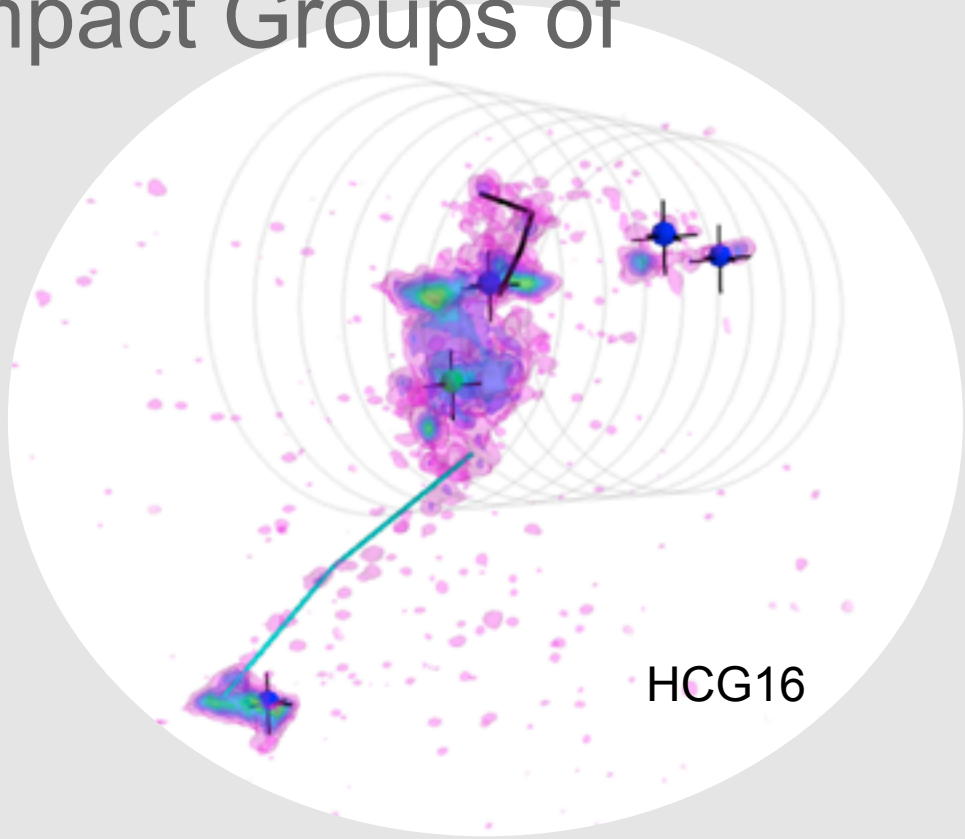
The X3D pathway applied to disentangling the HI component in Compact Groups of galaxies



Lourdes Verdes-Montenegro (IAA-CSIC)

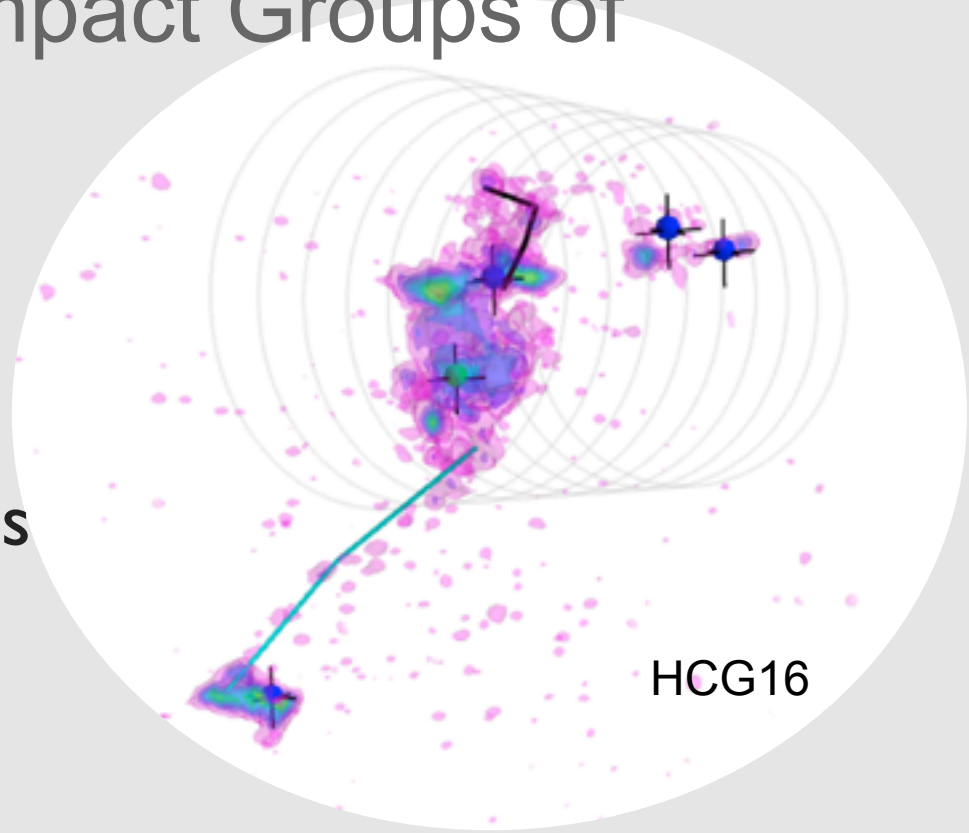
Vogt (ESO), Aubery*, Duret*, Garrido (IAA), Sanchez(IAA), Yun(UMass), Borthakur (JHU), Hess (ASTRON), Del Olmo (IAA), Perea (IAA)

* Aix-Marseille Université (Stage L3MPCI)

PHISCC - 2016, Cape Town

The X3D pathway applied to disentangling the HI component in Compact Groups of galaxies

- 3D Data Visualization & Sharing
- The X3D Pathway
- Application to Compact Groups



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3D Data Visualization & Sharing

State of the art in Astrophysics

- **Data**: 2D ---> 3D ----> Big Data (SKA)
- **Analysis**: radioastronomy community used to 3D
- **Visualization**: Definitely working on it!
- **Sharing data among teams**: Send the cube, moments maps, etc
- **Publishing** (≠ advertising):
  - Far from systematic sharing data+tools+methods
  - 2D printable diagrams

3D Data Visualization & Sharing

- **Publishing** (cont):
  - Discussions on: interactive PDFs (Barnes & Fluke'08), augmented reality (Vogt & Shingles'13), 3D Printing (Sttefen+'14)
  - **Weakness:**
    - **Largely associated to specific software**
    - ... often not open source: e.g Barnes & Fluke'08 - Adobe Acrobat Proffesional to go from 3D model to U3D**
    - risk of obsolescence (AdobeAP stopped supporting U3D)
- **Lack of actively supported format in Journals**

** U3D file format: the only suitable to include interactive 3D models in PDFs

The X3D Pathway

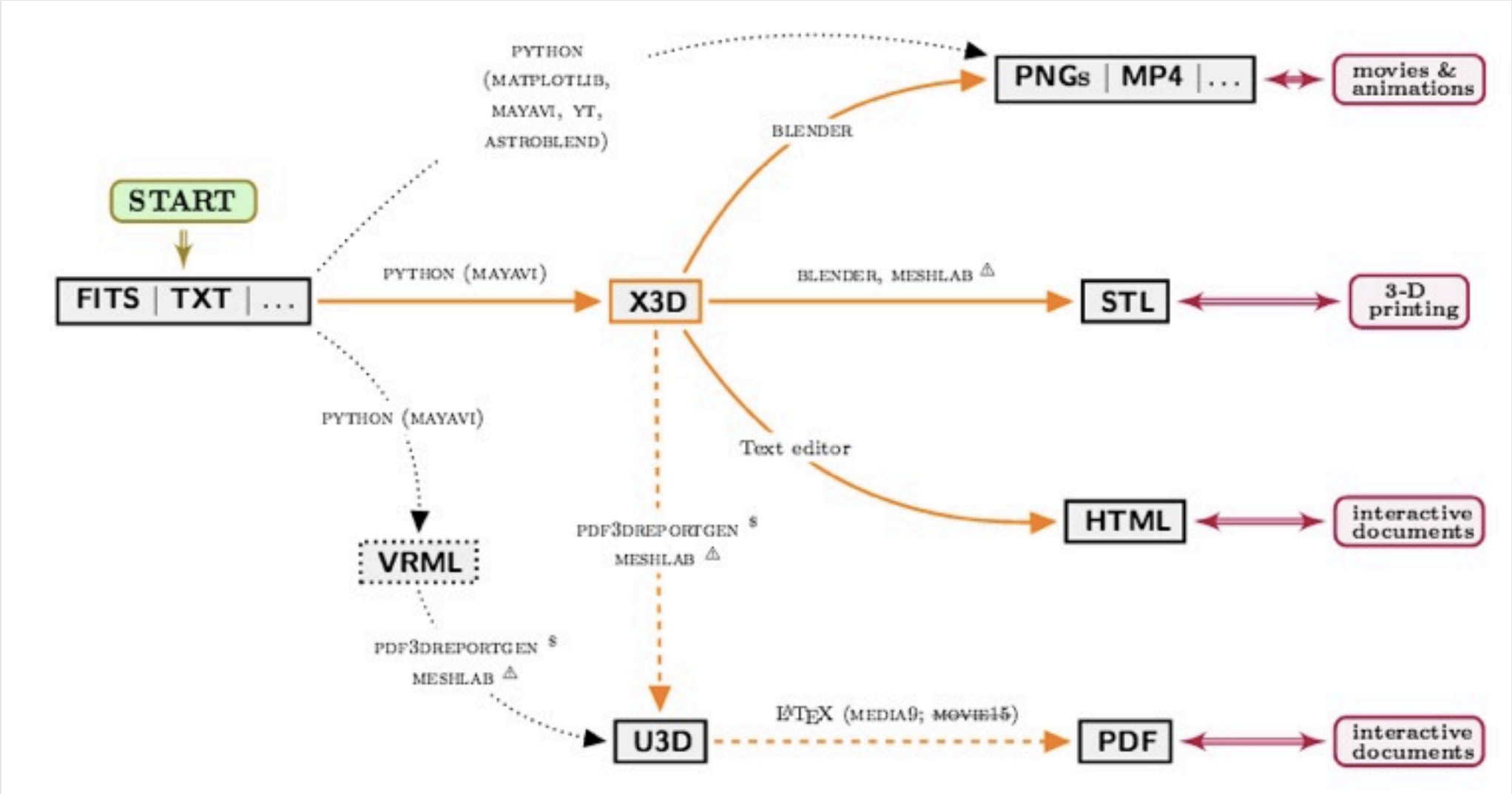
A new approach to visualize & publish multidimensional datasets using 3D diagrams

ISO ratified standard mantained by the Web3D Consortium

Web3D Cons. in contact with W.W.W. Consortium to ensure compatibility with evolving W.W.W.

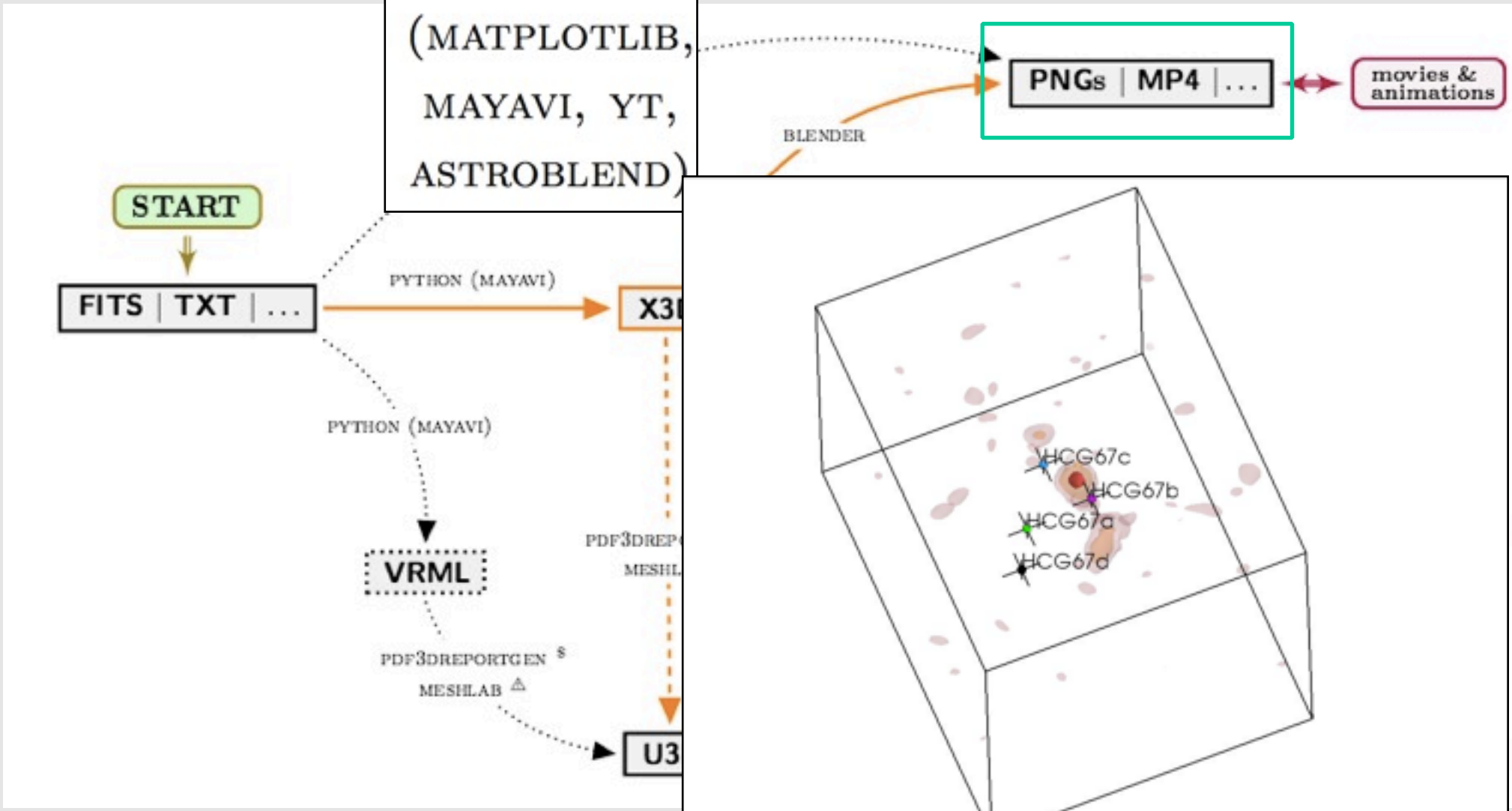
THE X3D PATHWAY

A new approach to visualize & publish multidimensional datasets using 3D diagrams

