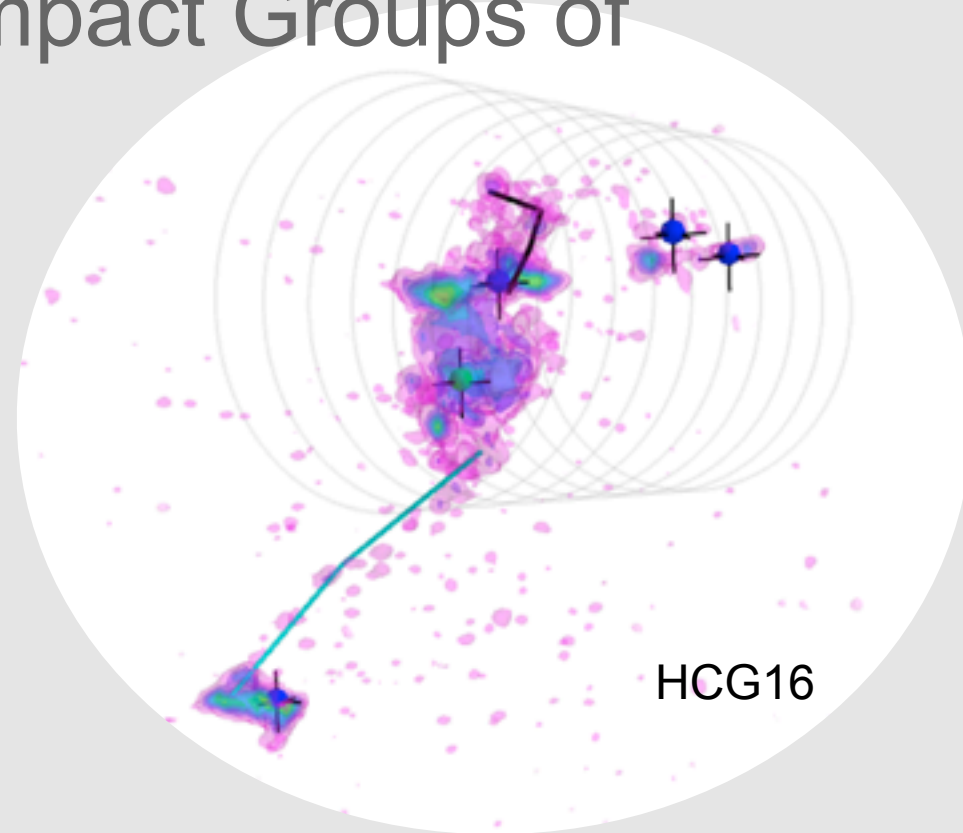


The X3D pathway applied to disentangling the HI component in Compact Groups of galaxies



Lourdes Verdes-Montenegro (IAA-CSIC)

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

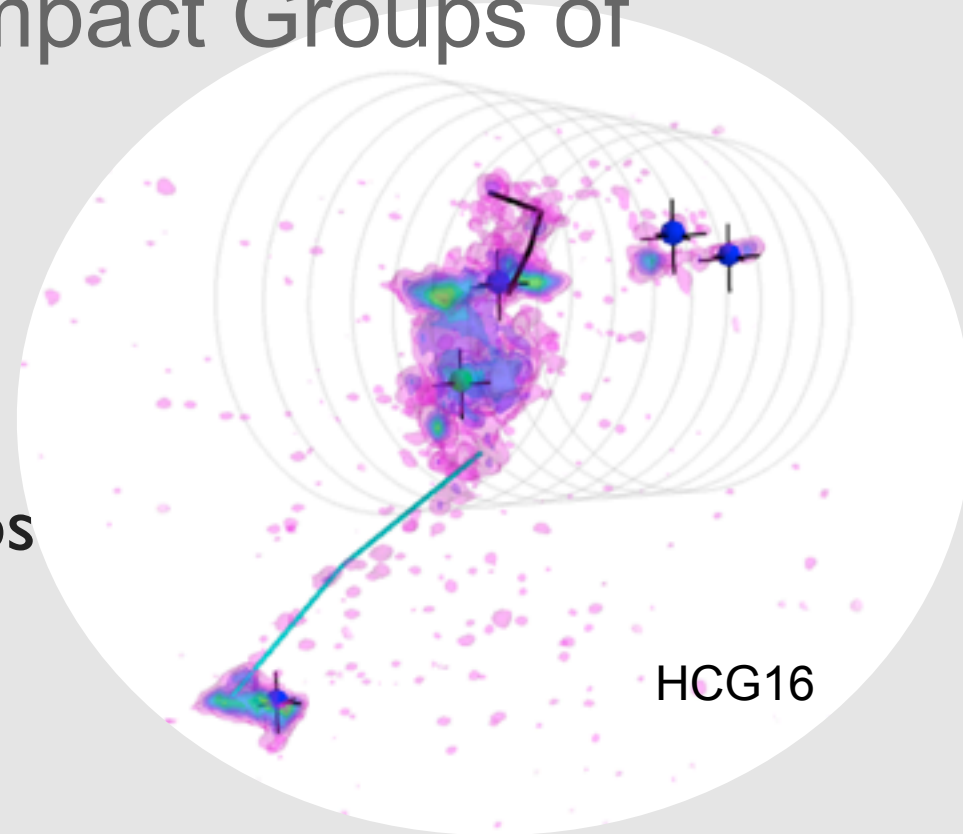
* Aix-Marseille Université (Stage L3MPCI)

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



Lourdes Verdes-Montenegro (IAA-CSIC)

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

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PHISCC - 2016, Cape Town

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** (\neq 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

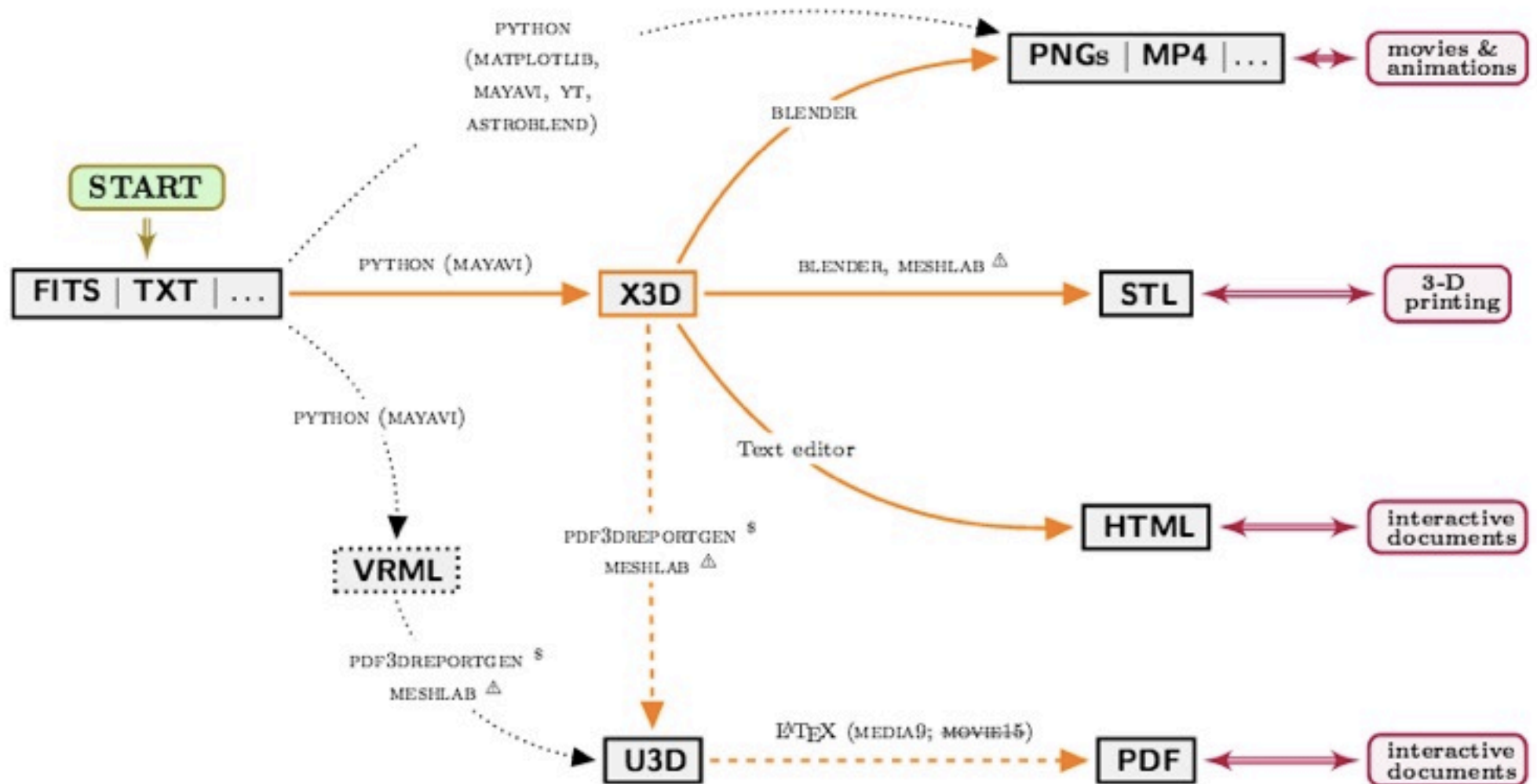
A new approach to **visualize & publish** multidimensional datasets
using **3D diagrams**

