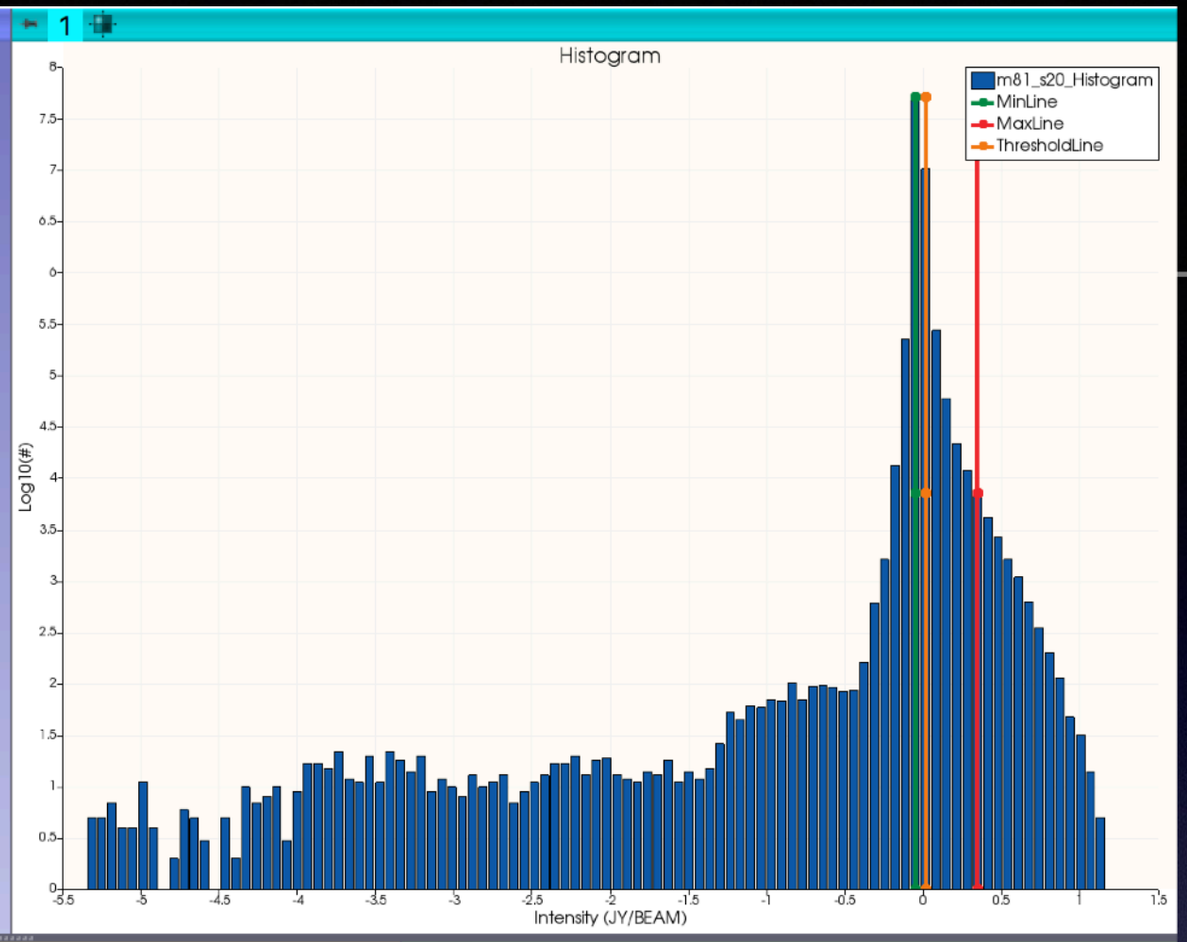
Data: Busekool et al. MNRAS **501,** 2608–2626 (2021)