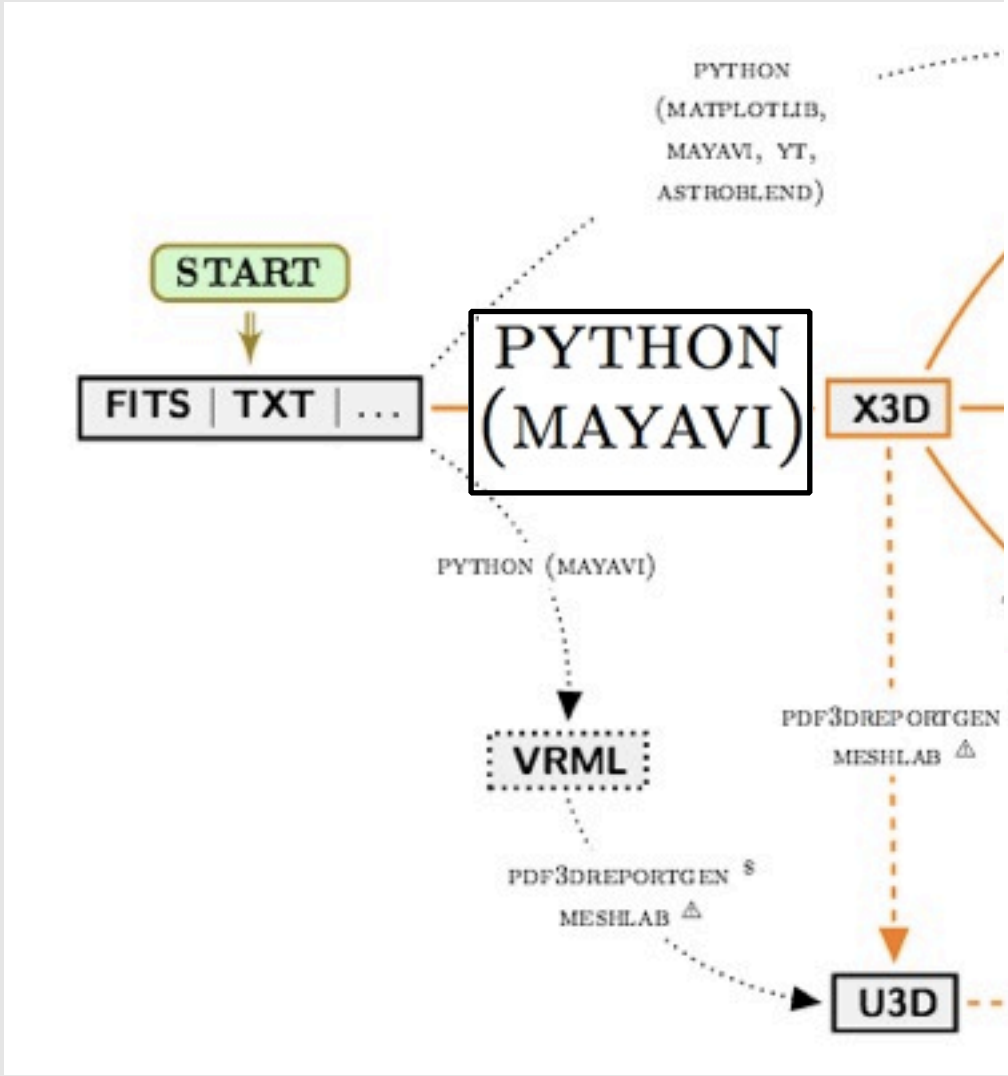


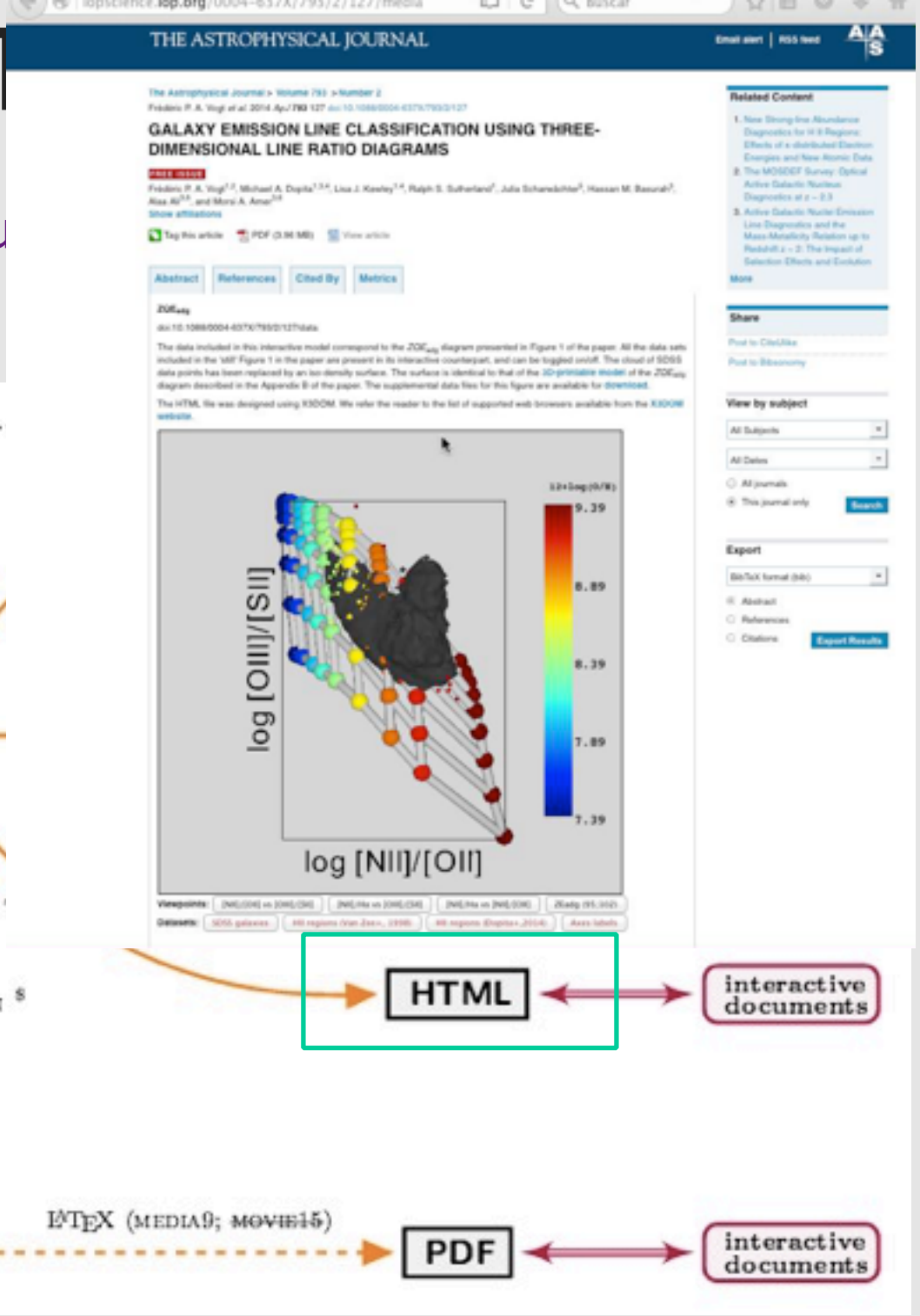
THE X3D PATHWAY

A new approach to visualize & publish multidimensional datasets using 3D diagrams

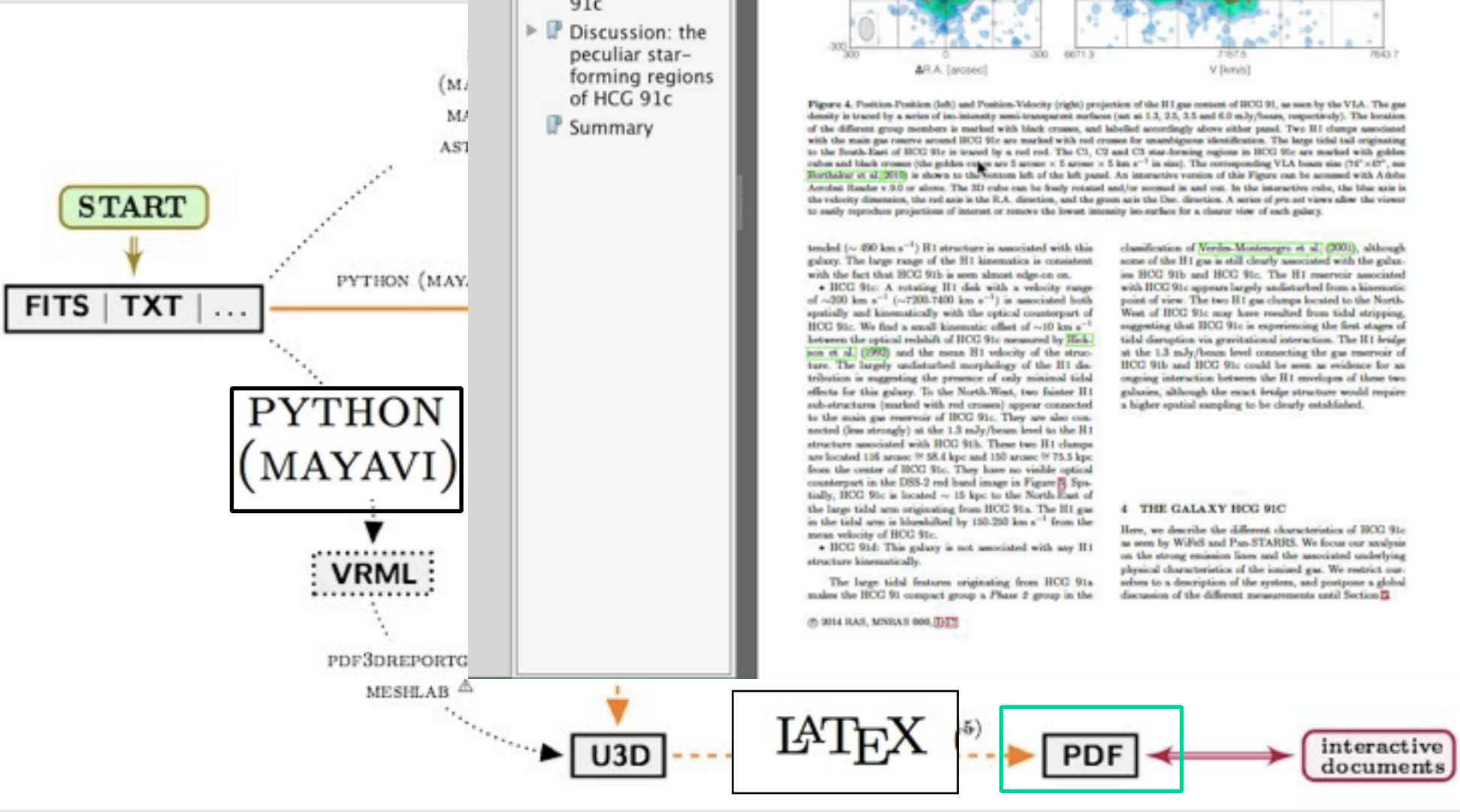


A new approach to visualize & pu
using 3D diagrams





A new approach to vis
using 3D diagrams



The X3D Pathway

arXiv.org > astro-ph > arXiv:1510.02796 In press in ApJ 2015

Astrophysics > Instrumentation and Methods for Astrophysics

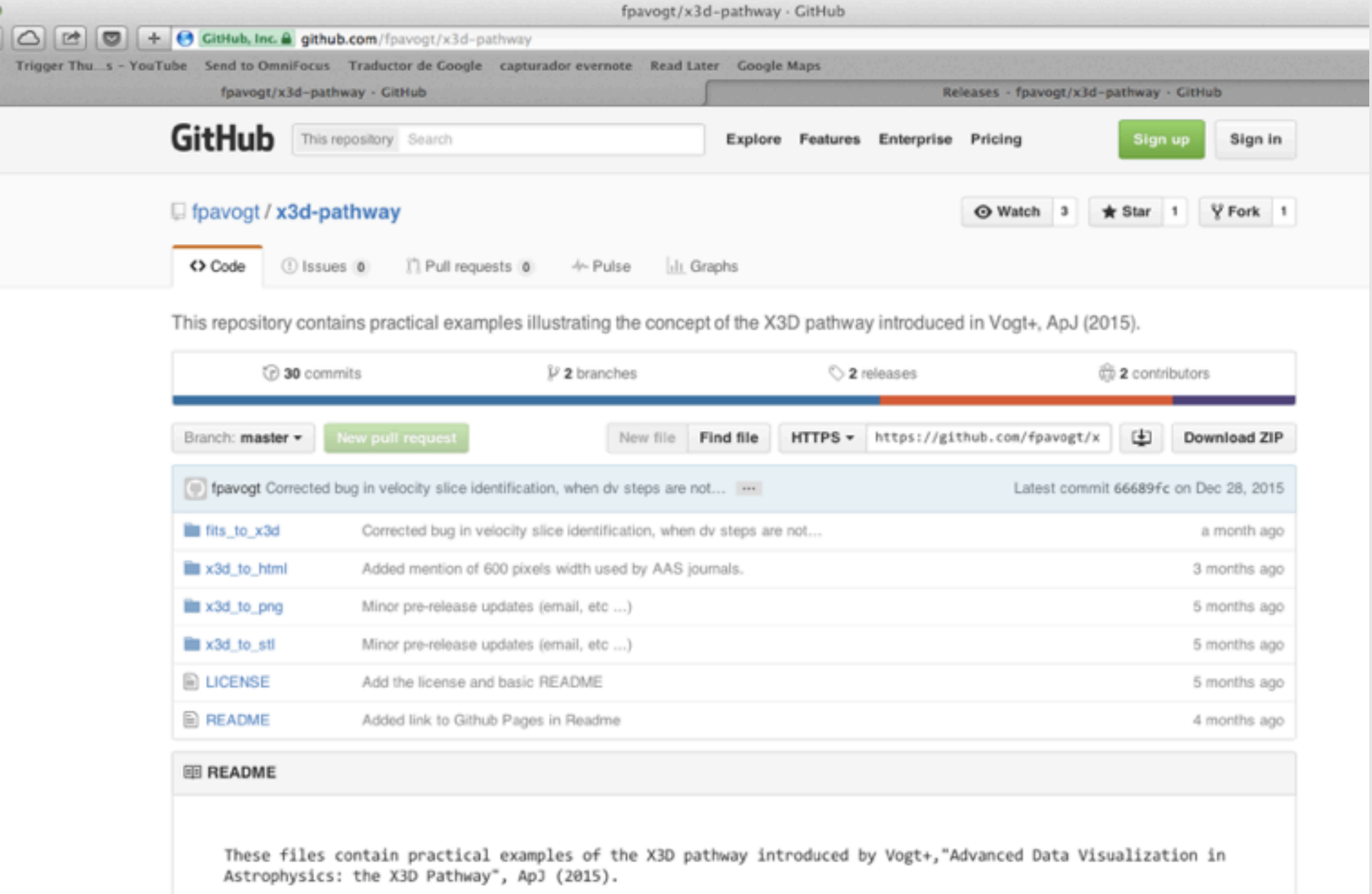
Advanced Data Visualization in Astrophysics: the X3D Pathway

F. P. A. Vogt, C. I. Owen, L. Verdes-Montenegro, S. Borthakur

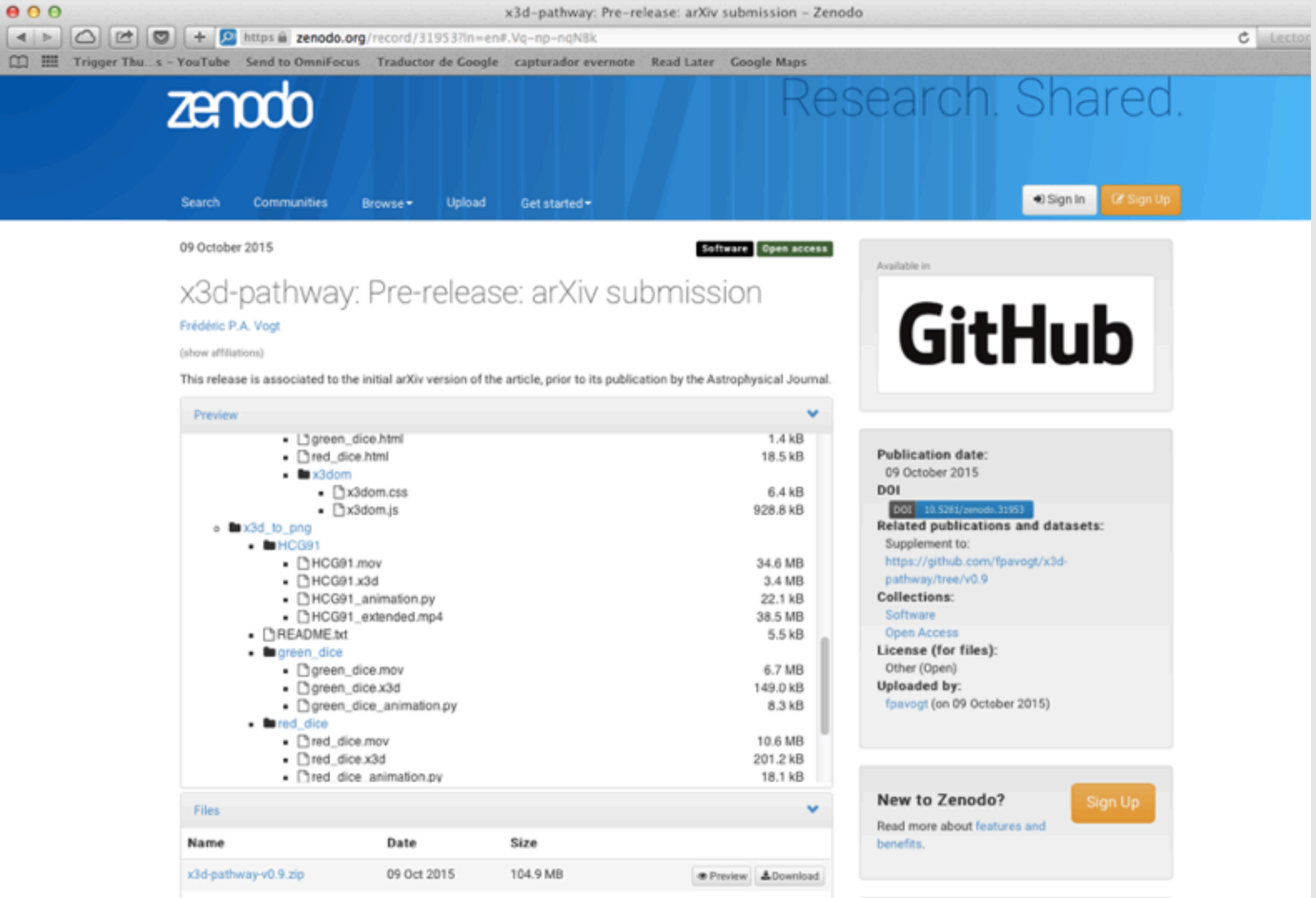
- Many scripts & examples included
- Designed as stepping stones
- Many interactions with AAS journals
- Use of **GitHub** and **Zenodo** to attach a **DOI** to the code, and make everything lost-lasting and citable