ISO ratified standard maintained by the Web3D Consortium

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

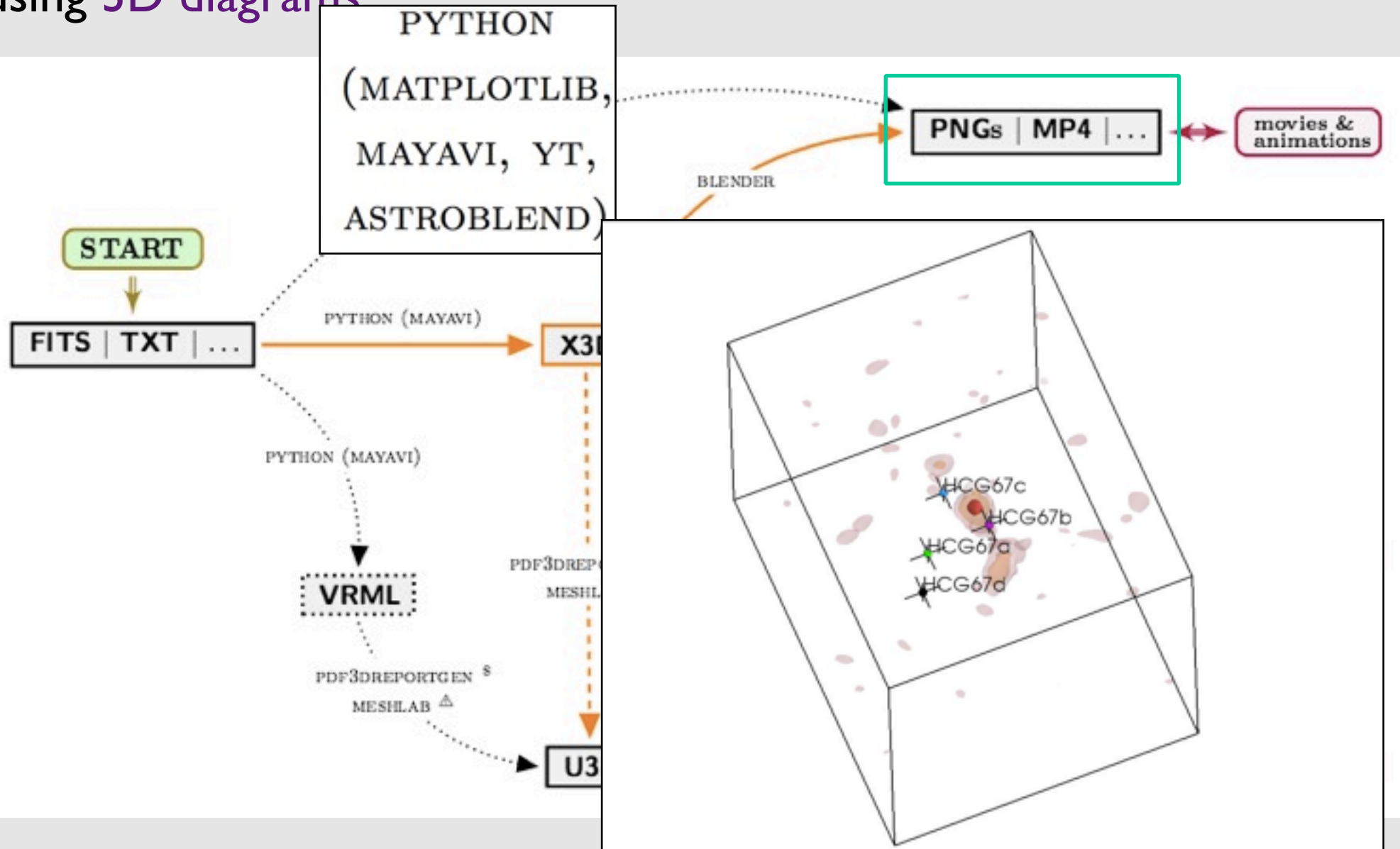
THE X3D PATHWAY

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

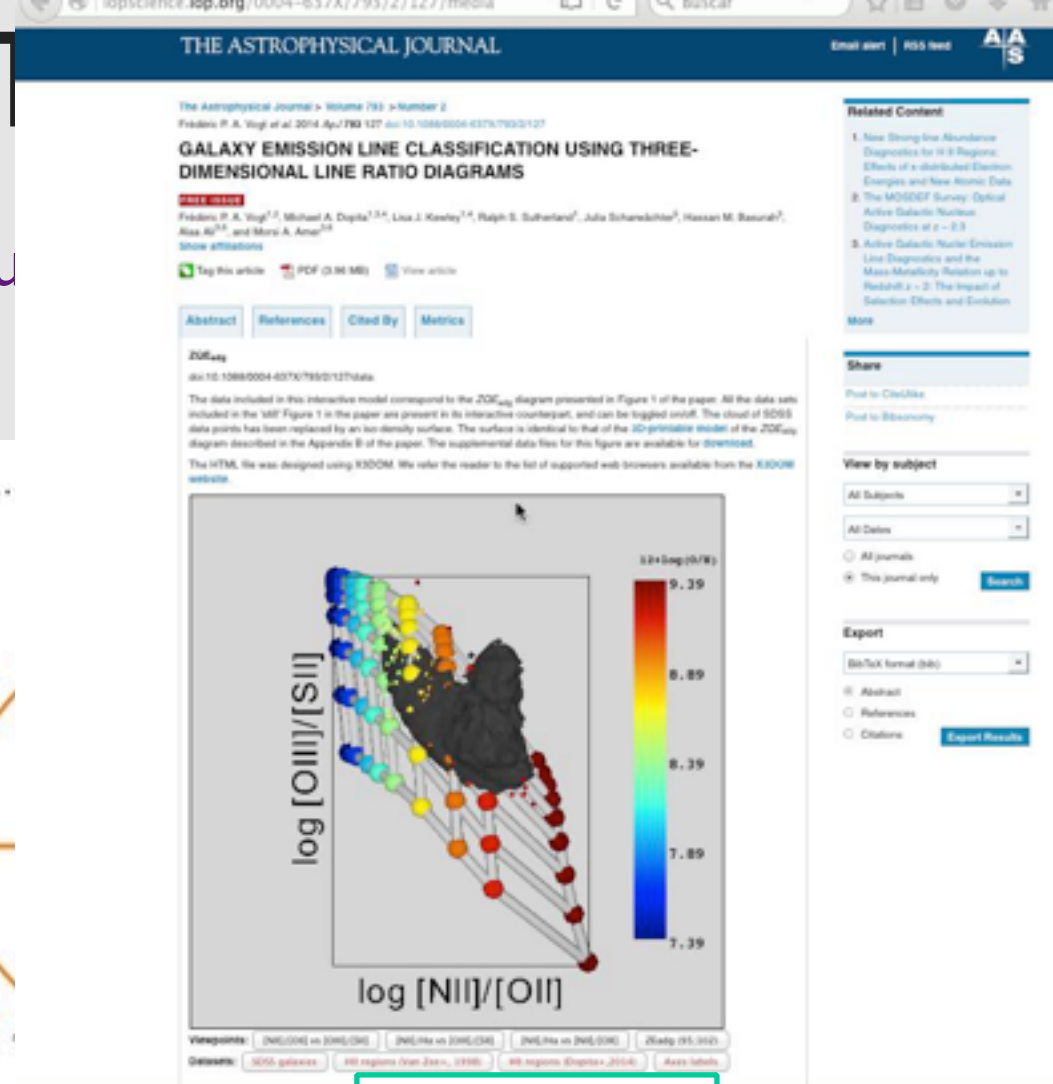
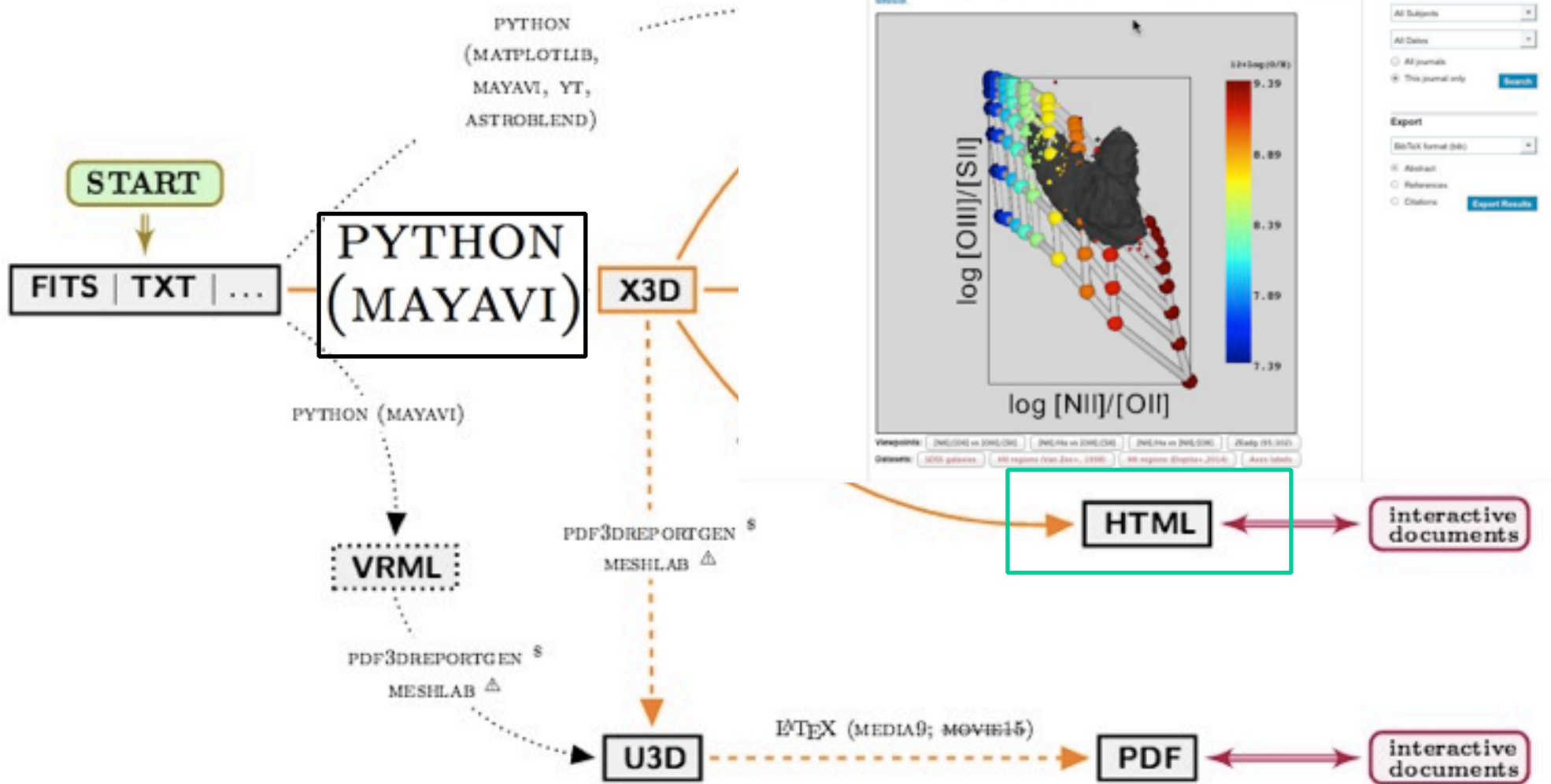