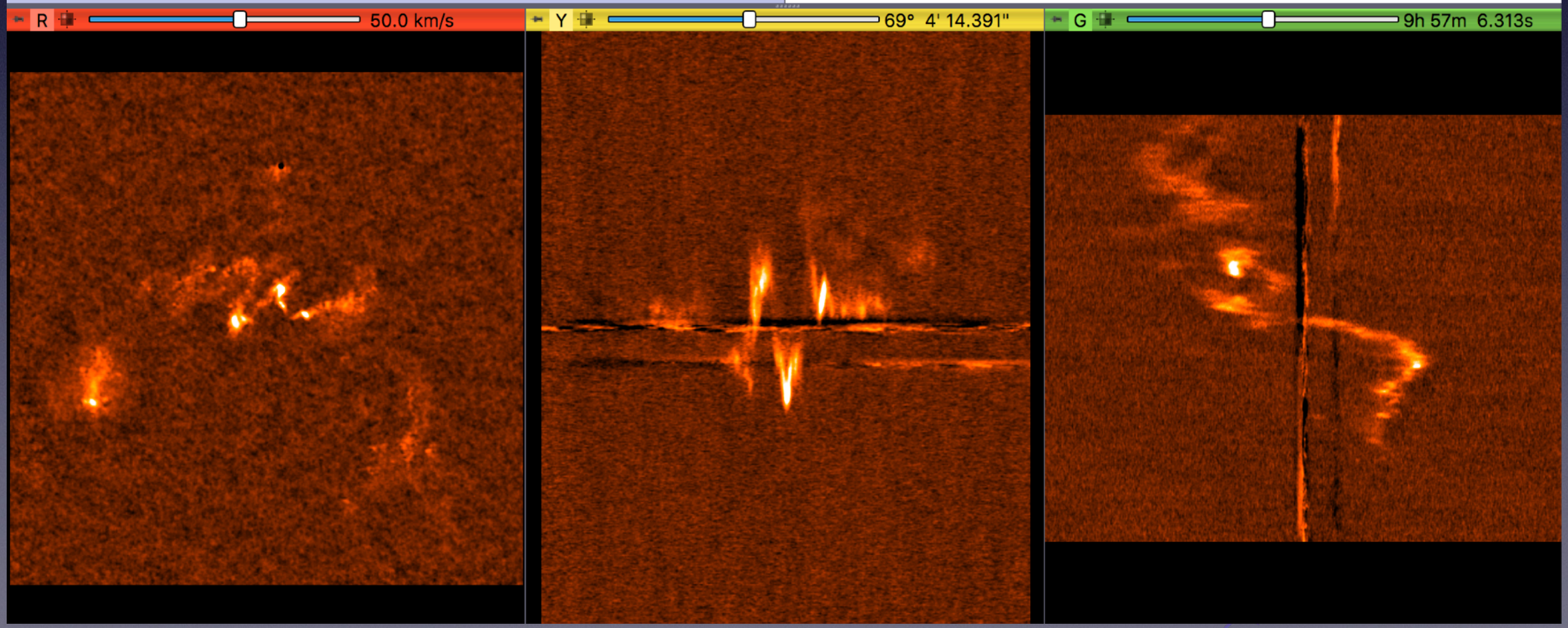
Visualisation: complex HI data sets

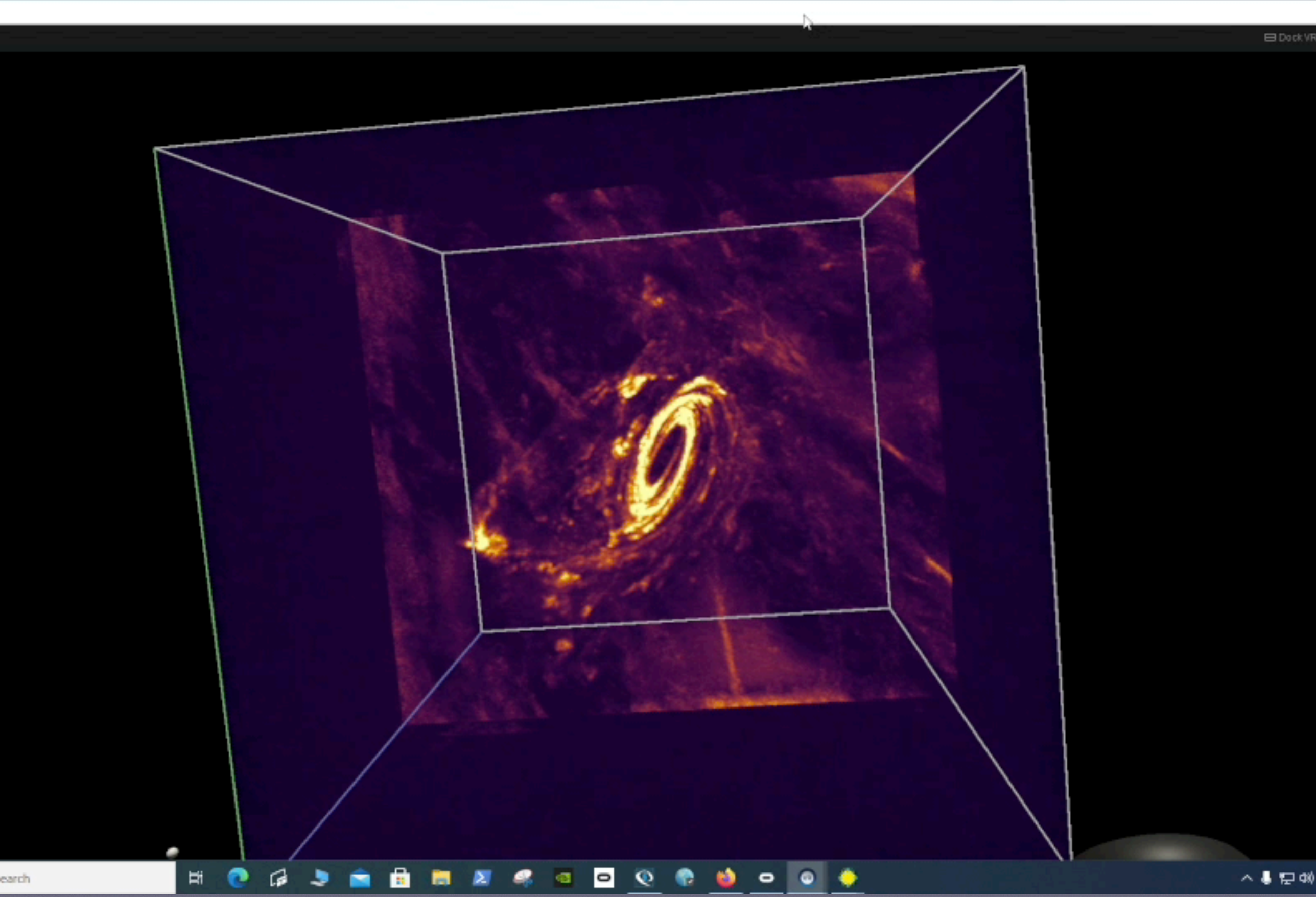