The X3D Pathway Features

Completely Open Source



THE X3D PATHWAY FEATURES



The X3D Pathway Features

Compatible with mainstream software

Including:

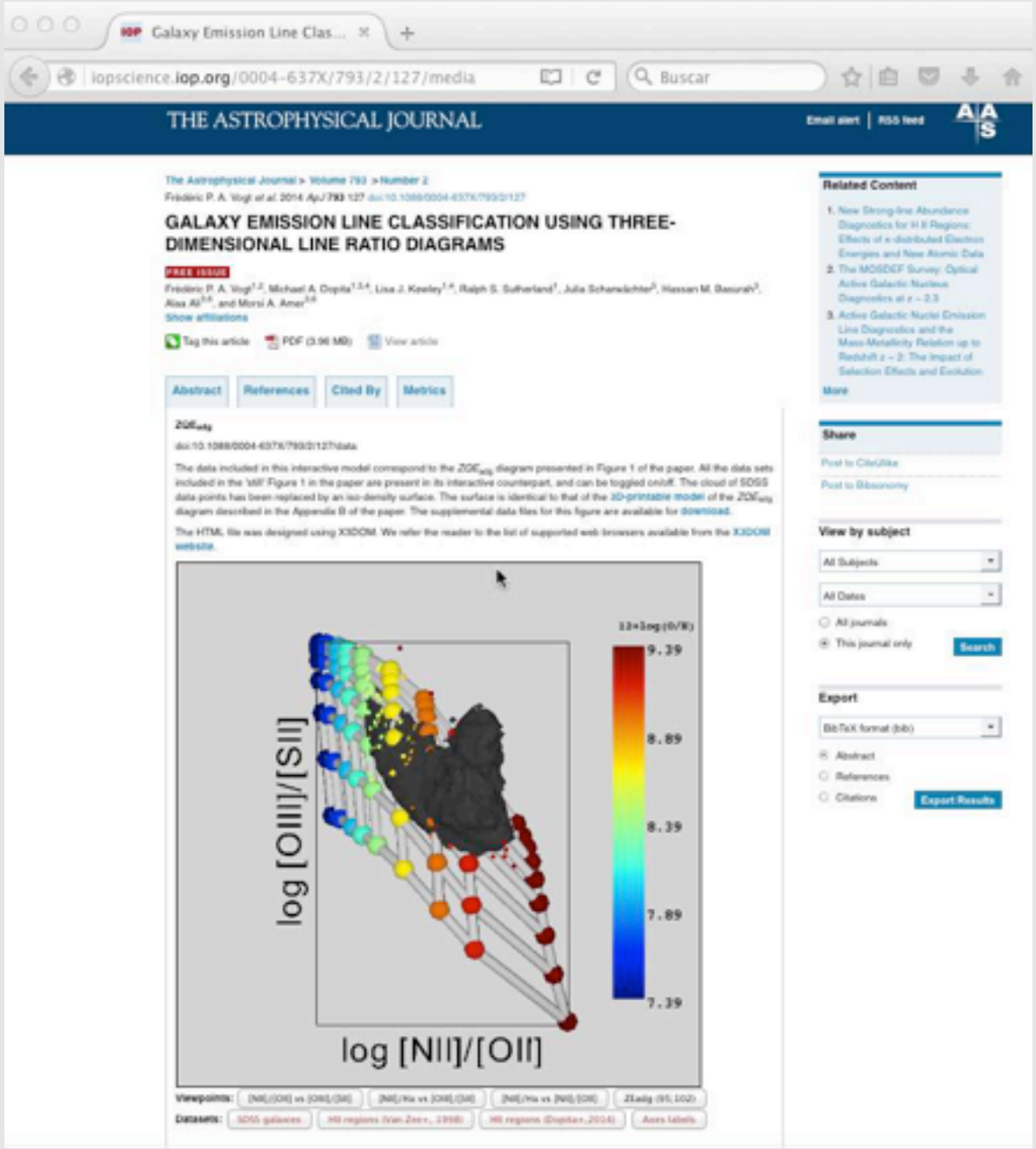
Python

- Matplotlib
- Mayavi

HTML

BLENDER

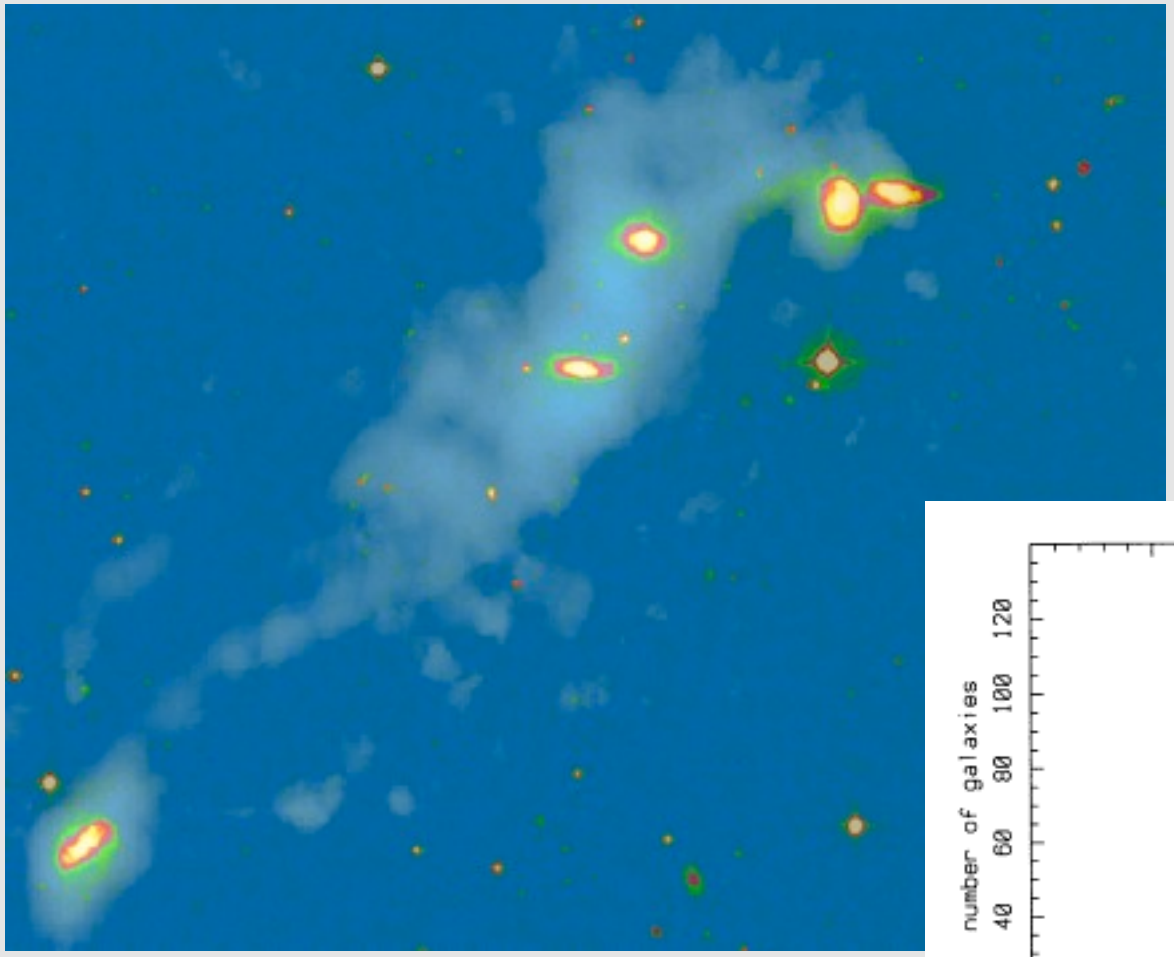
The X3D Pathway Features



Supported and encouraged by top astro journals

http://iopscience.iop.org/0004-637X/793/2/127/media

Application to Compact Groups



- 4-10 members
- as dense as cluster centers
- low vel. dispersion

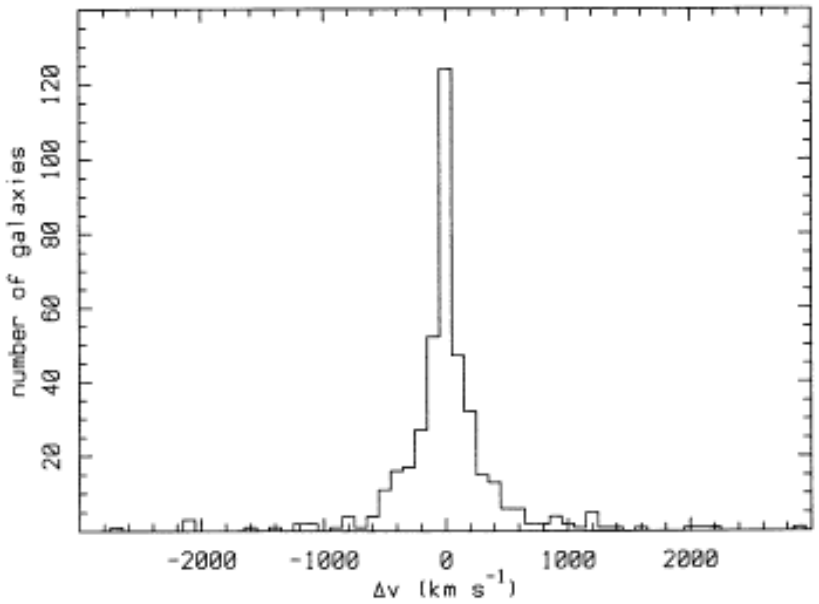
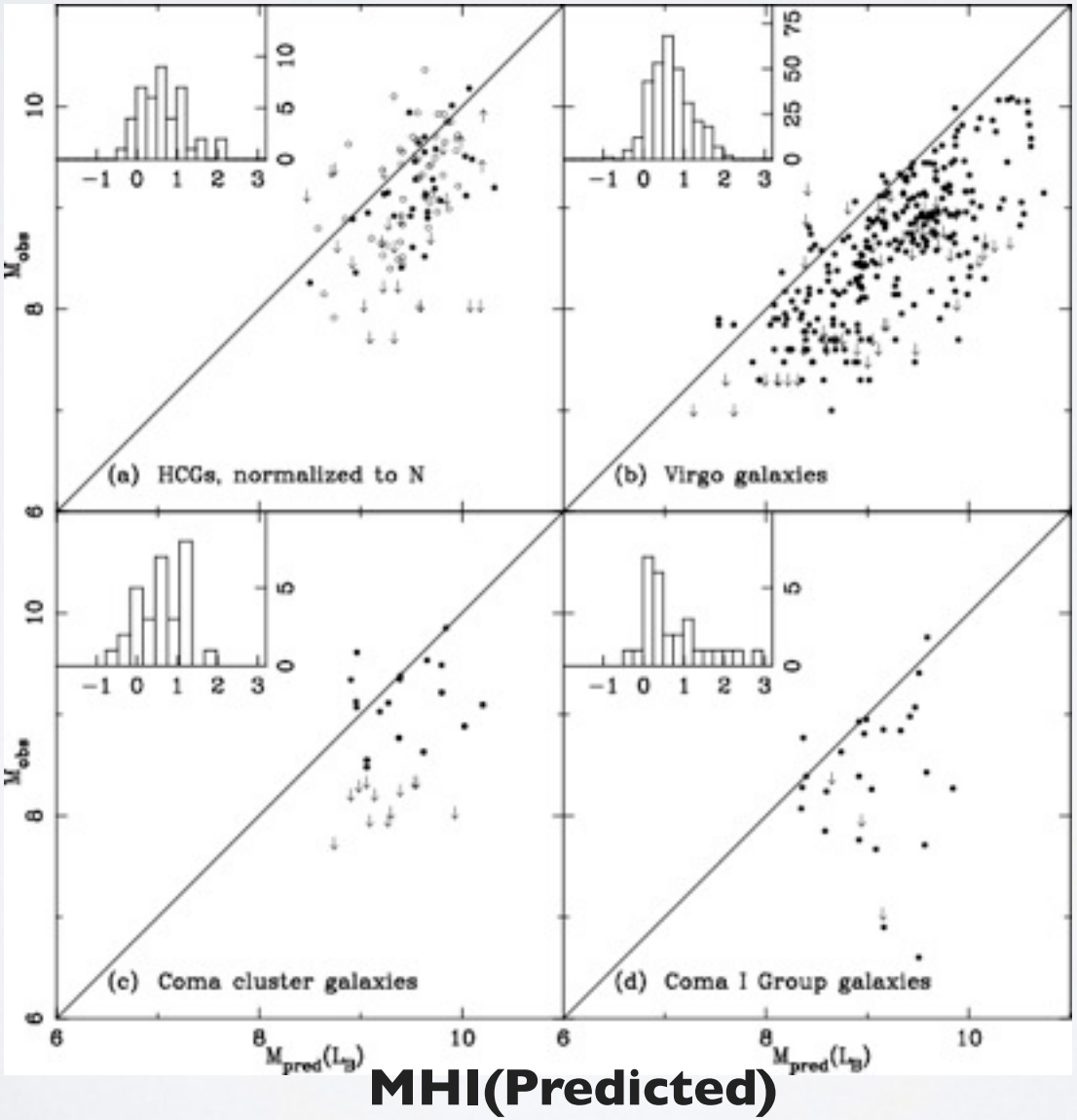


FIG. 1.—Distribution of galaxy velocities with respect to the median velocity of all cataloged galaxies in the same group.