THE X3D PATHWAY

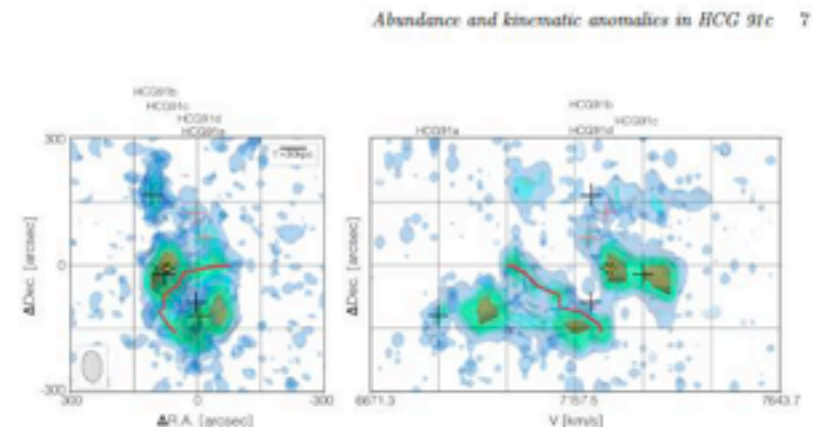
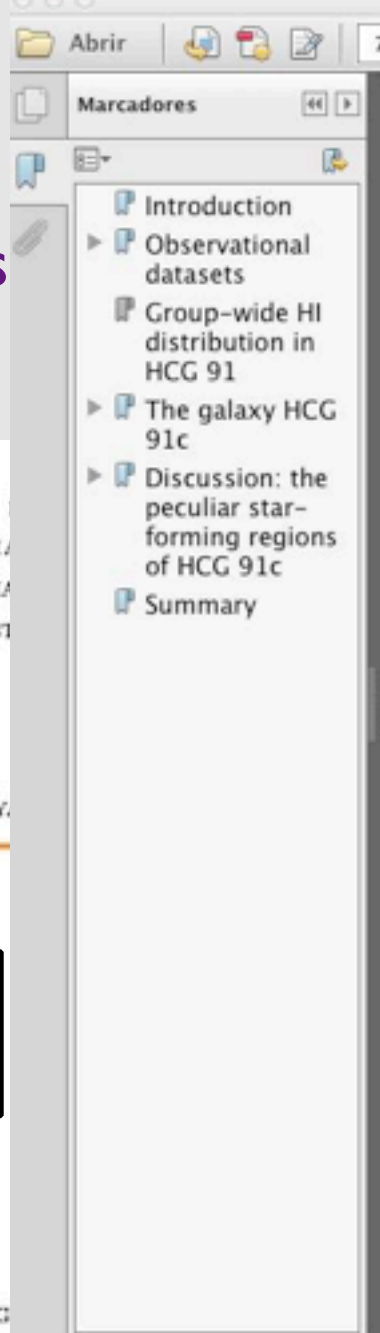
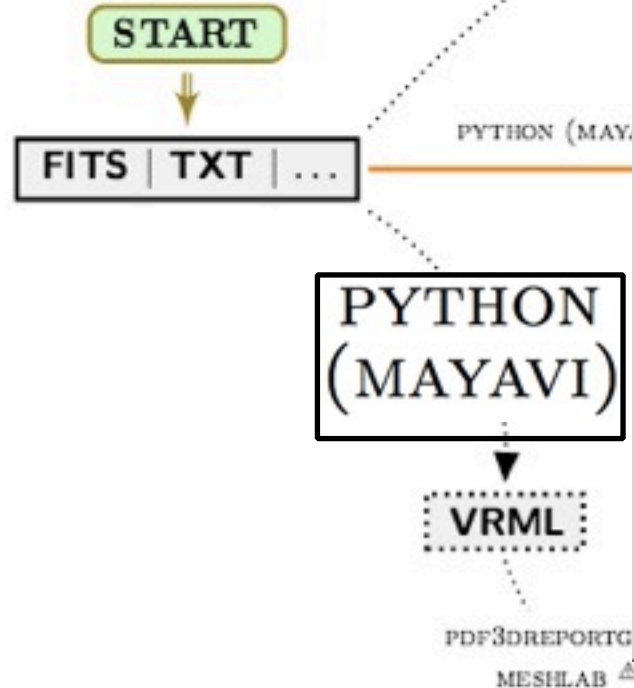
A new approach to **visualize & publish** multidimensional datasets using **3D diagrams**



A new approach to visualize & publish using 3D diagrams



A new approach to visualizing 3D diagrams



tended (~ 400 km s $^{-1}$) HI structure is associated with this galaxy. The large range of the HI kinematics is consistent with the fact that HCG 91b is seen almost edge-on.

- HCG 91c: A rotating HI disk with a velocity range of ~ 200 km s $^{-1}$ (~ 7200 - 7400 km s $^{-1}$) is associated both spatially and kinematically with the optical counterpart of HCG 91c. We find a small kinematic offset of ~ 10 km s $^{-1}$ between the optical redshift of HCG 91c measured by [Hickson et al. \(1992\)](#) and the mean HI velocity of the structure. The largely undisturbed morphology of the HI distribution is suggesting the presence of only minimal tidal effects for this galaxy. To the North-West, two fainter HI sub-structures (marked with red crosses) appear connected to the main gas reservoir of HCG 91c. They are also connected (less strongly) at the 1.3 mJy/beam level to the HI structure associated with HCG 91b. These two HI clumps are located 136 arcsec (≈ 58.4 kpc) and 150 arcsec (≈ 75.5 kpc) from the center of HCG 91c. They have no visible optical counterpart in the DSS-2 red band image in Figure 2. Spatially, HCG 91c is located ~ 15 kpc to the North-East of the large tidal arm originating from HCG 91a. The HI gas in the tidal arm is blueshifted by 150-200 km s $^{-1}$ from the mean velocity of HCG 91c.

- HCG 91d: This galaxy is not associated with any HI structure kinematically.

The large tidal features originating from HCG 91a makes the HCG 91 compact group a Phase 2 group in the

classification of [Verdes-Montenegro et al. \(2001\)](#), although some of the HI gas is still clearly associated with the galaxies HCG 91b and HCG 91c. The HI reservoir associated with HCG 91c appears largely undisturbed from a kinematic point of view. The two HI gas clumps located to the North-West of HCG 91c may have resulted from tidal stripping, suggesting that HCG 91c is experiencing the first stages of tidal disruption via gravitational interaction. The HI bridge at the 1.3 mJy/beam level connecting the gas reservoir of HCG 91b and HCG 91c could be seen as evidence for an ongoing interaction between the HI envelopes of these two galaxies, although the exact bridge structure would require a higher spatial sampling to be clearly established.

4 THE GALAXY HCG 91C

Here, we describe the different characteristics of HCG 91c as seen by WISE and Pan-STARRS. We focus our analysis on the strong emission lines and the associated underlying physical characteristics of the ionized gas. We restrict ourselves to a description of the system, and postpone a global discussion of the different measurements until Section 5.



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

fpavogt/x3d-pathway · GitHub

Trigger Thu...s - YouTube Send to OmniFocus Traductor de Google capturador evernote Read Later Google Maps

fpavogt/x3d-pathway - GitHub Releases - fpavogt/x3d-pathway - GitHub

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fpavogt / x3d-pathway Watch 3 Star 1 Fork 1

Code Issues 0 Pull requests 0 Pulse Graphs

This repository contains practical examples illustrating the concept of the X3D pathway introduced in Vogt+, ApJ (2015).

30 commits 2 branches 2 releases 2 contributors

Branch: master New pull request New file Find file HTTPS https://github.com/fpavogt/x Download ZIP

fpavogt Corrected bug in velocity slice identification, when dv steps are not... Latest commit 66689fc on Dec 28, 2015

fits_to_x3d	Corrected bug in velocity slice identification, when dv steps are not...	a month ago
x3d_to_html	Added mention of 600 pixels width used by AAS journals.	3 months ago
x3d_to_png	Minor pre-release updates (email, etc ...)	5 months ago
x3d_to_stl	Minor pre-release updates (email, etc ...)	5 months ago
LICENSE	Add the license and basic README	5 months ago
README	Added link to Github Pages in Readme	4 months ago

README

These files contain practical examples of the X3D pathway introduced by Vogt+, "Advanced Data Visualization in Astrophysics: the X3D Pathway", ApJ (2015).

THE X3D PATHWAY FEATURES

zenodo

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09 October 2015

Software Open access

x3d-pathway: Pre-release: arXiv submission

Frédéric P.A. Vogt

(show affiliations)

This release is associated to the initial arXiv version of the article, prior to its publication by the Astrophysical Journal.

Preview

green_dice.html

1.4 kB

red_dice.html

18.5 kB

x3dom

x3dom.css

6.4 kB

x3dom.js

928.8 kB

x3d_to_png

HCG91

HCG91.mov

34.6 MB

HCG91.x3d

3.4 MB

HCG91_animation.py

22.1 kB

HCG91_extended.mp4

38.5 MB

README.txt

5.5 kB

green_dice

green_dice.mov

6.7 MB

green_dice.x3d

149.0 kB

green_dice_animation.py

8.3 kB

red_dice

red_dice.mov

10.6 MB

red_dice.x3d

201.2 kB

red_dice_animation.py

18.1 kB

Files

Name	Date	Size	
x3d-pathway-v0.9.zip	09 Oct 2015	104.9 MB	<div>PreviewDownload</div>

Available in

GitHub

Publication date:

09 October 2015

DOI

DOI 10.5281/zenodo.31953

Related publications and datasets:

Supplement to:

<https://github.com/fpavogt/x3d-pathway/tree/v0.9>

Collections:

Software

Open Access

License (for files):

Other (Open)

Uploaded by:

fpavogt (on 09 October 2015)

New to Zenodo?