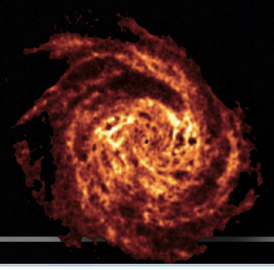


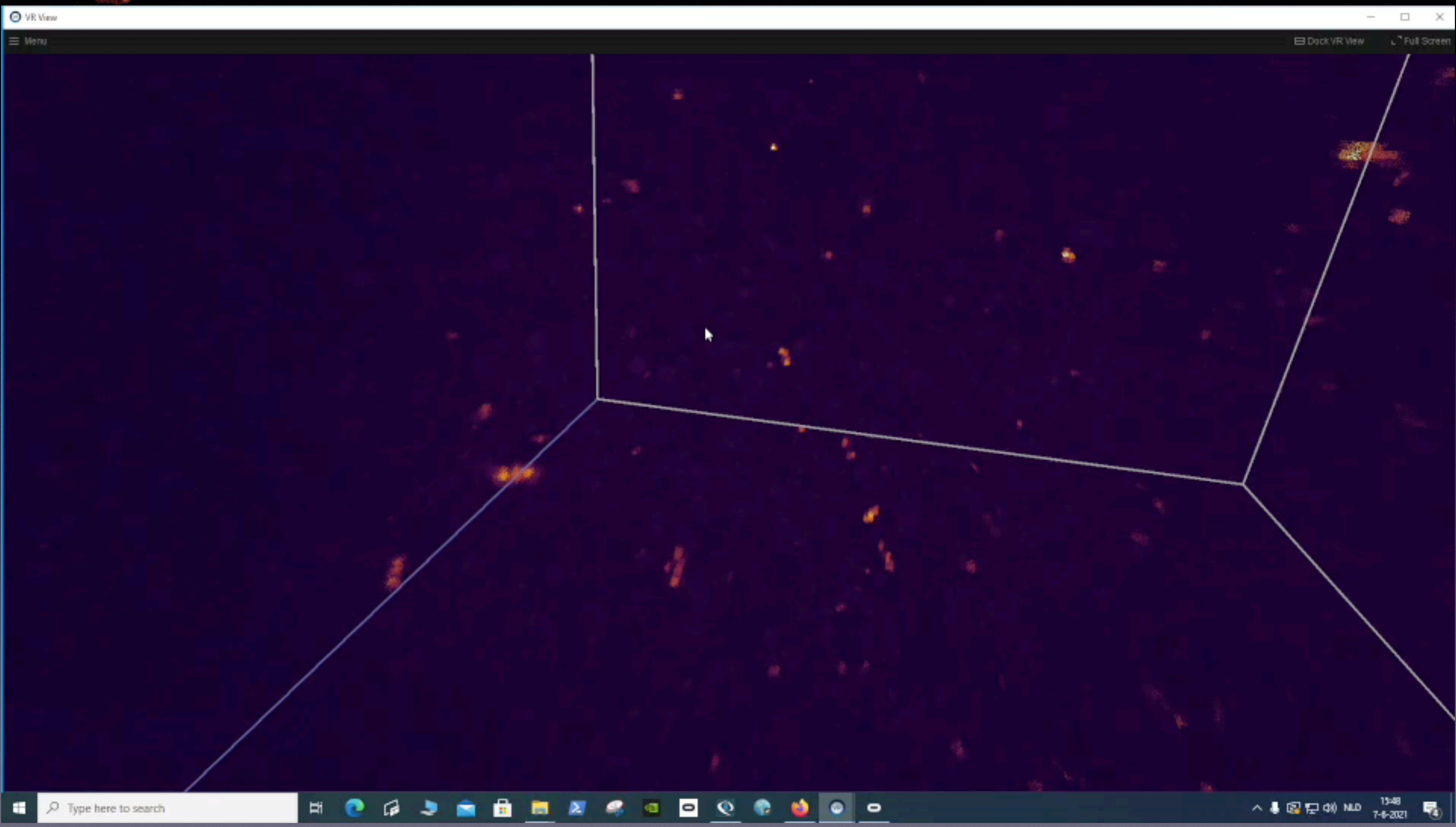

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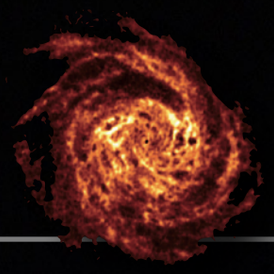