COMPACT GROUPS OF GALAXIES

HI deficiency of groups similar to Virgo or Coma clusters

Single dish analysis of 72 Hickson Compact Groups (Verdes-Montenegro et al 2001)



- Data from Williams & Rood 1987, Huchtmeier 1997)

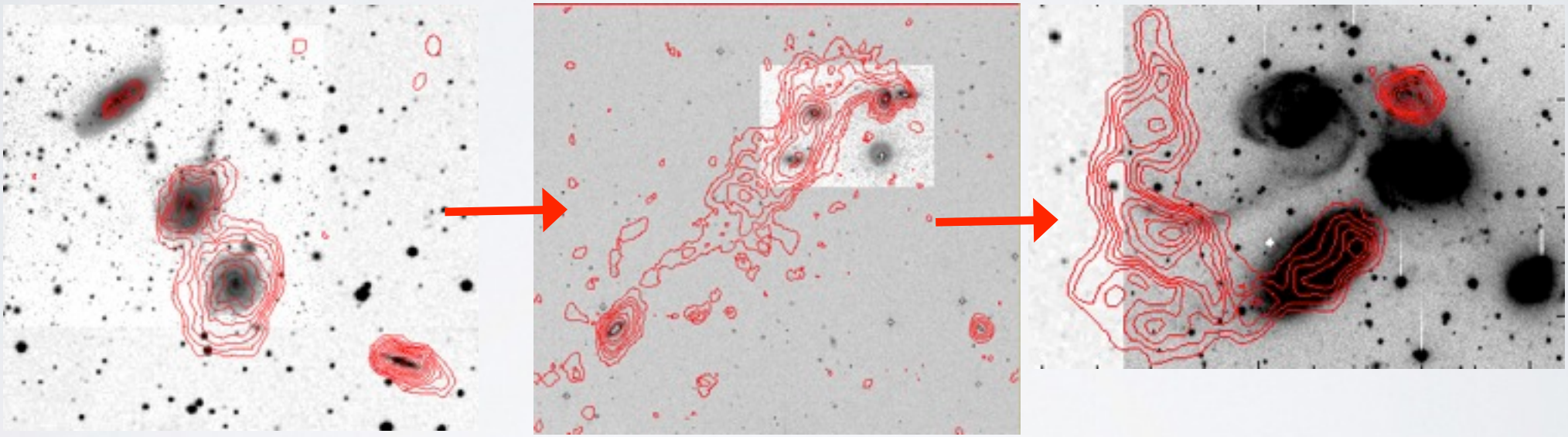
Compact Groups Of Galaxies

VLA study of 26 Hickson Compact Groups (Verdes-Montenegro et al 2001, 2007)

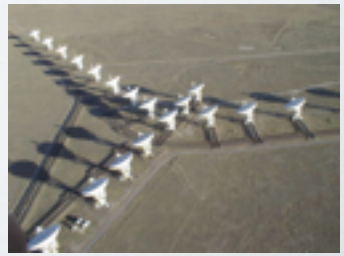
Phase 1: Low level of interaction

Phase 2: Gas in tidal features

Phase 3. No HI in the galaxies



Evolutionary model: amount of detected HI decreases further with evolution, by continuous tidal stripping



COMPACT GROUPS OF GALAXIES

VLA study of 26 Hickson Compact Groups (Verdes-Montenegro et al 2001, 2007)

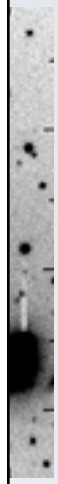
Phase 1: Low level of interaction

Phase 2: Gas in tidal features

Phase 3. No HI in the galaxies

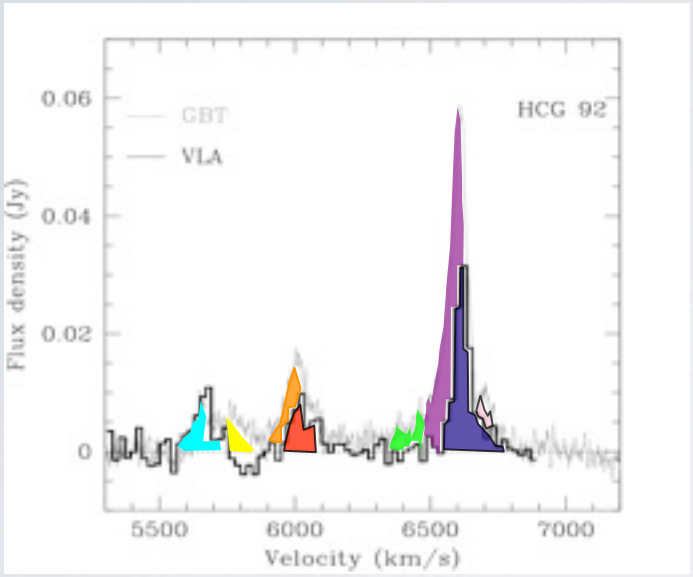
Follow-up studies of the model, among others:

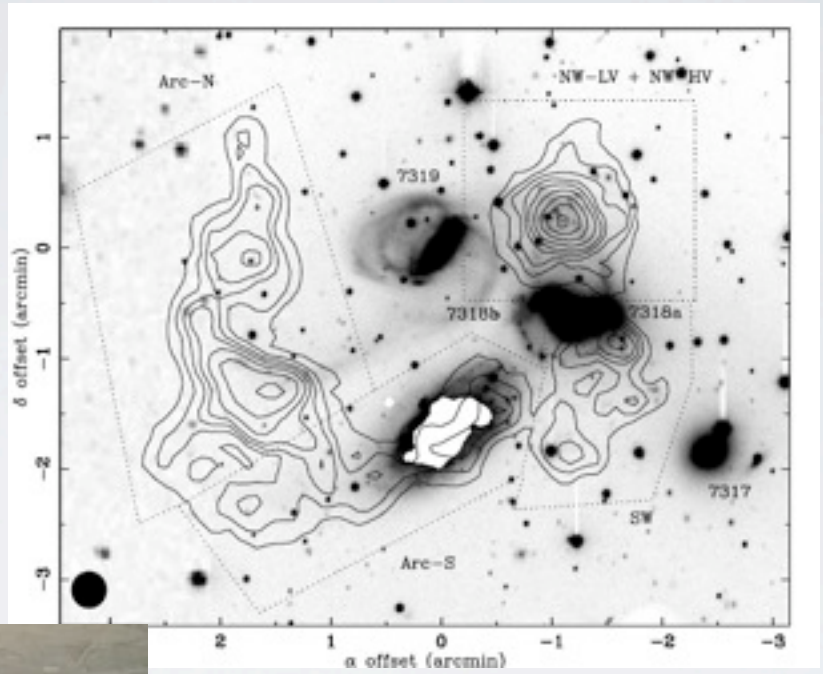
- X-rays (XMM, Chandra; Rasmussen+ 08)
- MIR (Spitzer; Cluver+ 13)
- MIR, UV (Swift, Spitzer -Tzanavaris+ 10, Bitzakis+10)
- Molecular gas (30m - Martínez-Badenes+12; CARMA - Alatalo+15)
- HI GBT (Borthakur et al 2010, 2015)



COMPACT GROUPS OF GALAXIES

- Squeezing current HI data





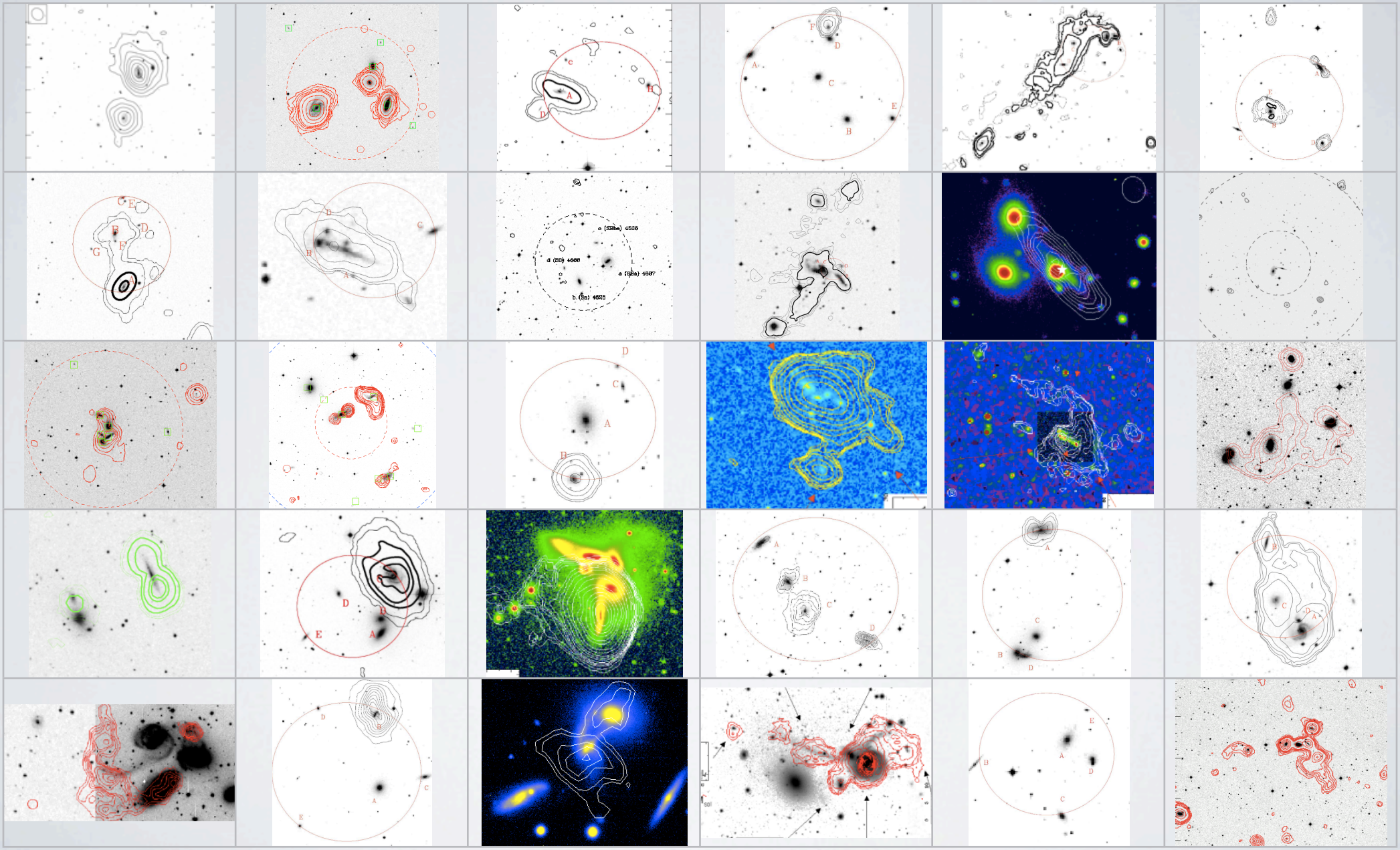
N(HI) = 5 x 10^19 cm-2

VLA C+CnB+D (20")

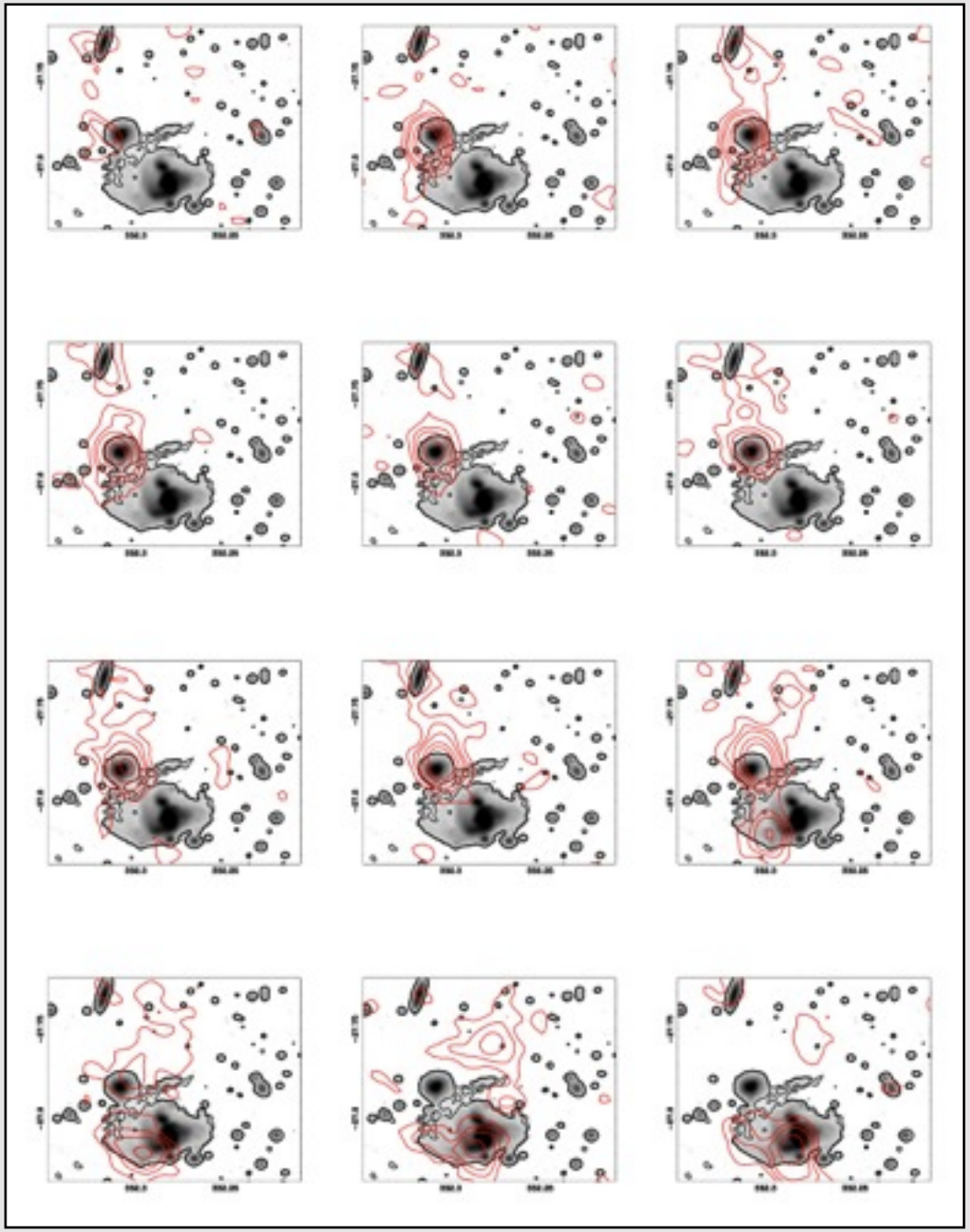
- GBT: diffuse HI component missed by the VLA
  - increasing with evolutionary stage, more consistent with tidal stripping than with ram-pressure, and spread over a velocity range of more than 1000 km/s.
    - Borthakur+ (2010,2014)