Sign Up

Read more about [features and benefits](#).

THE X3D PATHWAY FEATURES

Compatible with mainstream software

Including:

Python

Matplotlib

Mayavi

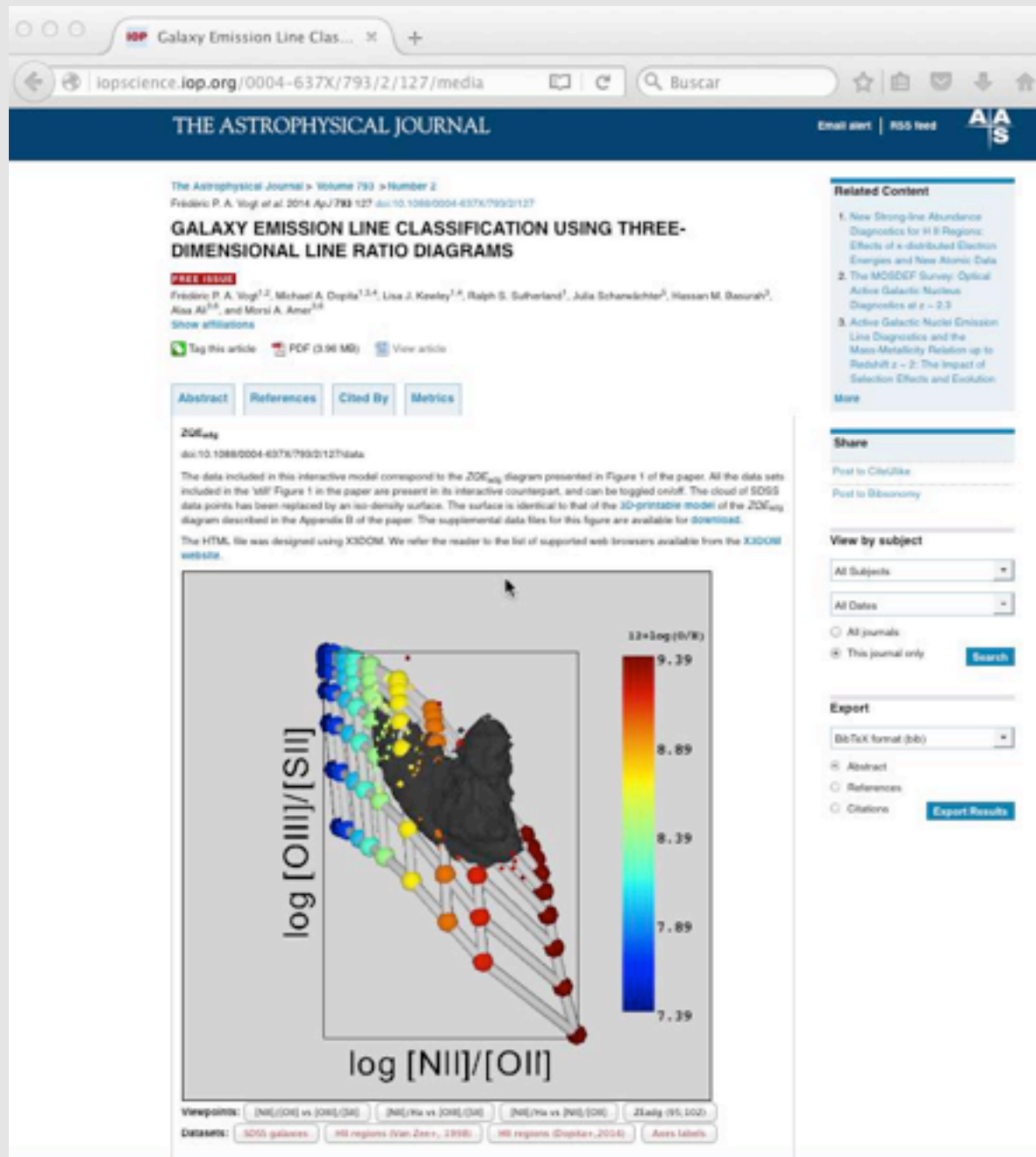
HTML

BLENDER

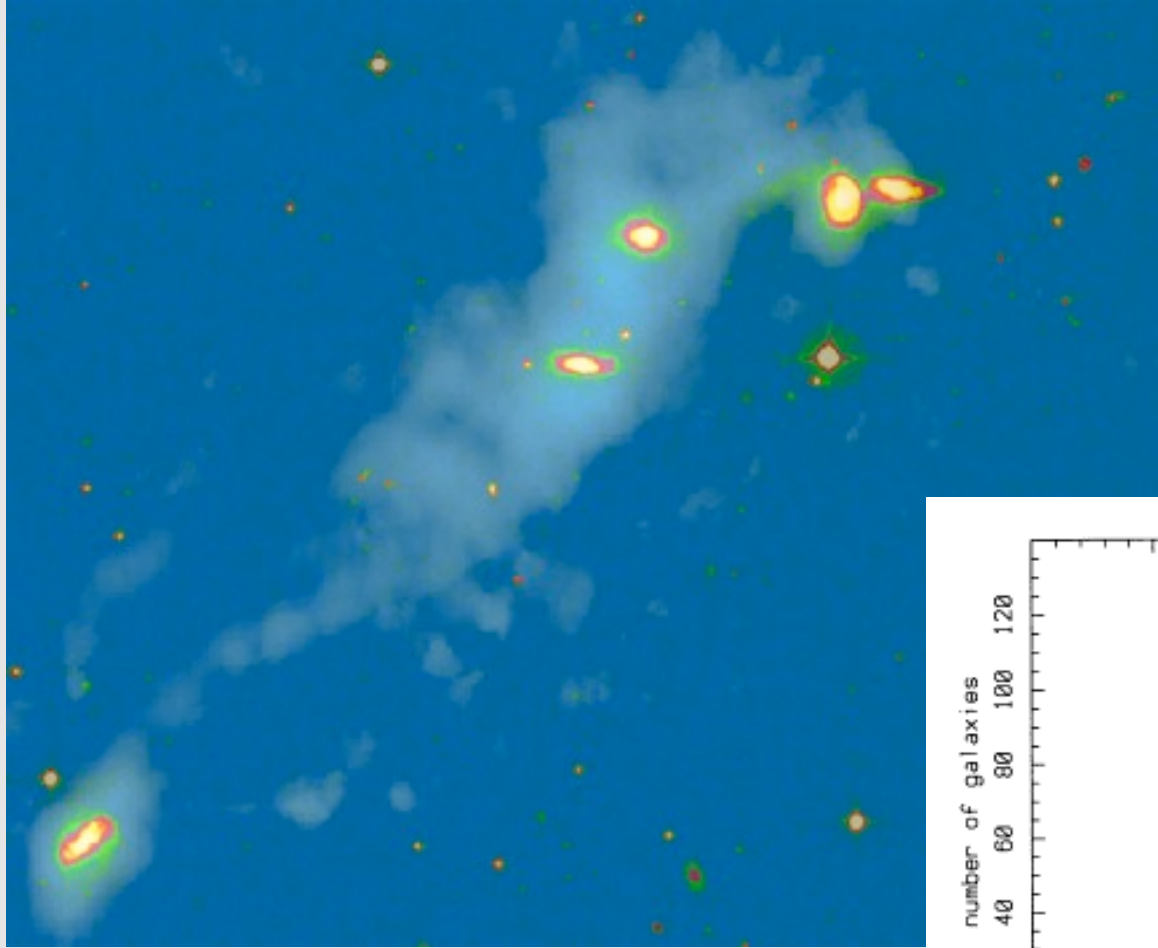


THE X3D PATHWAY FEATURES

Supported and encouraged by top astro journals



APPLICATION TO COMPACT GROUPS



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

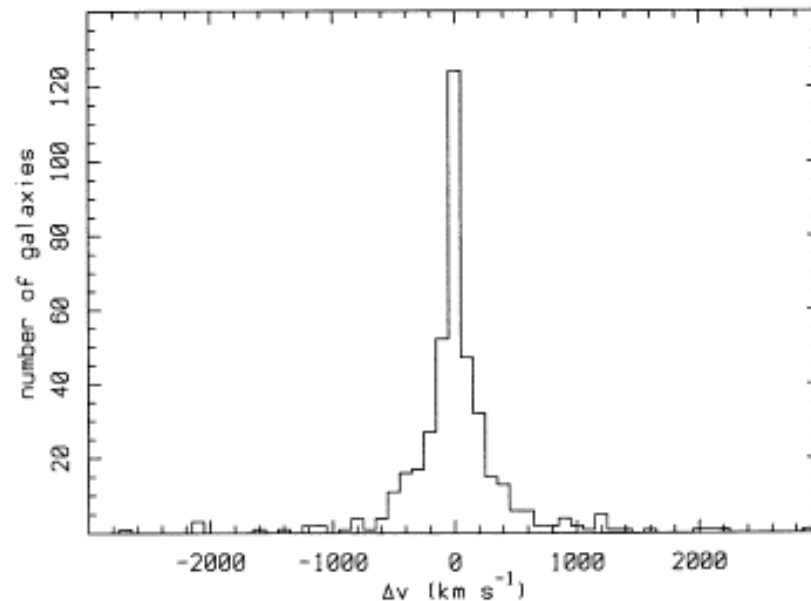
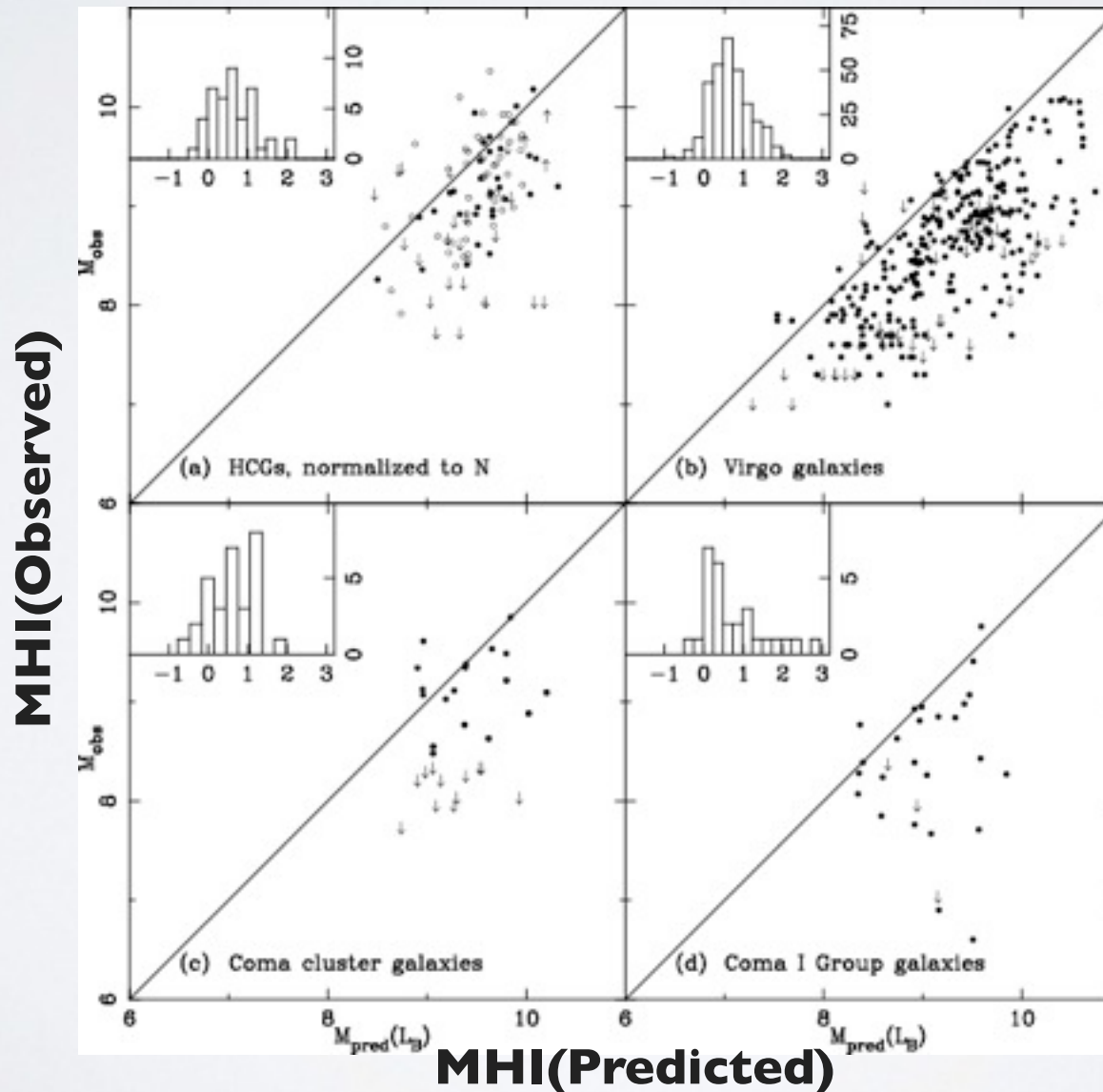


FIG. 1.—Distribution of galaxy velocities with respect to the median velocity of all cataloged galaxies in the same group.