1
Histogram
m81_s20_Histogram
MinLine
MaxLine
ThresholdLine
Log10(#)
Intensity (JY/BEAM)

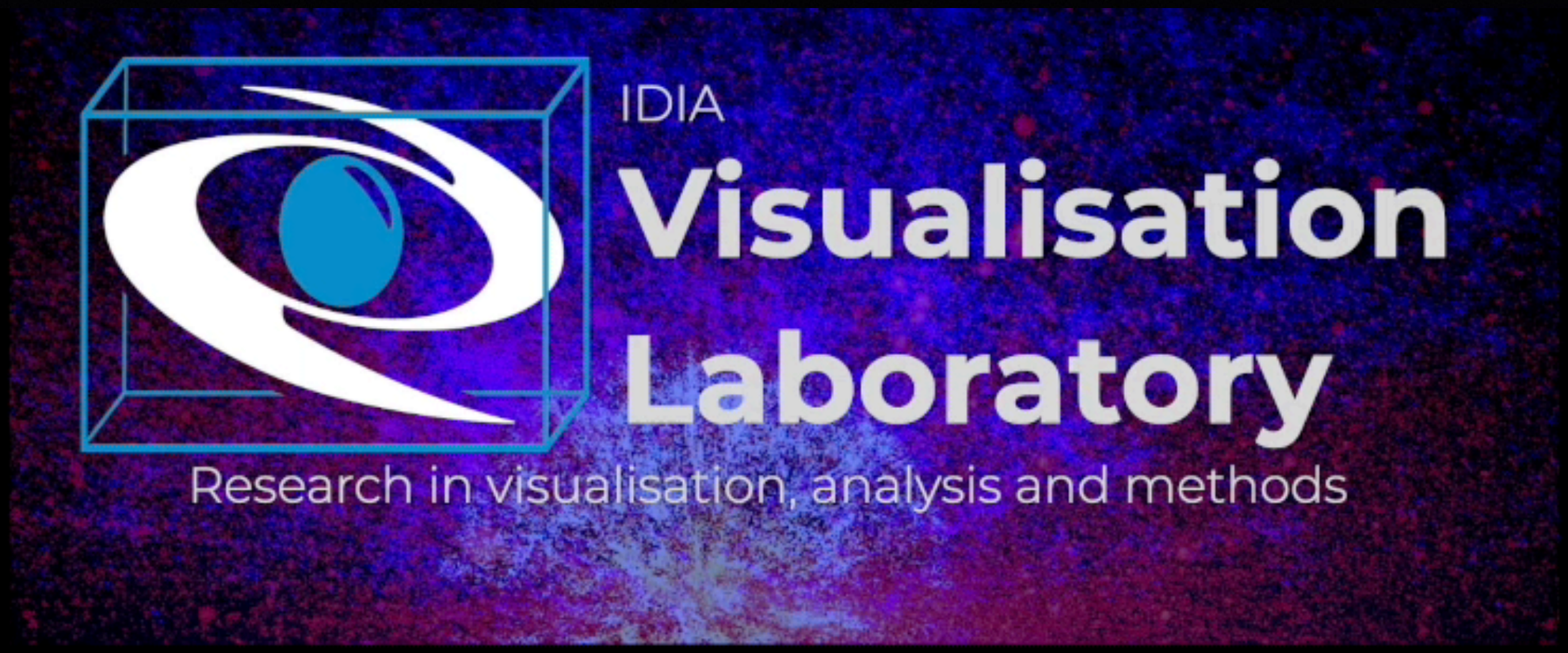

R
50.0 km/s
Y
69° 4' 14.391"
G
9h 57m 6.313s






VR View
Menu
Dock VR View
Full Screen
Type here to search
NLD
15:48
7-6-2021

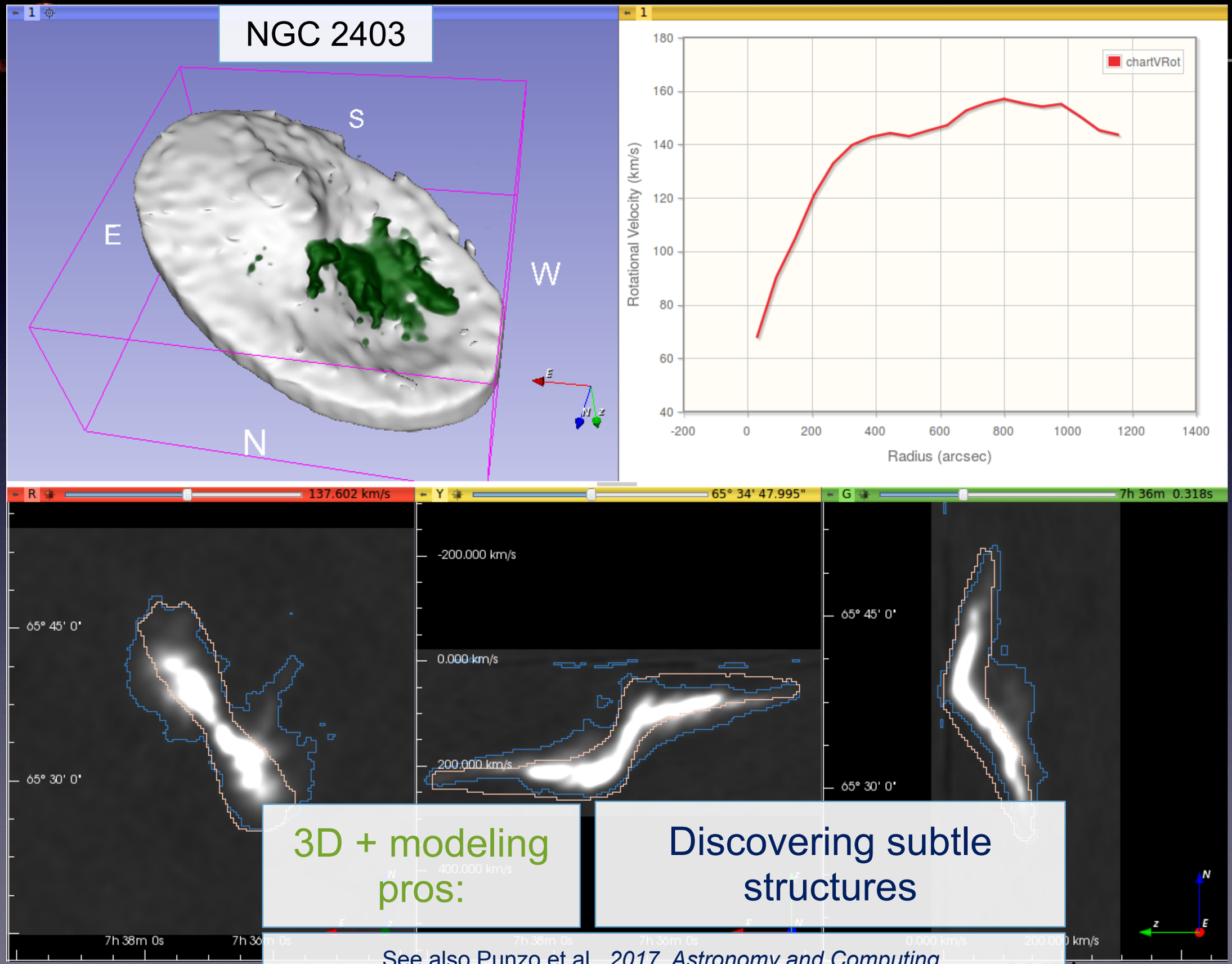




immersive Data Visualisation Interactive Explorer
(iDaVIE)

mask editing: painting

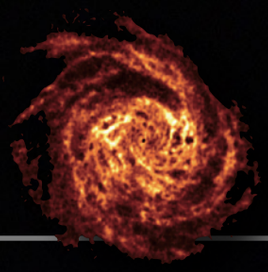
Kinematic models as masks



3D + modeling pros:

Discovering subtle structures

See also Punzo et al., *2017, Astronomy and Computing*.



Summary

- many existing viewers
- most are standalone
- some can read several different formats
- very few provide good volume rendering
- Karma probably the most versatile, despite its age
- CARTA now widely used and developed further
- SlicerAstro has added volume rendering capabilities coupled to analysis tools
- iDaVIE fills the niche of immersed cube viewing