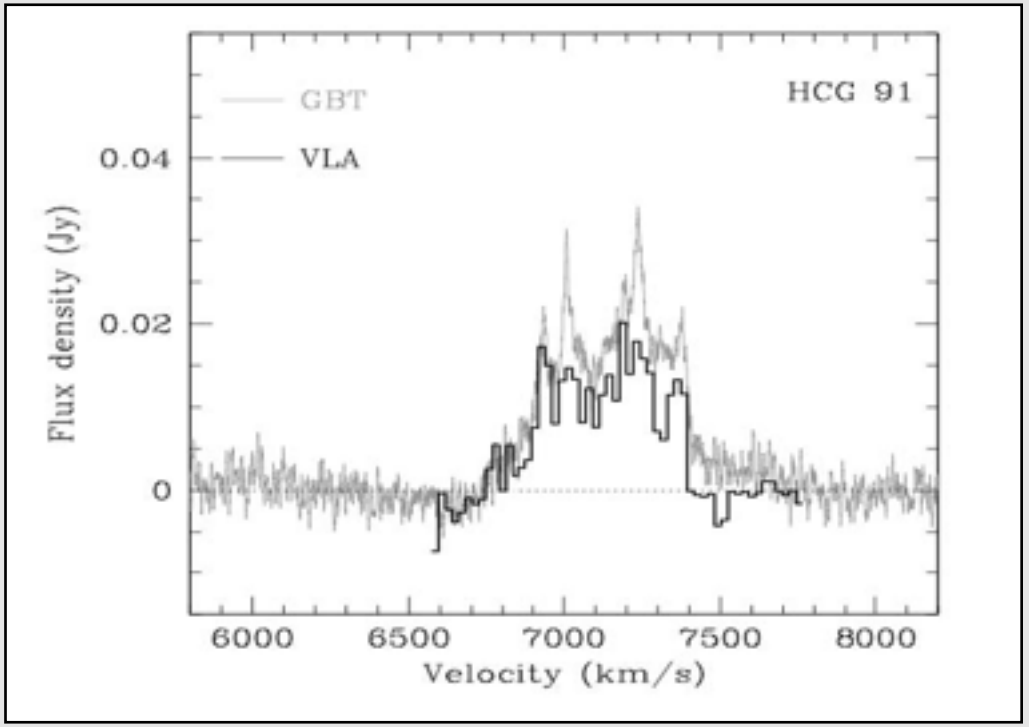
Compact Groups Of Galaxies

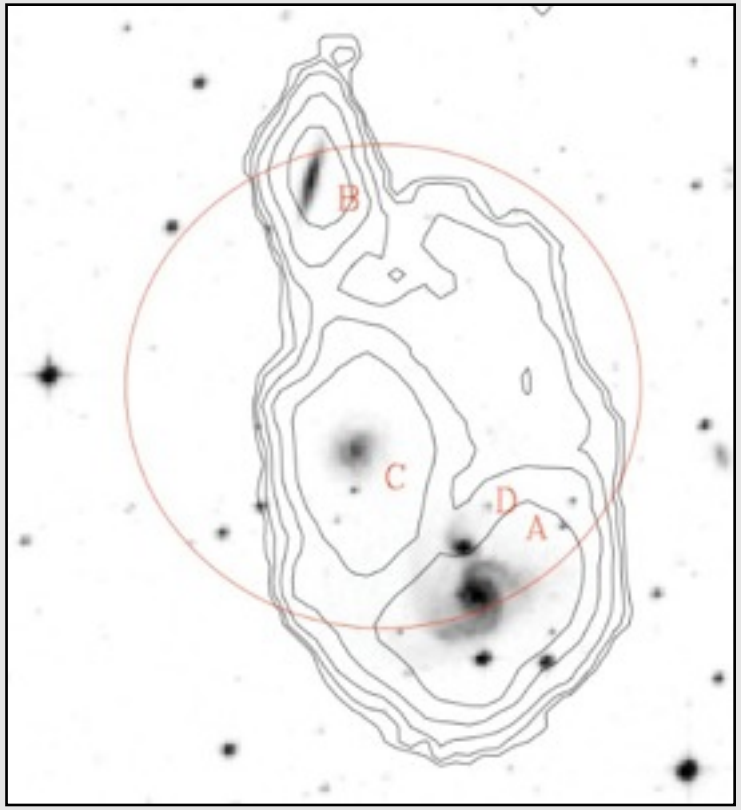
- VLA HI data available for 37 HCGs



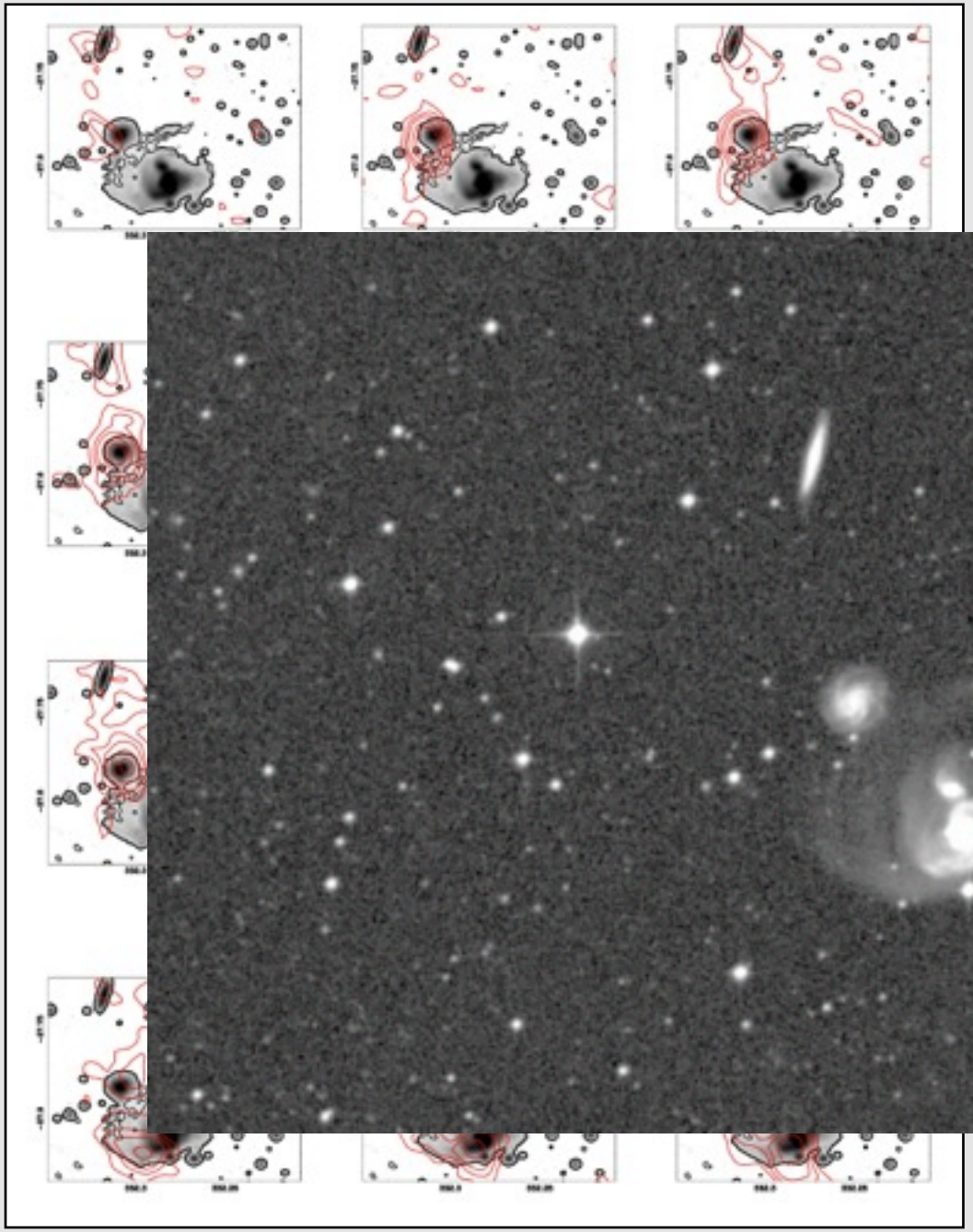
Verdes-M, Yun, Borthakur, archive

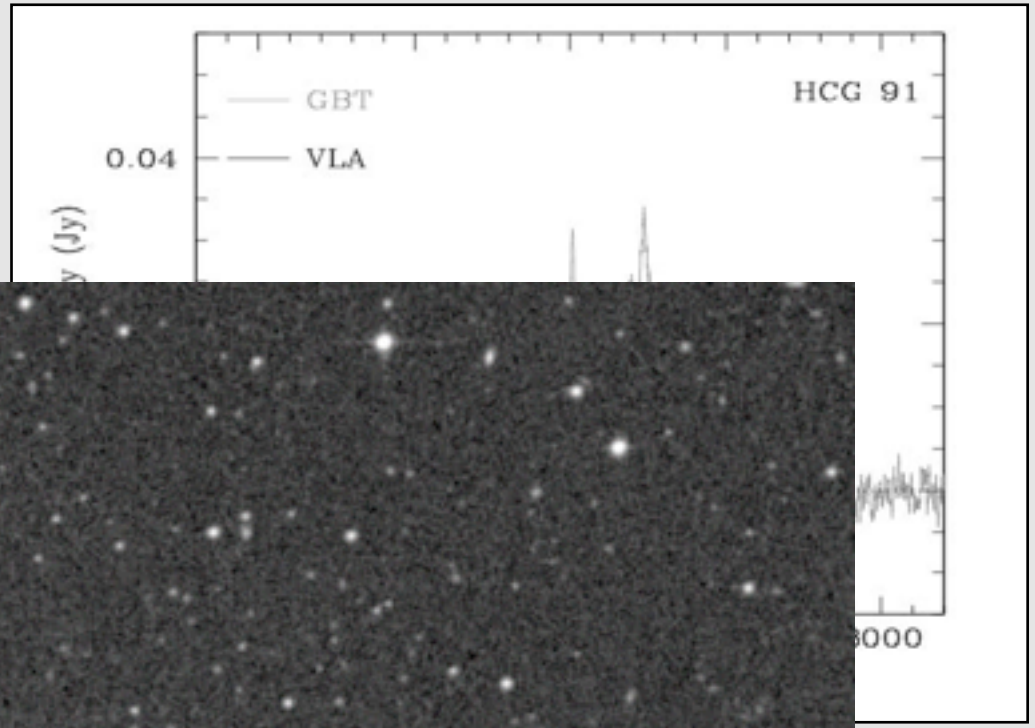



GBT
VLA
HCG 91
0.04
0.02
0
Flux density (Jy)
6000
6500
7000
7500
8000
Velocity (km/s)

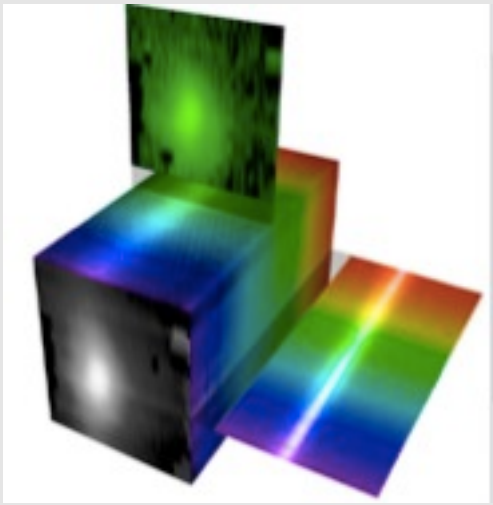

B
C
D
A

HCG 91





HCG 91



1	3280.6
2	3238.5
3	3196.4
4	3154.3
5	3112.2
6	3070.1
7	3028.0
8	2986.0
9	2943.9
10	2901.9
11	2859.9
12	2817.9
13	2775.9
14	2733.9
15	2692.0
16	2650.0
17	2608.1
18	2566.1
19	2524.2
20	2482.3
21	2440.4
22	2398.5
23	2356.6
24	2314.8
25	2272.9
26	2231.1
27	2189.2
28	2147.4
29	2105.6
30	2063.8

```
62 plot_loc = './'
63
64 # Open the FITS file from the VLA
65 hdulist=pyfits.open('./data/HCG91.fits')
66
67 # Load the array
68 # It must be scaled to a 'reasonable' range to avoid small number issues.
69 scidata = hdulist['PRIMARY'].data[0] * 1000.
70 header = hdulist['PRIMARY'].header
71
72 # Load the correspondance between channels and velocity
73 c_v = np.loadtxt('./data/HCG91.dat')
74
75 # Extract some useful parameters
76 n_slice=scidata.shape[0]
77 size_y=scidata.shape[1]
78 size_x=scidata.shape[2]
79 hdulist.close()
80
81 # Define the min and max velocity slice of interest (no HI outside these)
82 slice_min = 5
83 slice_max = 50
84
85 # Define the x/y limits (in pixels; no HI signal outside these)
86 limx = [100,160]
87 limy = [105,165]
88
89 # Extract some more parameters of the datacube, and run some safety checks
90 dv = np.mean(c_v[:-1,1] - c_v[1:,1])
91 stdv = np.std(c_v[:-1,1] - c_v[1:,1])
92 vmin = c_v[slice_max,1]
93 vmax = c_v[slice_min,1]
94
95 # The galaxies in the field RA,DEC,v,z
96 # From Hickson (1992)
97 gals = {'hcg91a':{'ra':[22,9,07.7],
98                   'dec':[-27,48,34.0],
99                   'v':6832.},
100        'hcg91b':{'ra':[22,9,16.3],
101                  'dec':[-27,43,49.0],
102                  'v':7196.},
103        'hcg91c':{'ra':[22,9,14.0],
104                  'dec':[-27,46,56.0],
105                  'v':7319.},
106        'hcg91d':{'ra':[22,9,08.4],
107                  'dec':[-27,48,02.0],
108                  'v':7195.},
109    }
```

RANGES

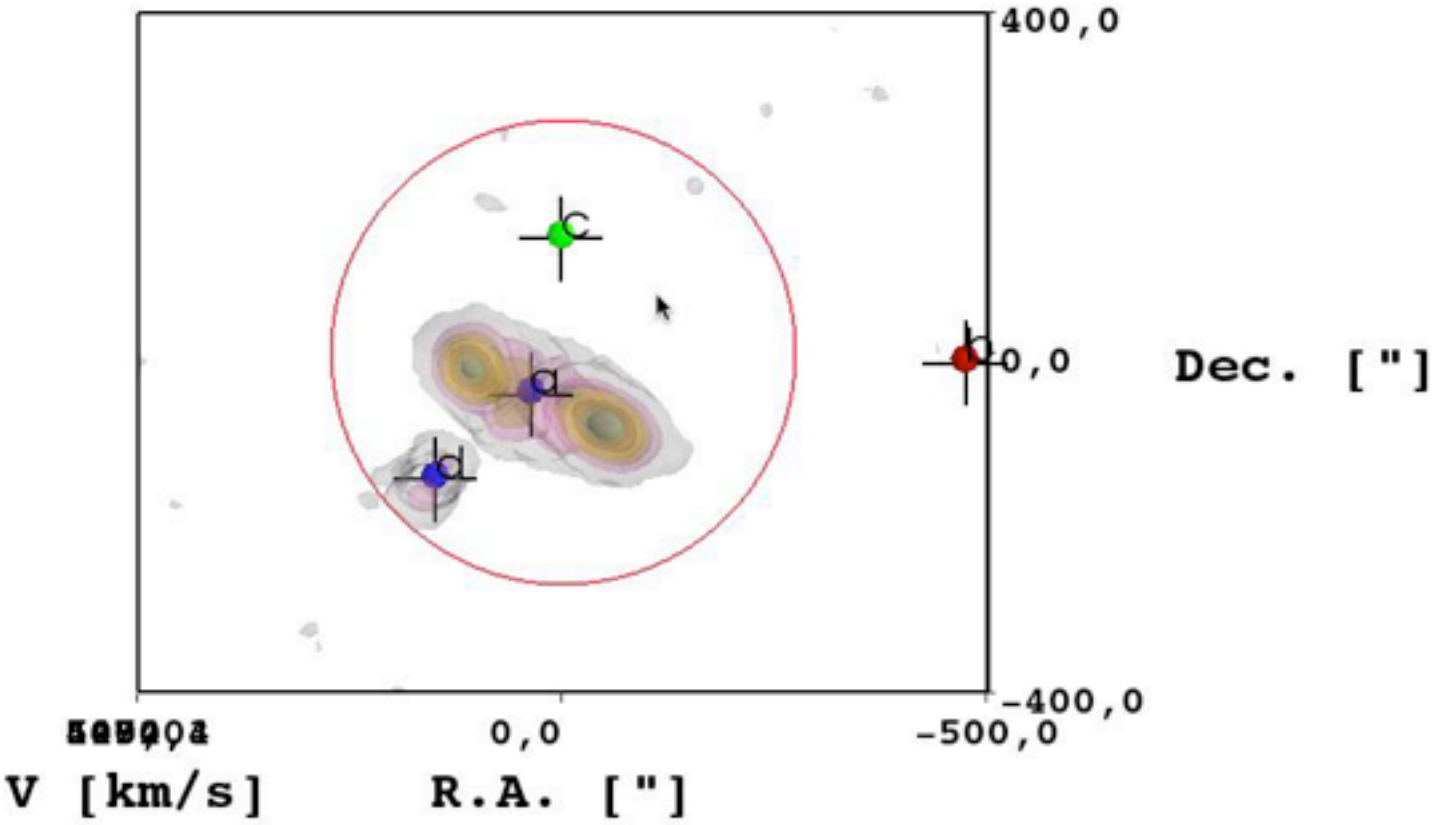
POSITIONS, SYMBOLS

LEVELS, COLORS...