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)

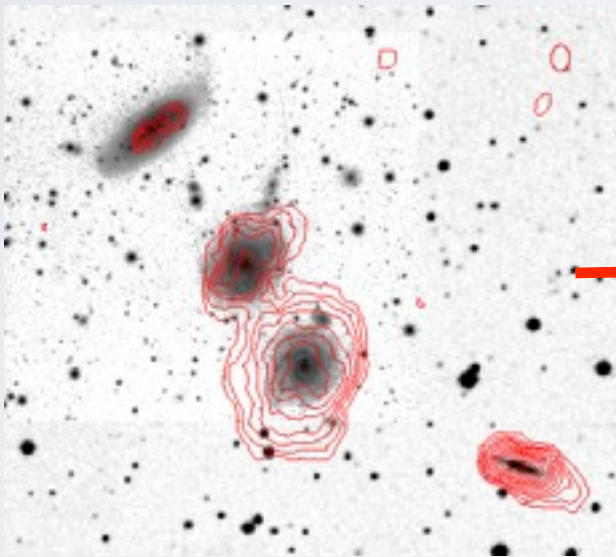


- Data from Williams & Rood 1987, Huchtmeier 1997)

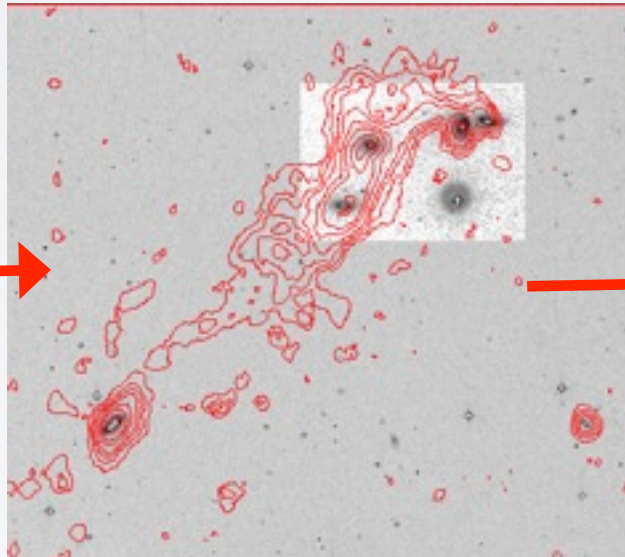
COMPACT GROUPS OF GALAXIES

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

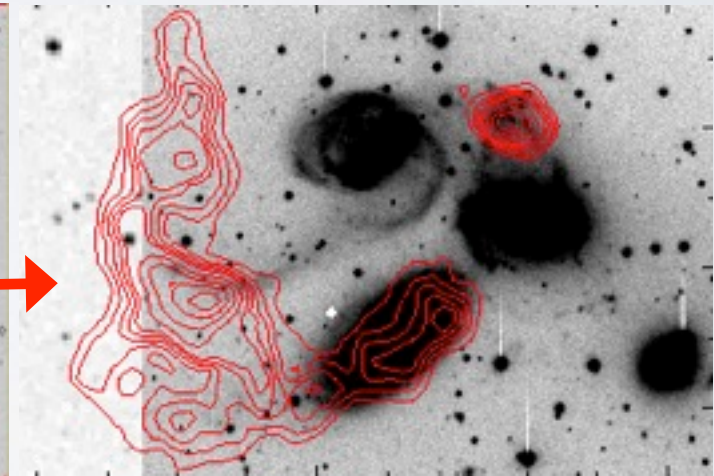
Phase 1: Low
level of interaction



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

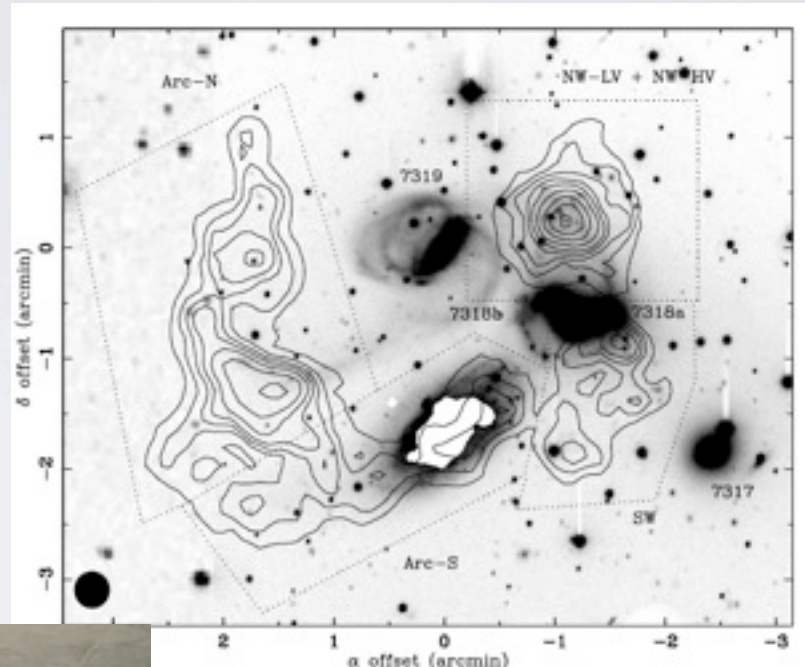
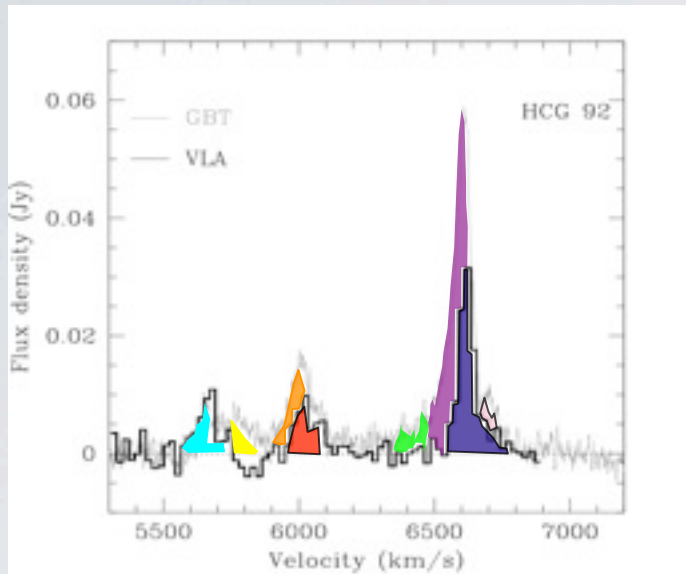
Phase 3. No HI in the
galaxies

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



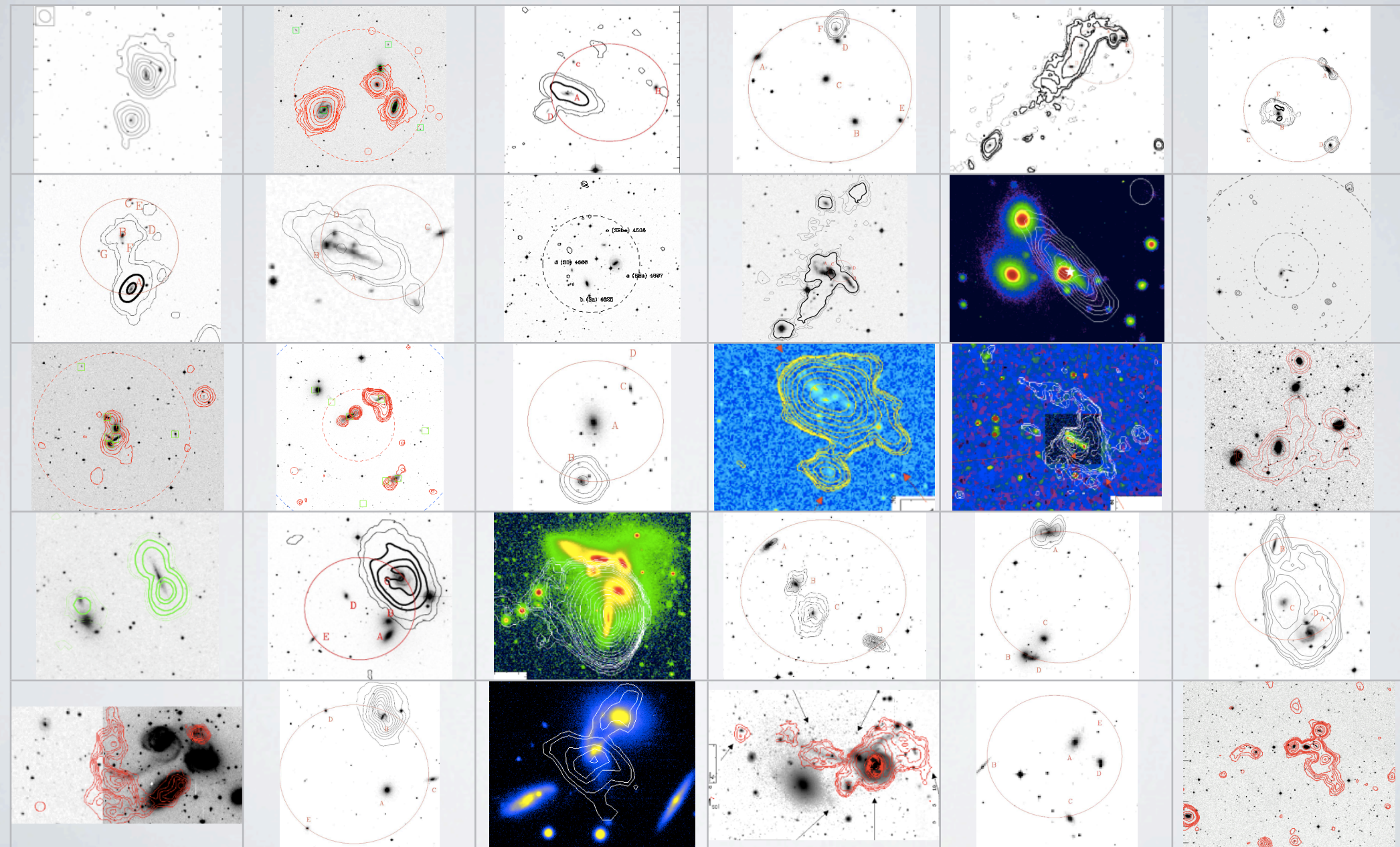
$N(\text{HI}) = 5 \times 10^{19} \text{ cm}^{-2}$
VLA C+CnB+D (20'')



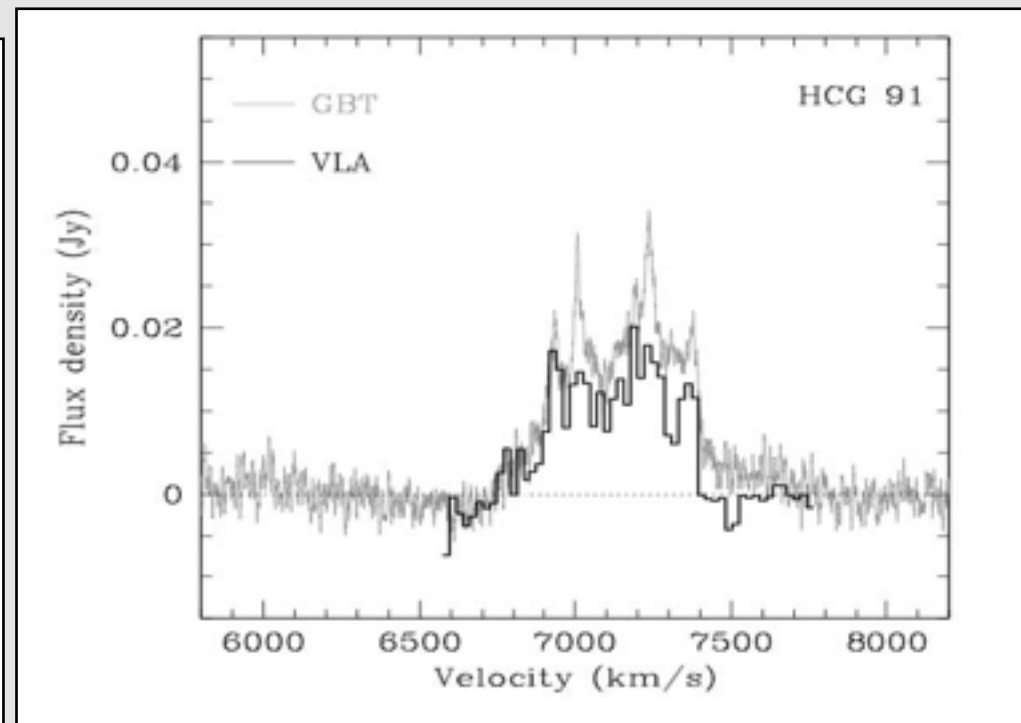
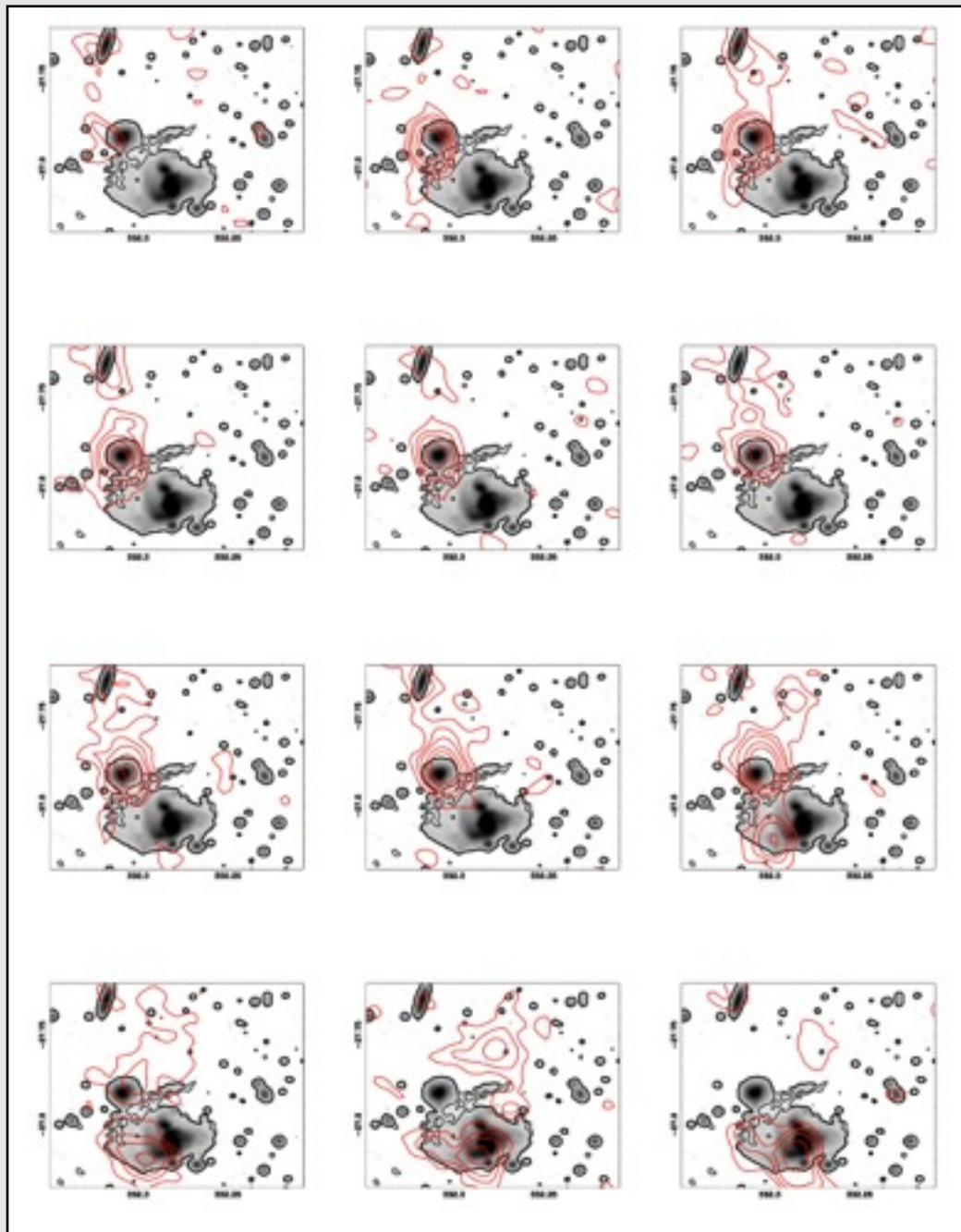
- GBT: diffuse HI component missed by the VLA
 - increasing with evolutionary stage, more consistent with tidal stripping than with ram-pressure, and spread over a velocity range of more than 1000 km/s.
- Borthakur+ (2010,2014)