PYTHON CODE --> X3D

Mayavi Scene 1

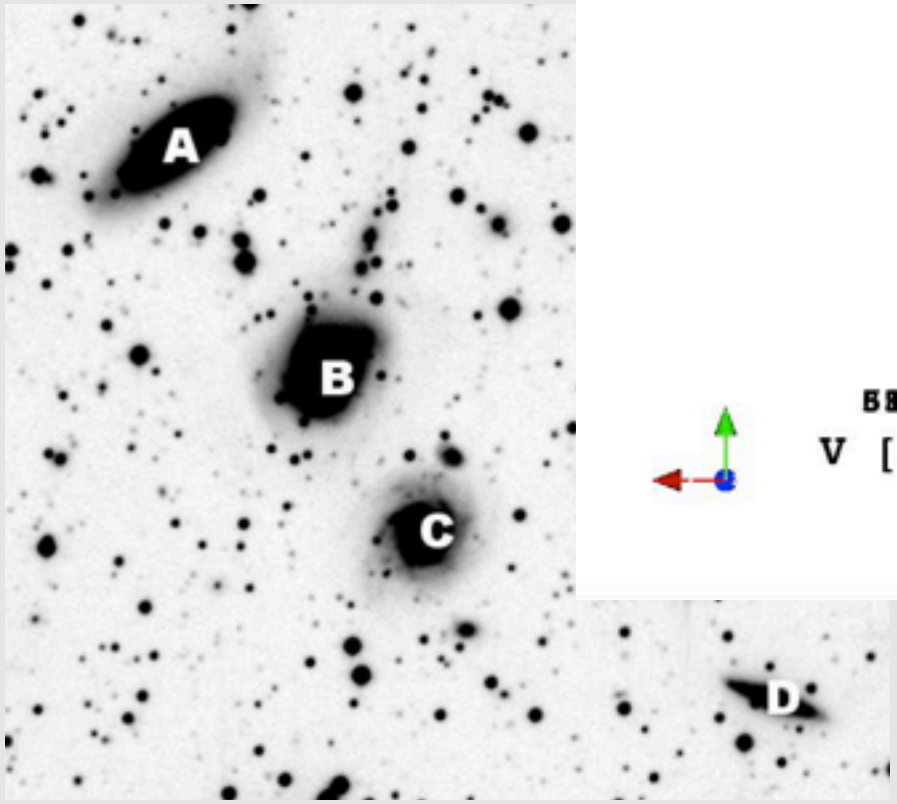
HCG 10

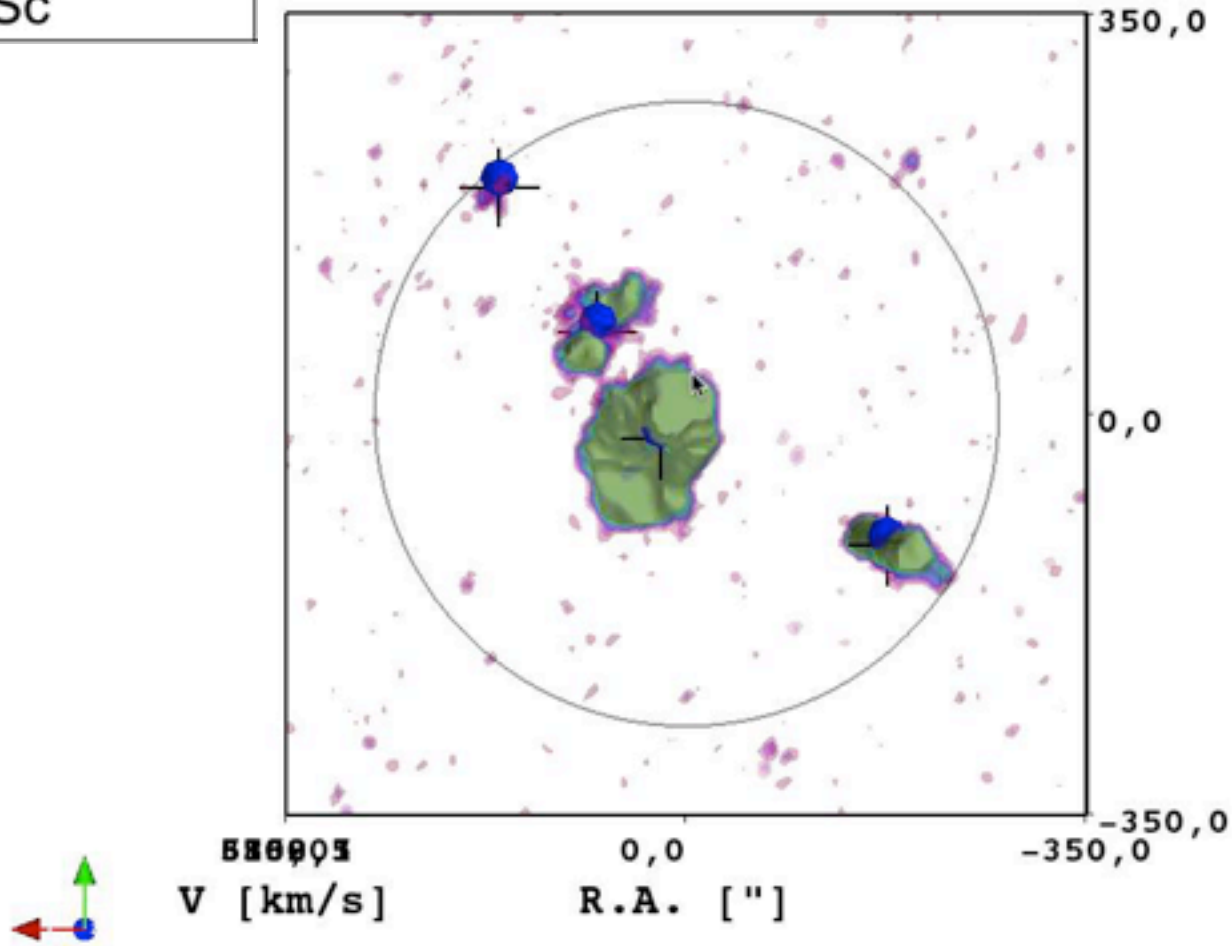


HCG 88

DEC -5

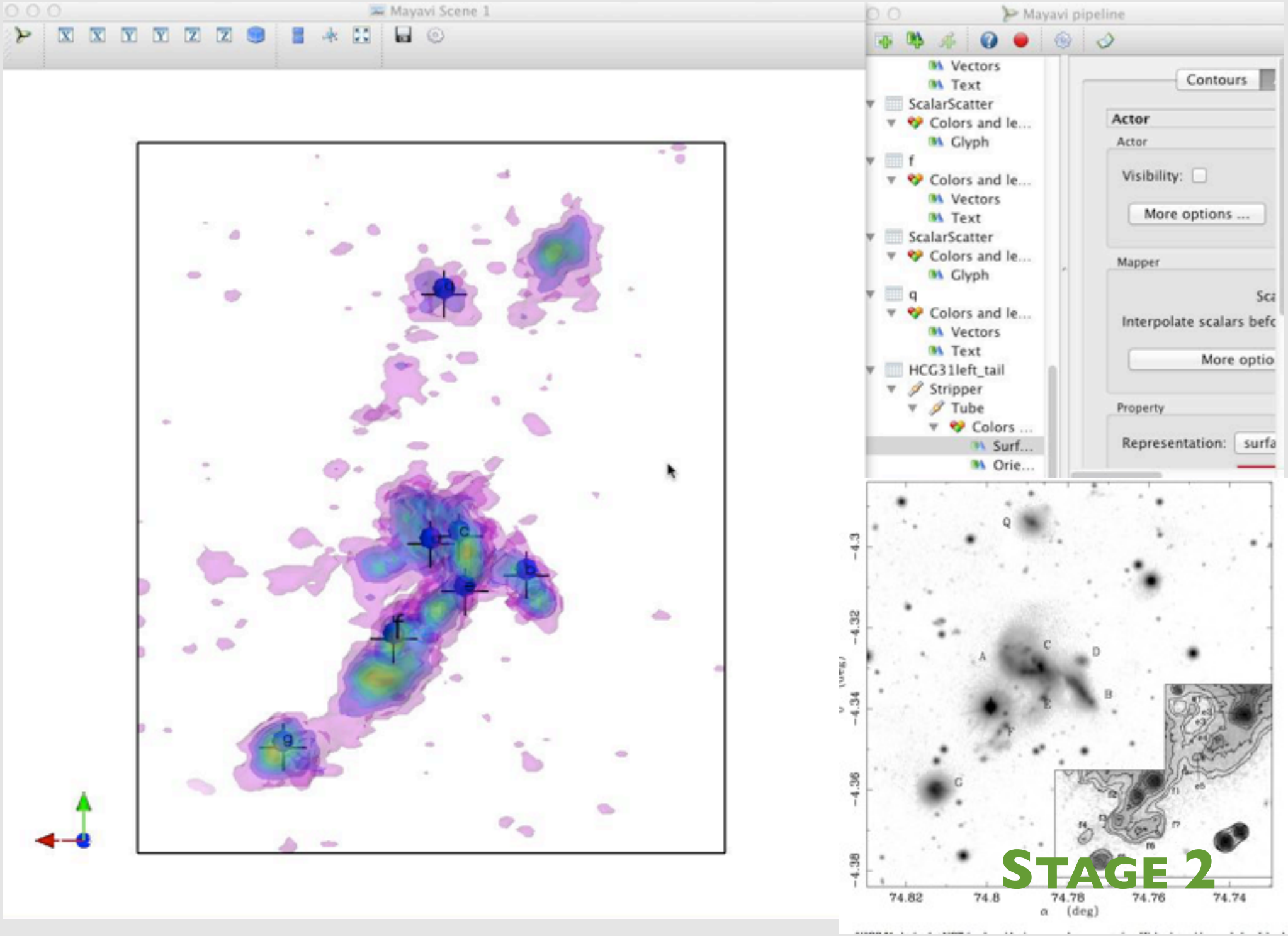
HCG88a	Sb
HCG88b	SBa
HCG88c	SABbc
HCG88d	Sc

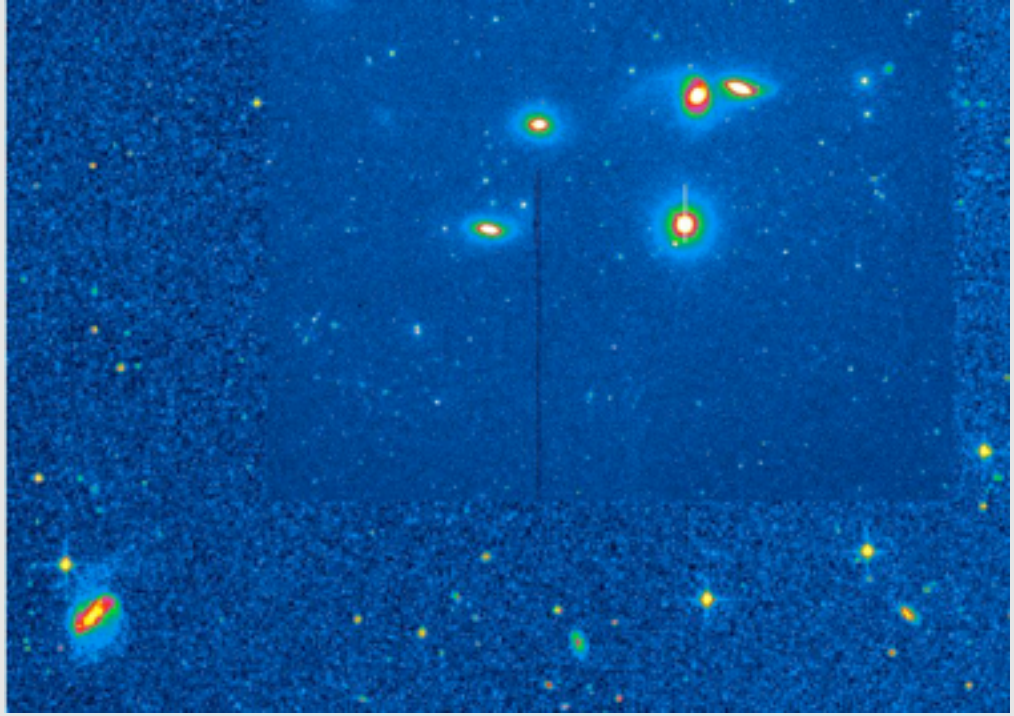




STAGE I

HCG 31 DEC -4

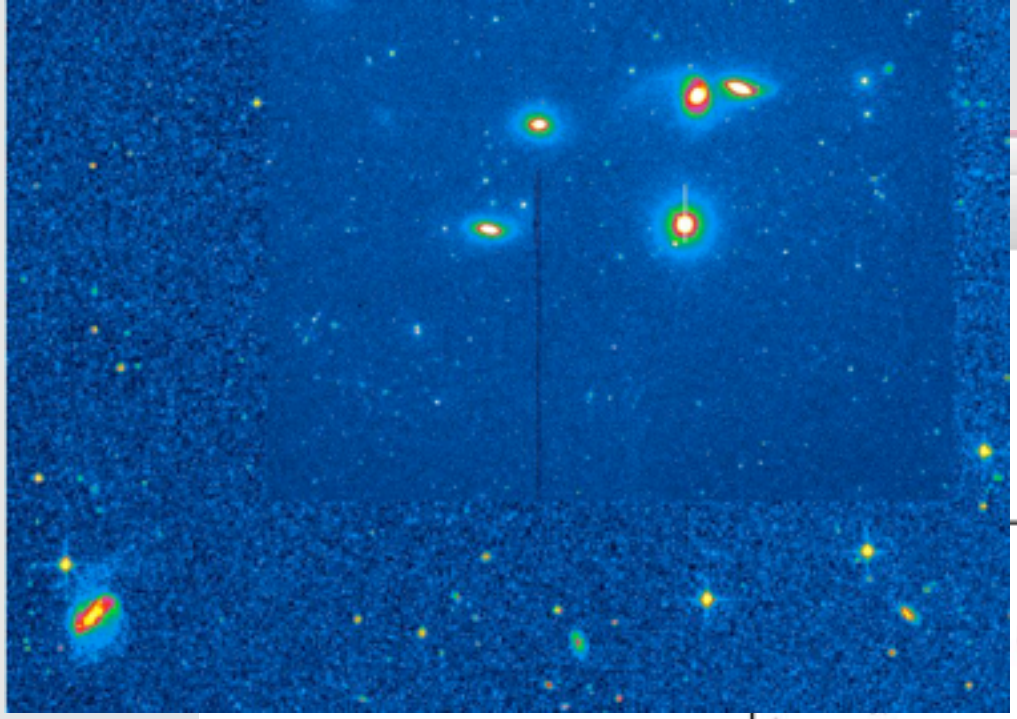

Mayavi Scene 1
Mayavi pipeline
Vectors
Text
ScalarScatter
Colors and le...
Glyph
f
Colors and le...
Vectors
Text
ScalarScatter
Colors and le...
Glyph
q
Colors and le...
Vectors
Text
HCG31left_tail
Stripper
Tube
Colors ...
Surf...
Orie...
Contours
Actor
Actor
Visibility:
More options ...
Mapper
Interpolate scalars befc
More optio
Property
Representation:
surfa
Q
A
C
D
B
E
F
G
-4.3
-4.32
-4.34
-4.36
-4.38
74.82
74.8
74.78
74.76
74.74
α (deg)
STAGE 2