COMPACT GROUPS OF GALAXIES

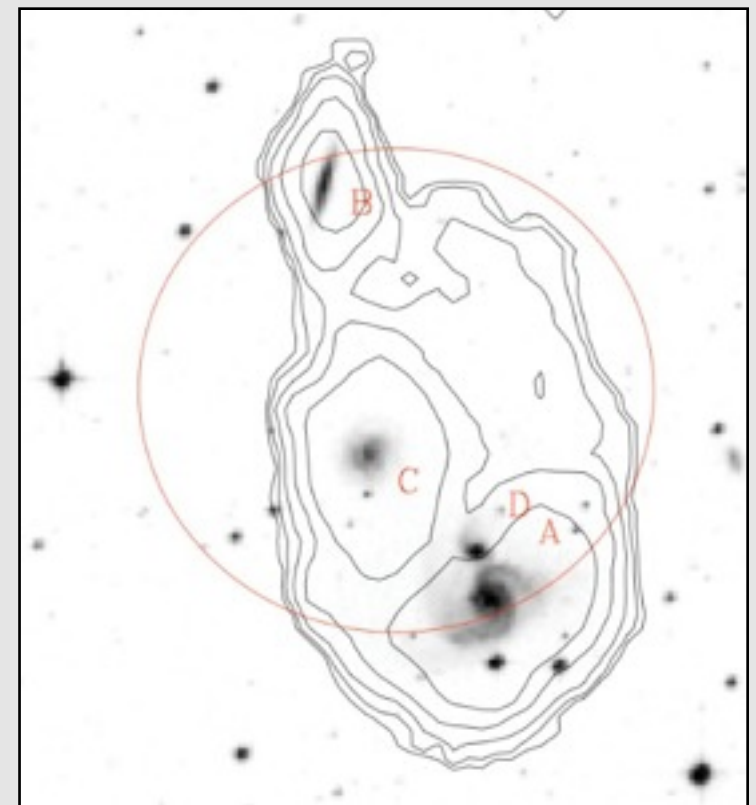
► VLA HI data available for 37 HCGs

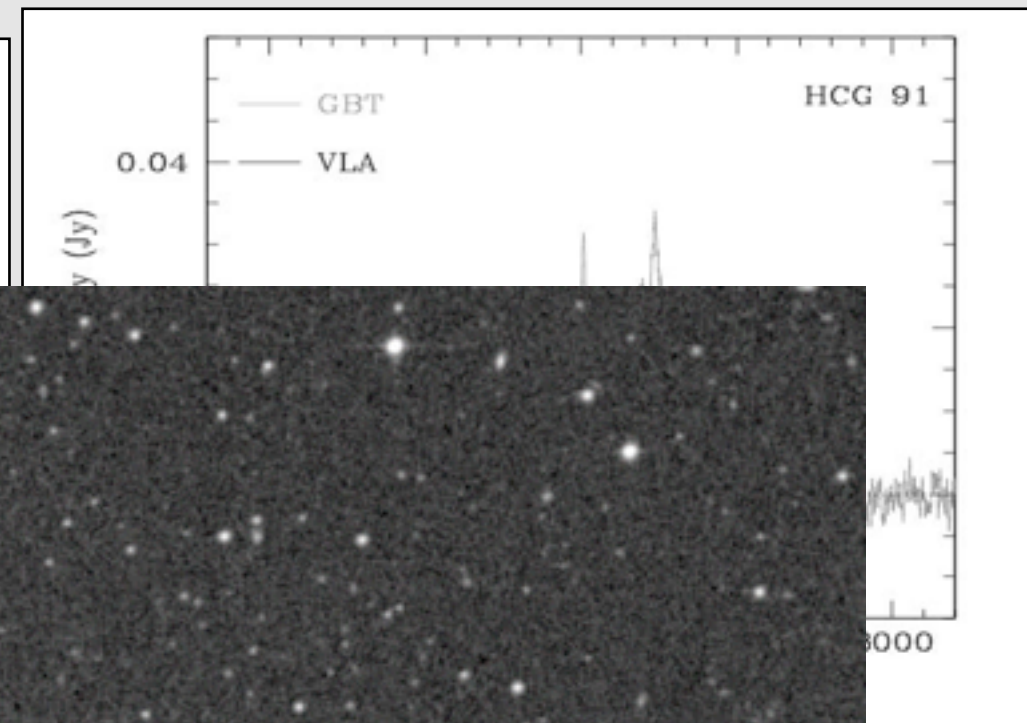
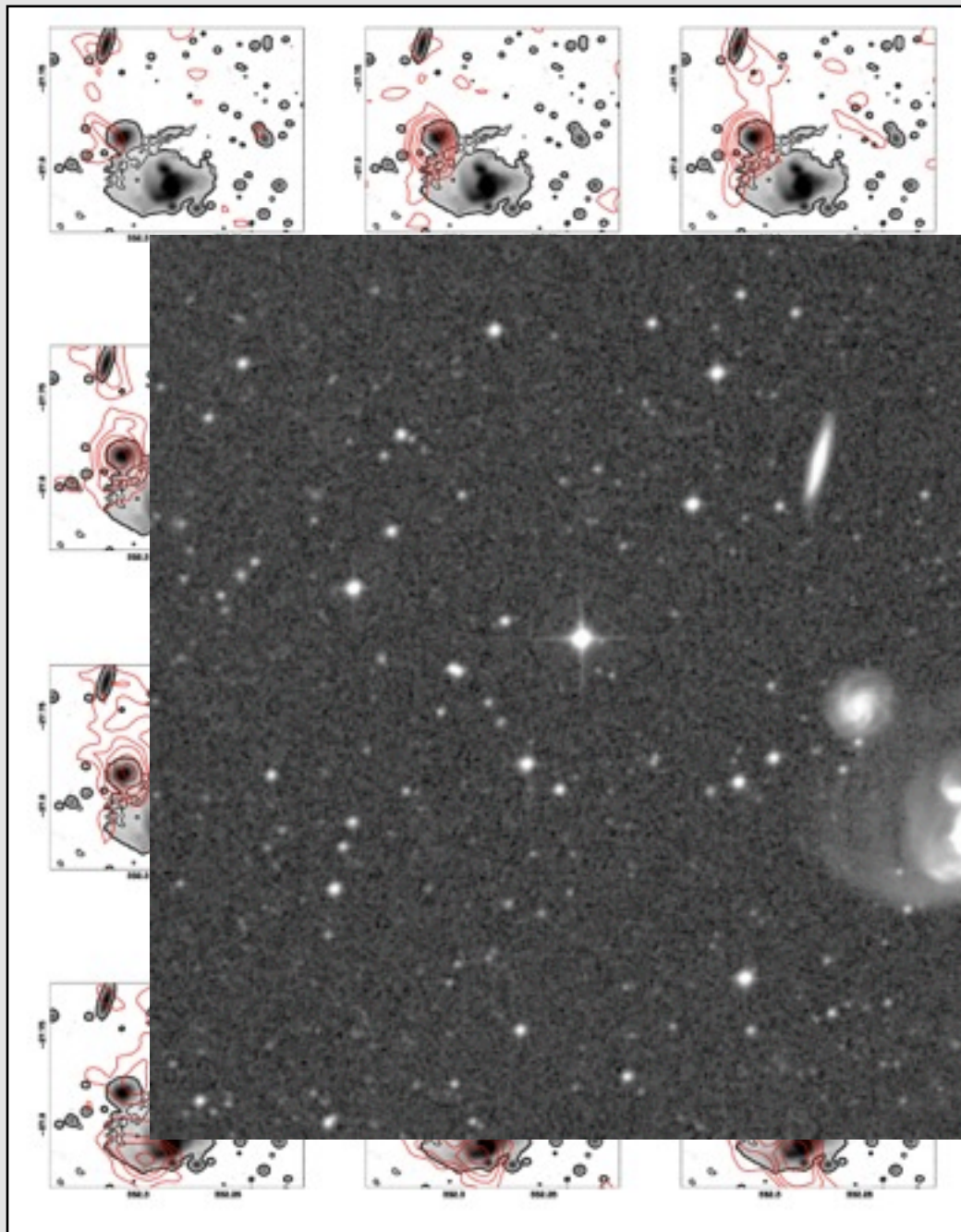


Verdes-M, Yun, Borthakur, archive

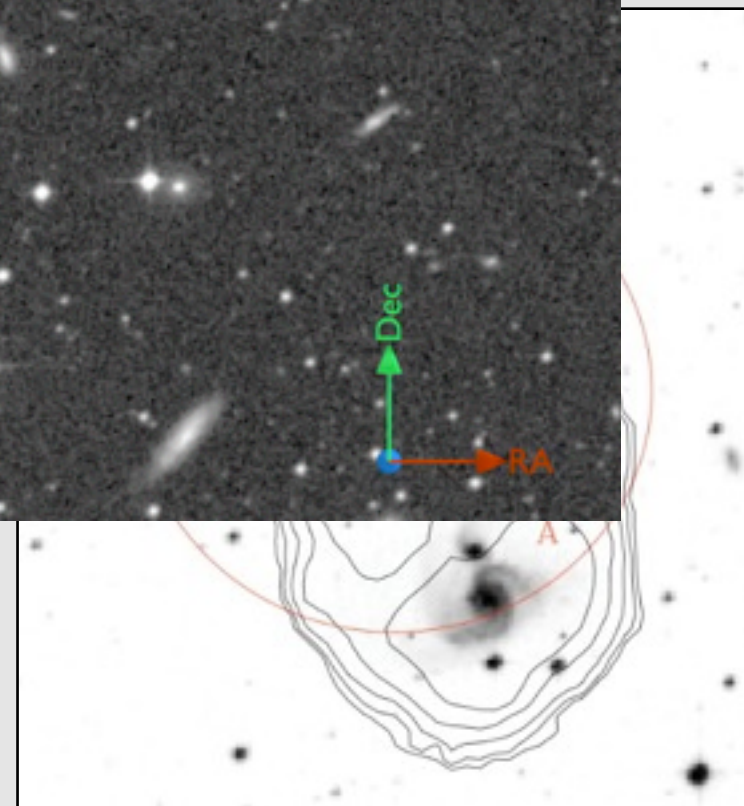


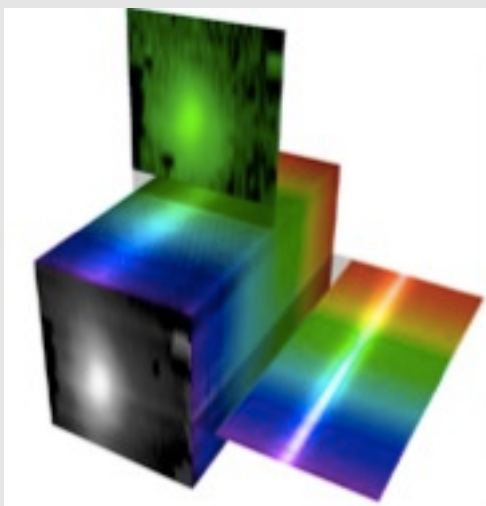
HCG 91





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 correspondence 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 linx = [100,160]
87 liny = [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],
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108                  'v':7195.},
109        }