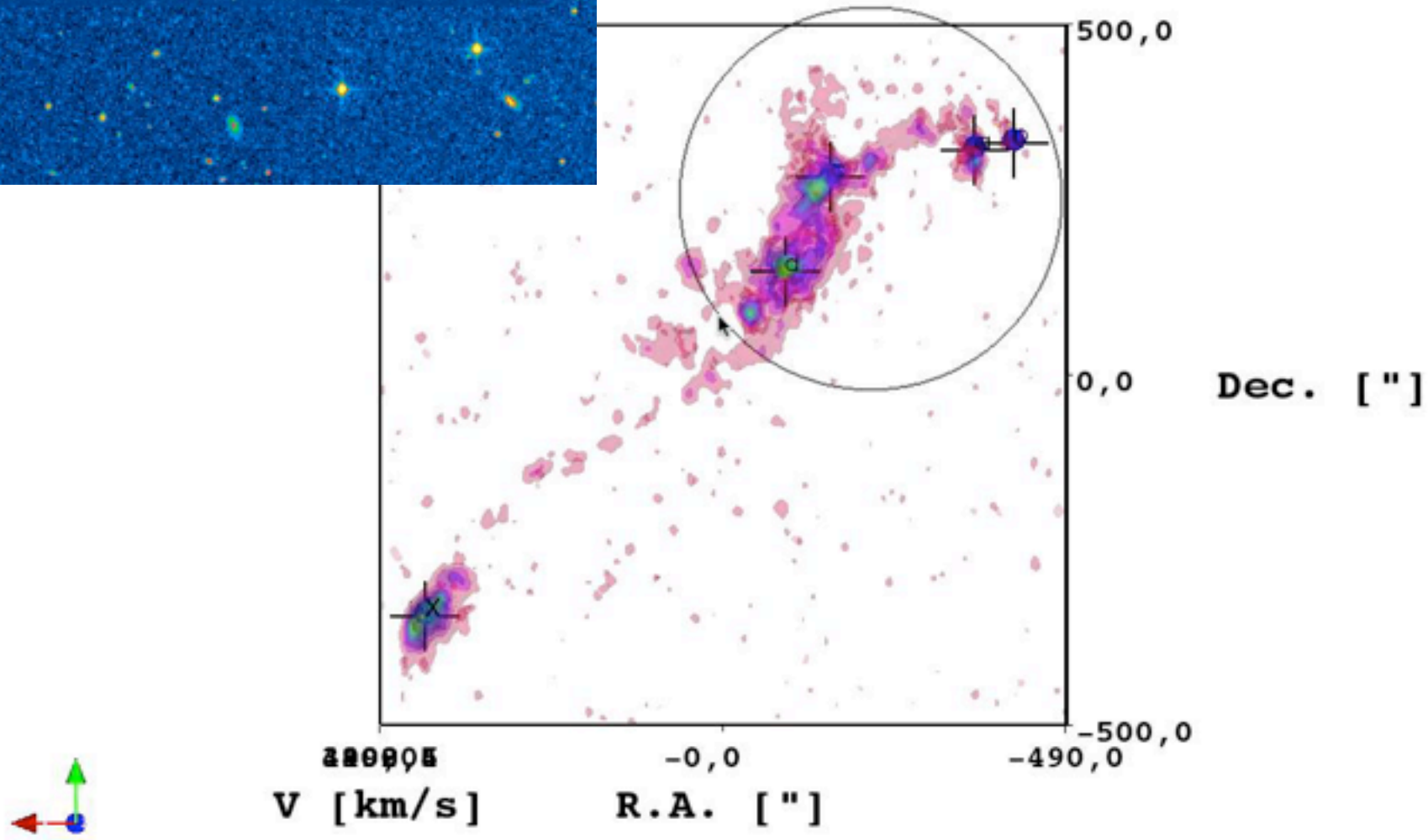


HCG 16, DEC -10

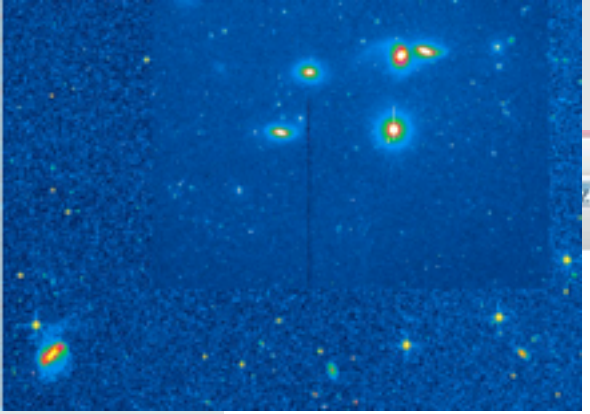
STAGE 2

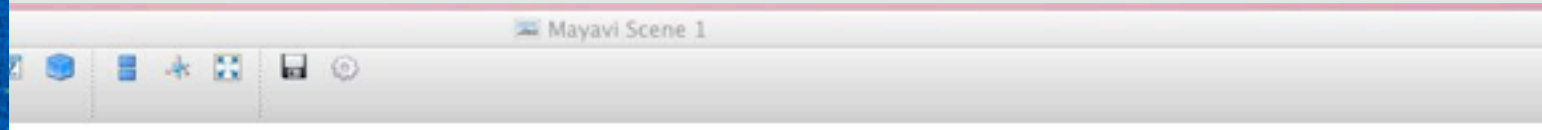
HCG 16, DEC -10

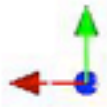


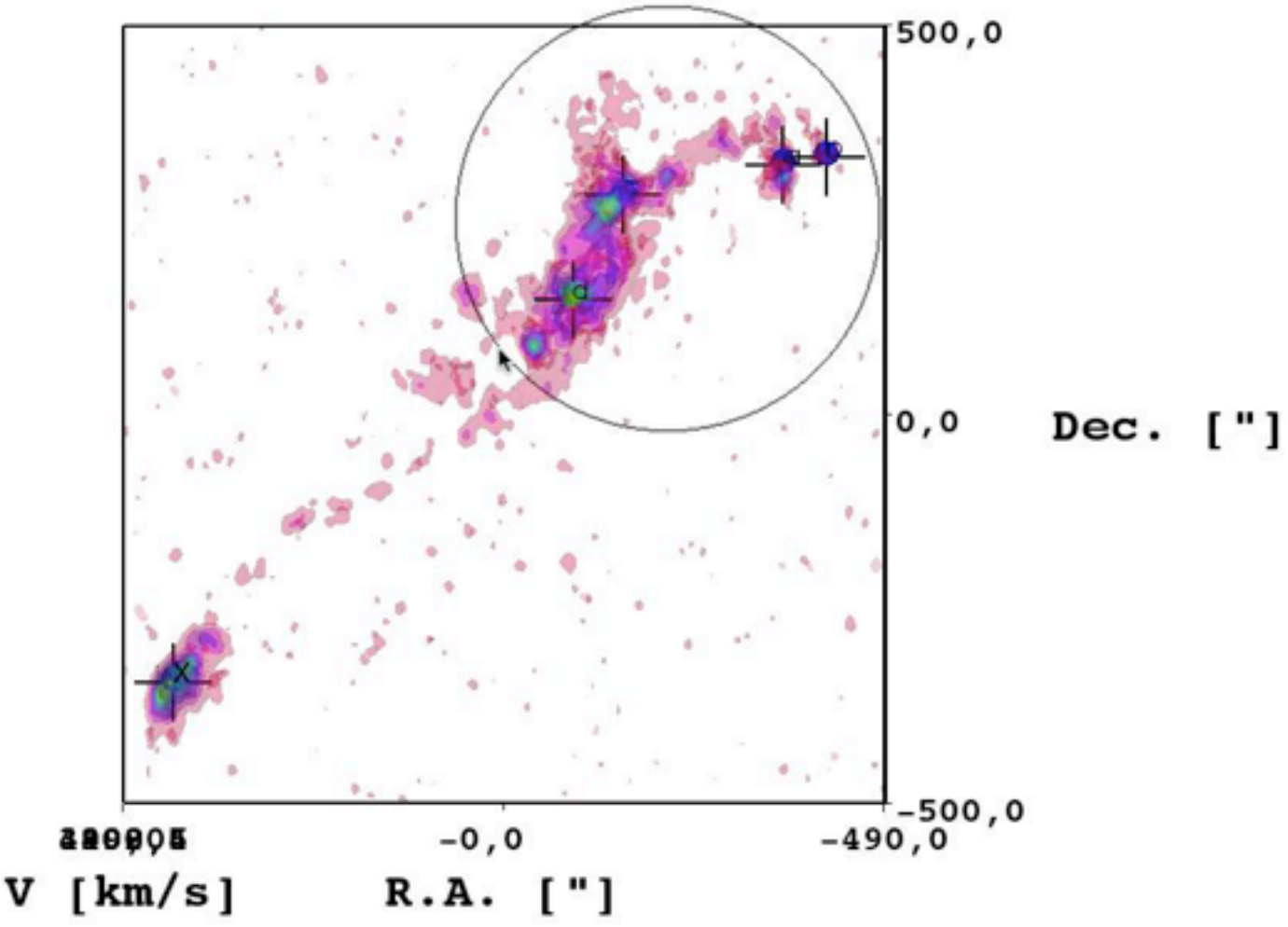


HCG 16, DEC -10

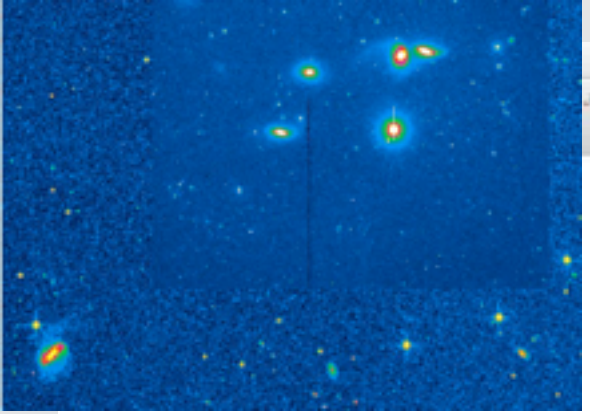


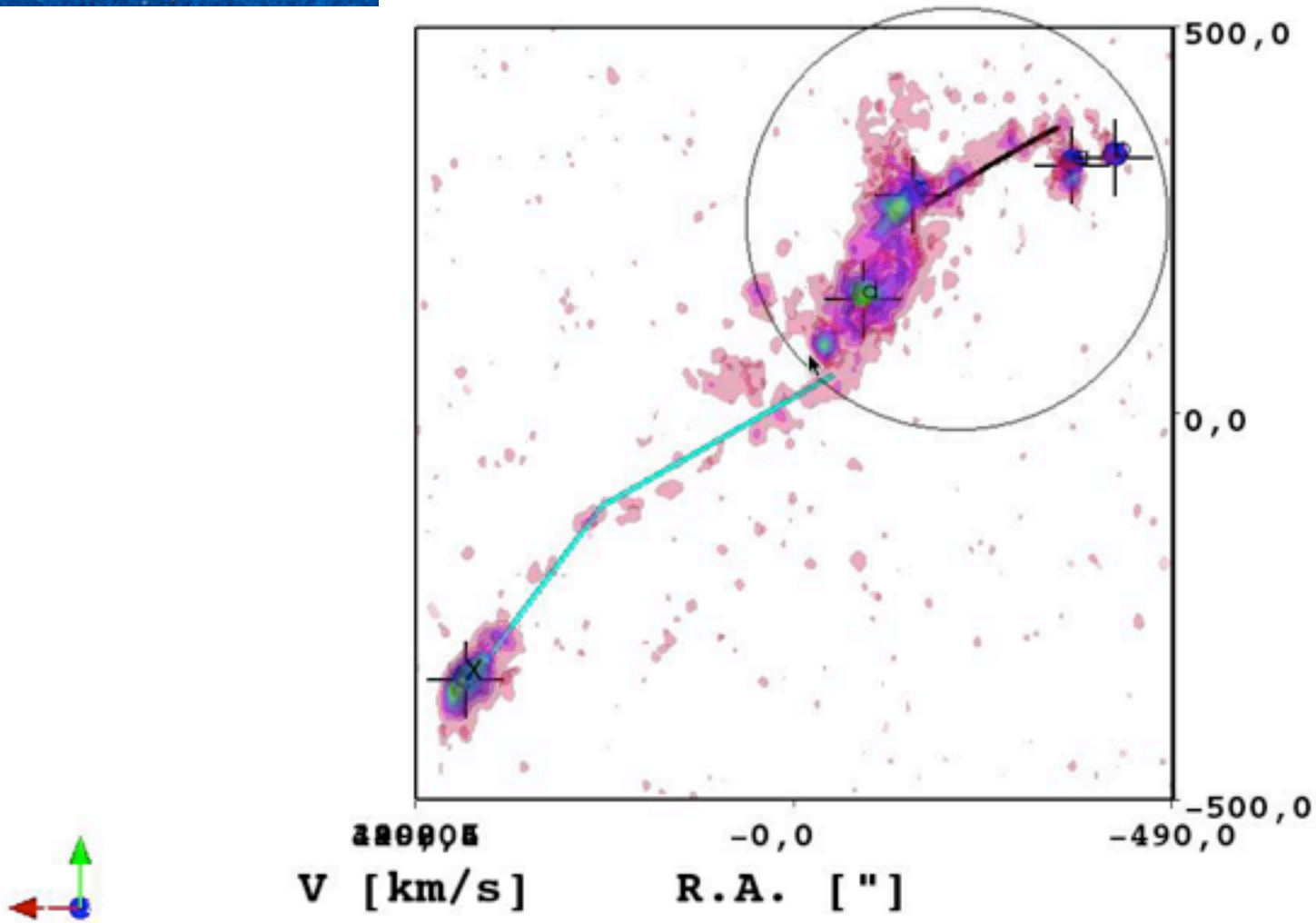






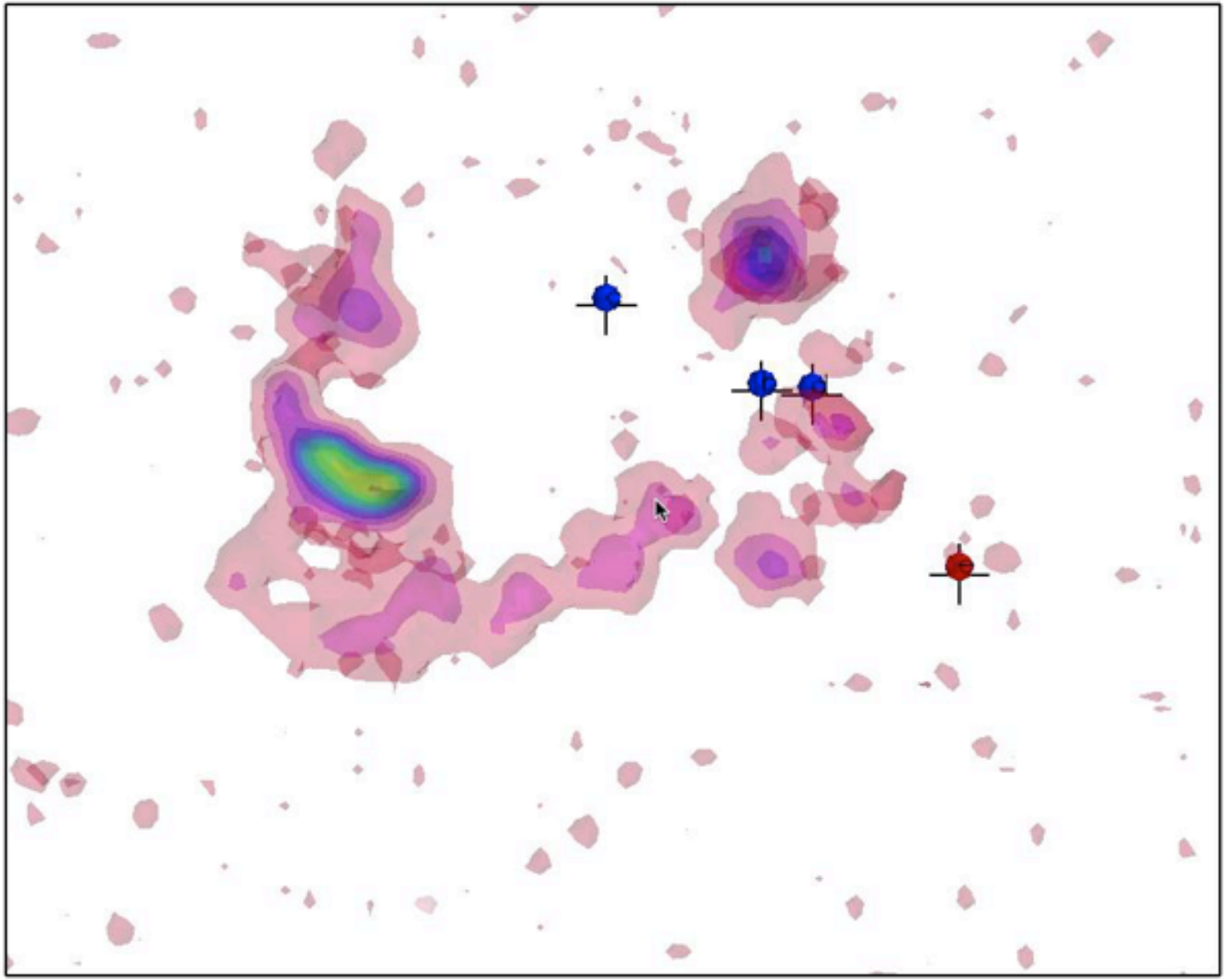
HCG 16, DEC -10





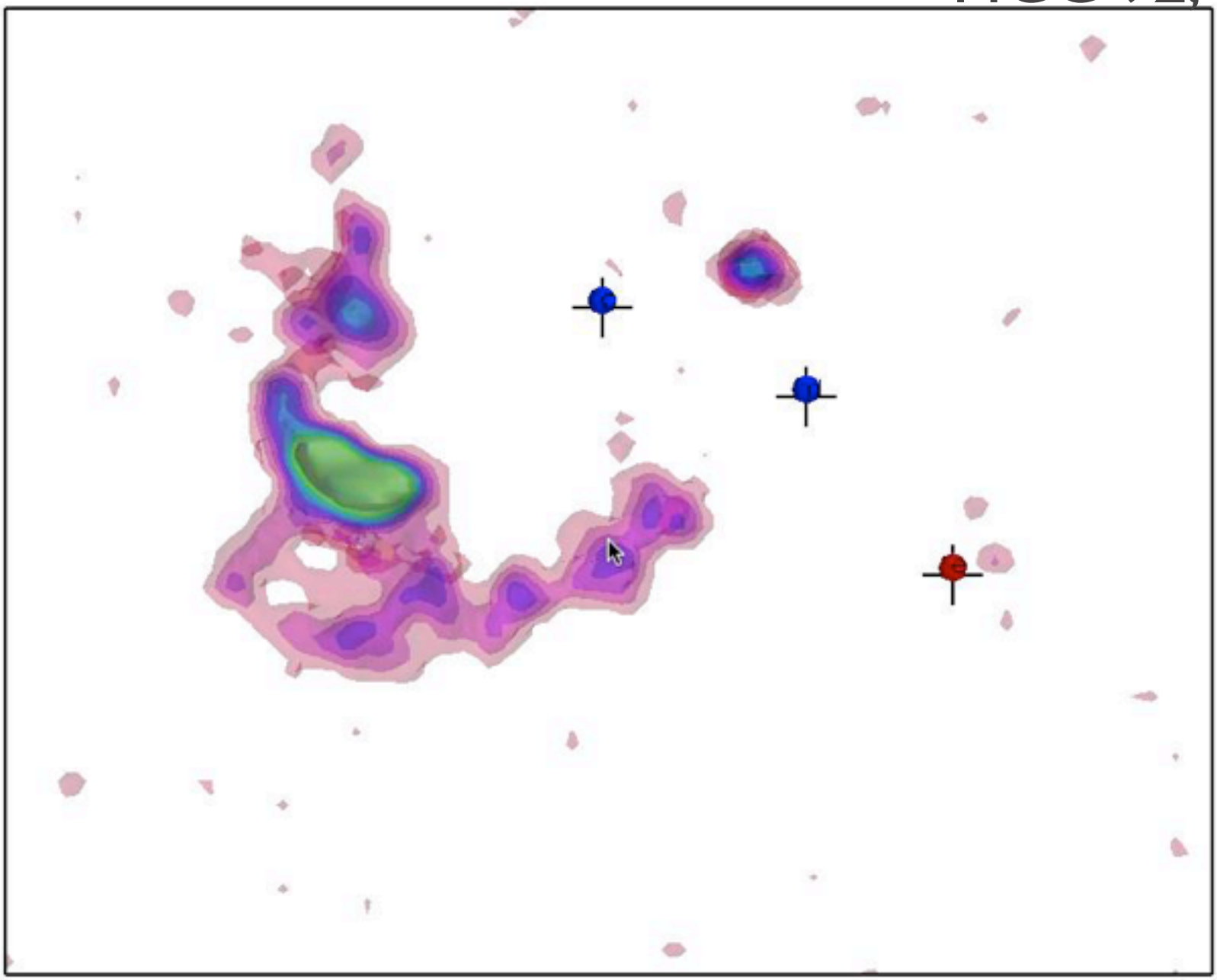
STAGE 2

HCG 92, DEC +33



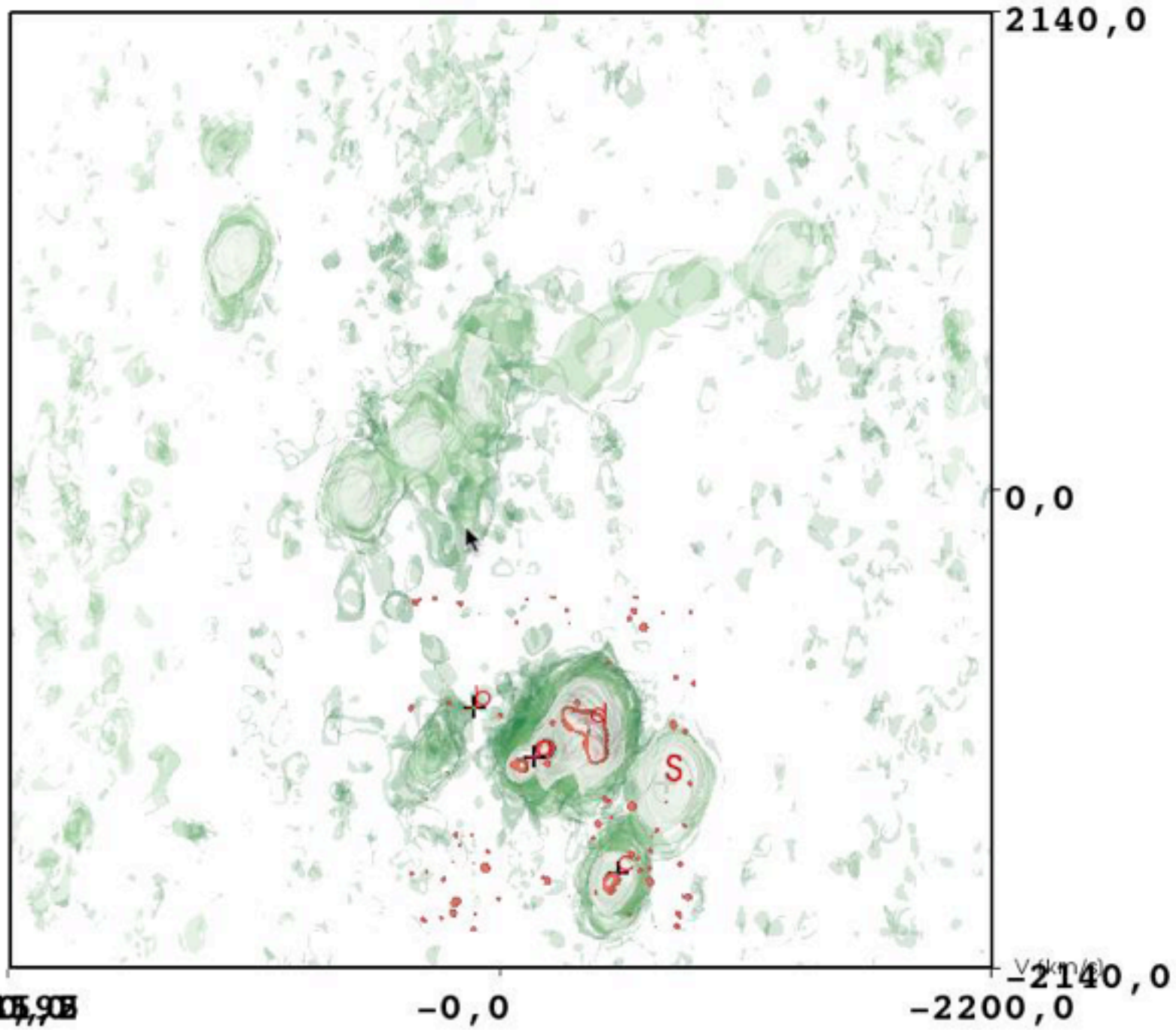
STAGE 3

HCG 92, Dec +33



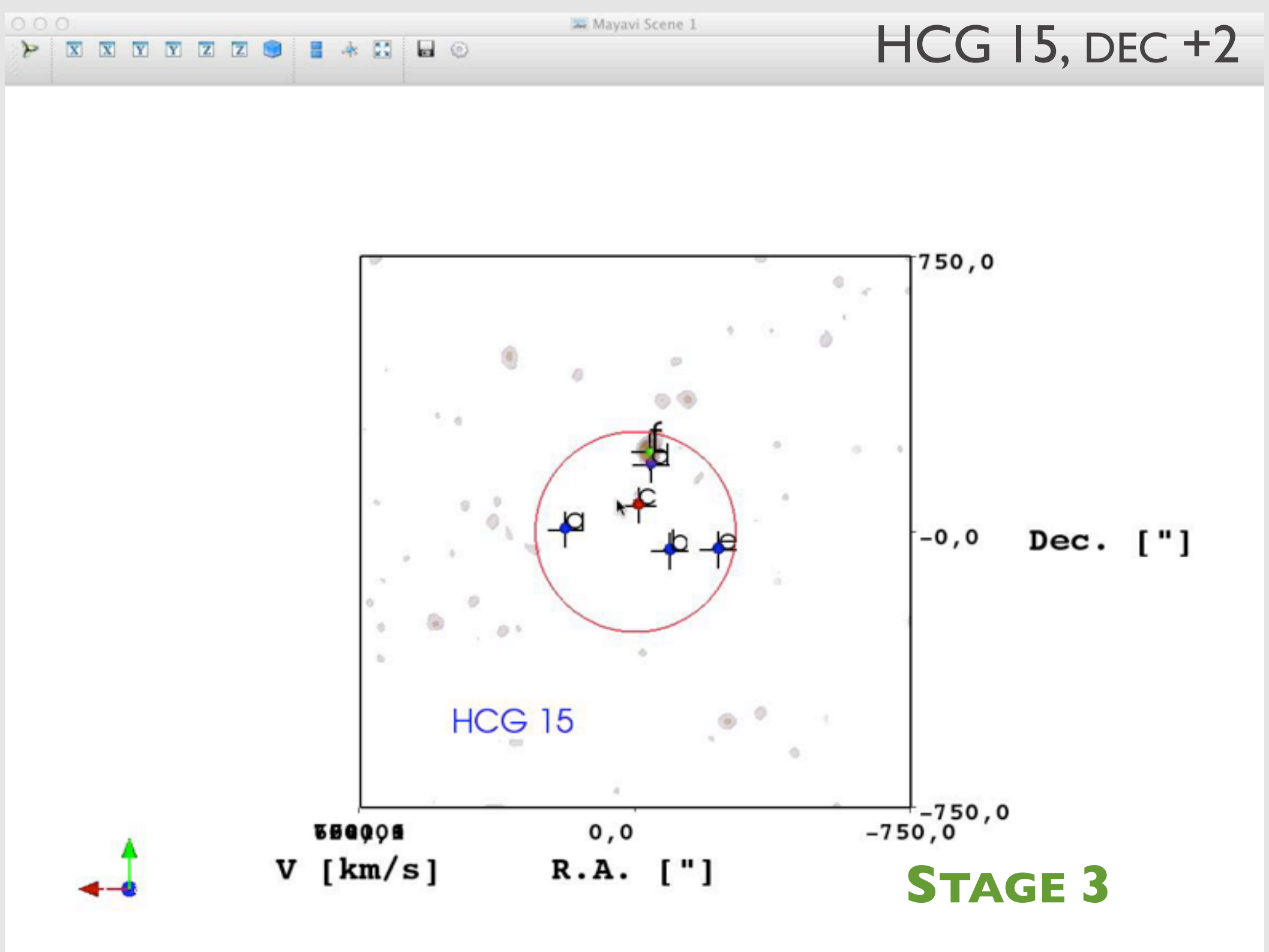
Stage 3

HCG 44 KAT7 / VLA



Hess et al in prep

HCG 15, DEC +2



STAGE 3

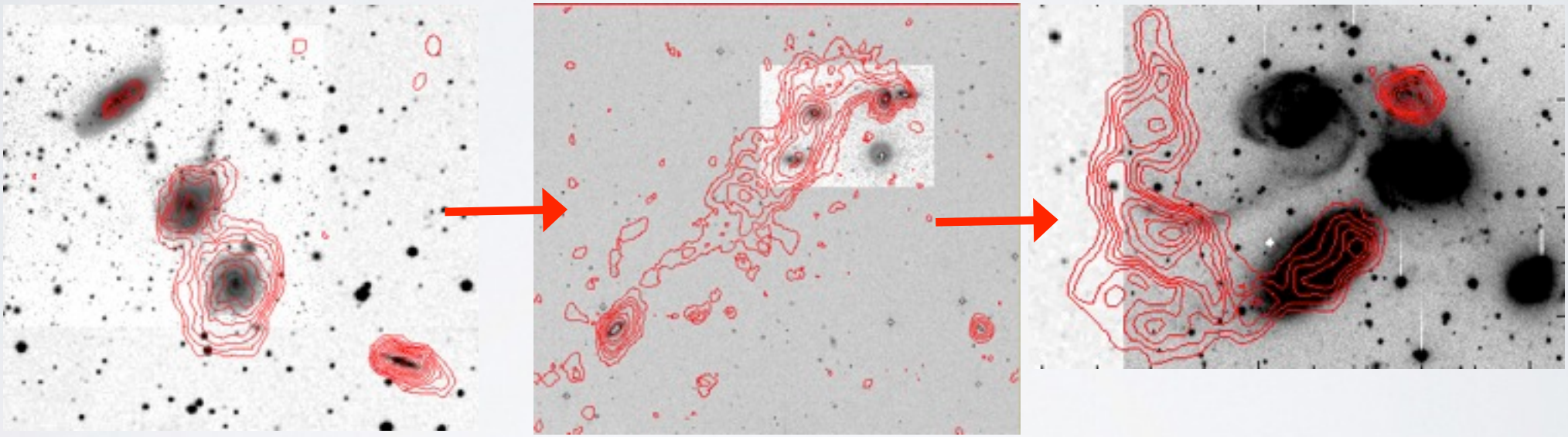
Compact Groups Of Galaxies

VLA study of 26 Hickson Compact Groups (Verdes-Montenegro et al 2001, 2007)

Phase 1: Low level of interaction

Phase 2: Gas in tidal features

Phase 3. No HI in the galaxies



COMPACT GROUPS OF GALAXIES

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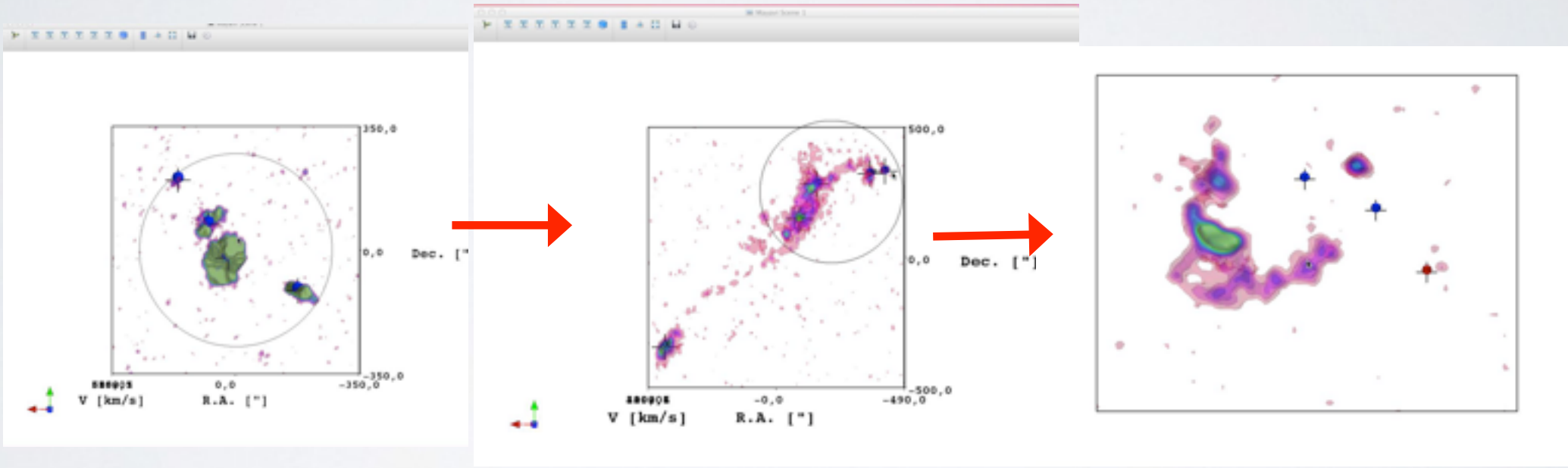

The X3D pathway applied to disentangling the HI component in Compact Groups of galaxies

Postdoctoral Position at IAA in Granada

HI studies of environmental effects in nearby galaxies

Work on

- large database of interferometric HI data for galaxies in extreme environments (isolated galaxies, compact groups)
- ALMA and GTC time granted for AMIGA (isolated galaxies)
- Preparation for the SKA first science via involvement in precursors/pathfinders.

To work with Lourdes Verdes-Montenegro as part of AMIGA team:

- coordinators the Spanish participation in the SKA
- part MeerKAT Nearby Galaxy survey MHONGOOSE,
- member of SKA HI Science Working Group
- members of Consortium in charge of designing the SKA Science Data Processor

Job description

- Required experience in reduction and analysis of interferometric HI data of nearby galaxies.
- **Funds secured for 4 (1+3) years**. Possibility of a further extension