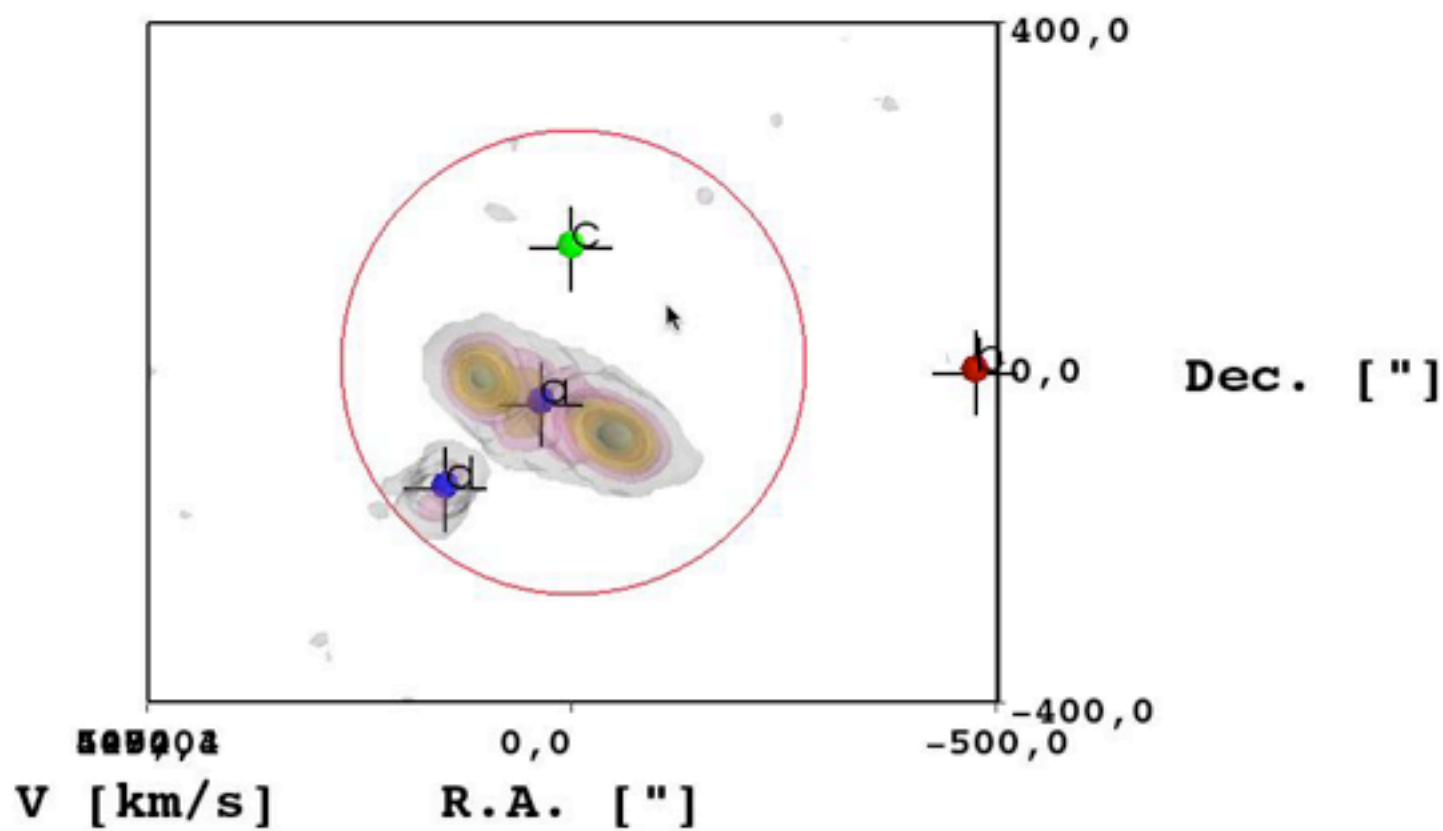
```

RANGES

POSITIONS,
SYMBOLS

LEVELS, COLORS...

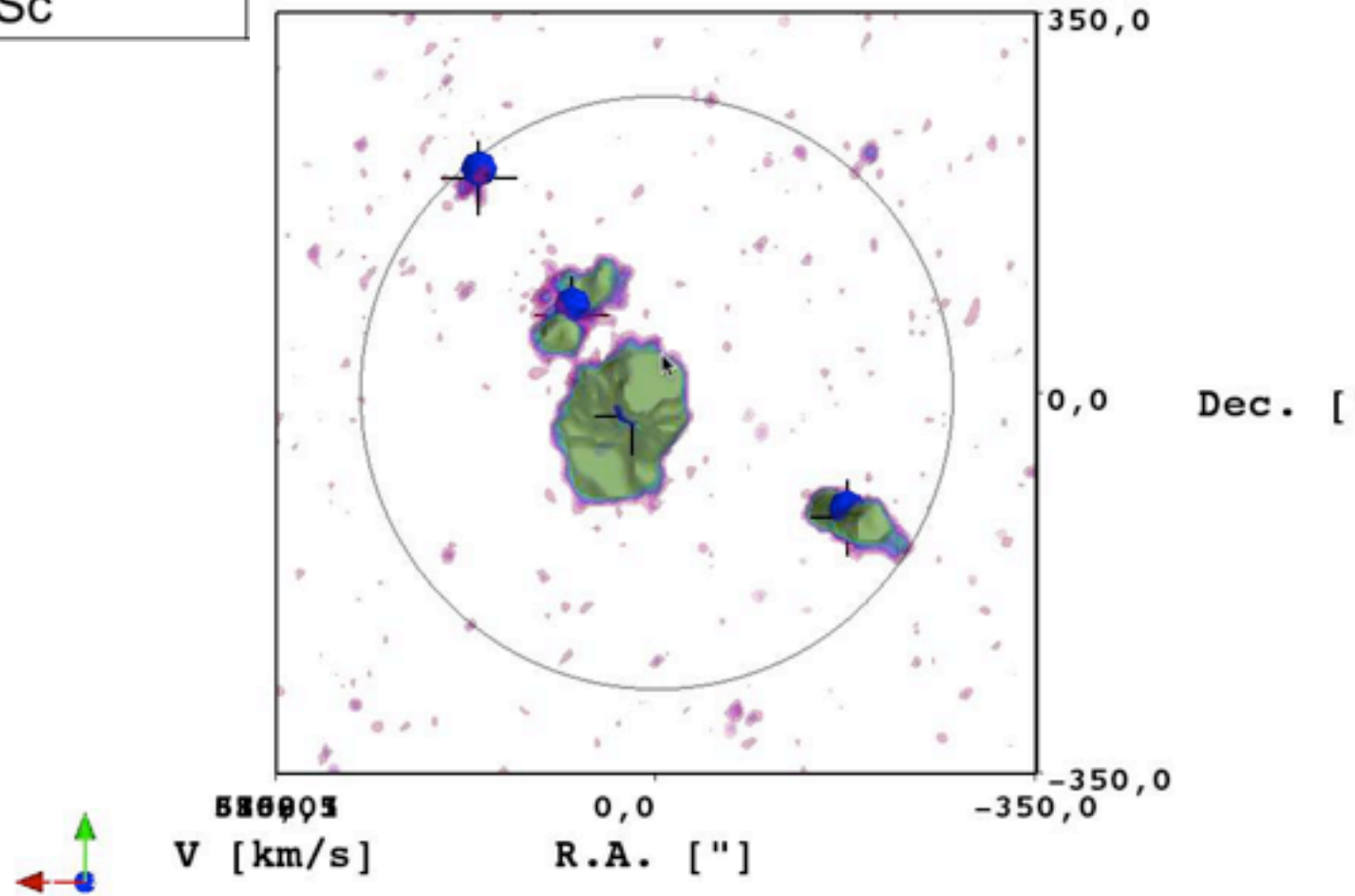
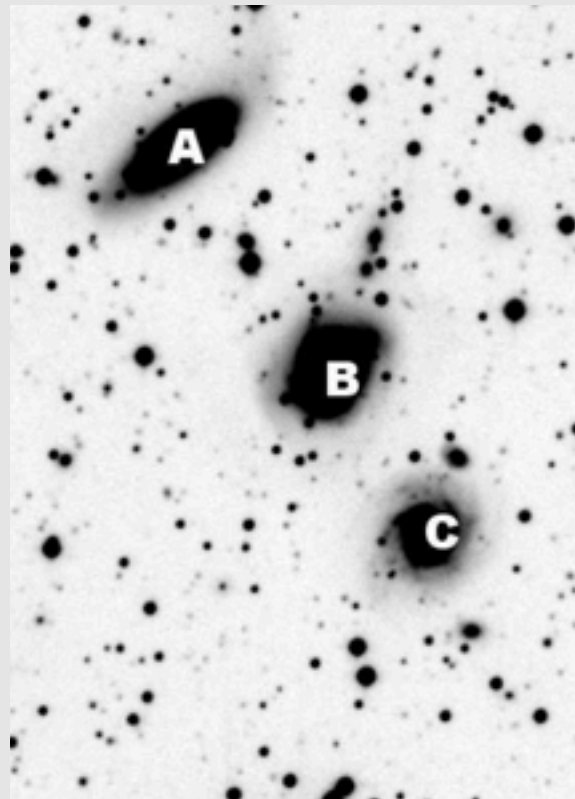
PYTHON CODE --> X3D



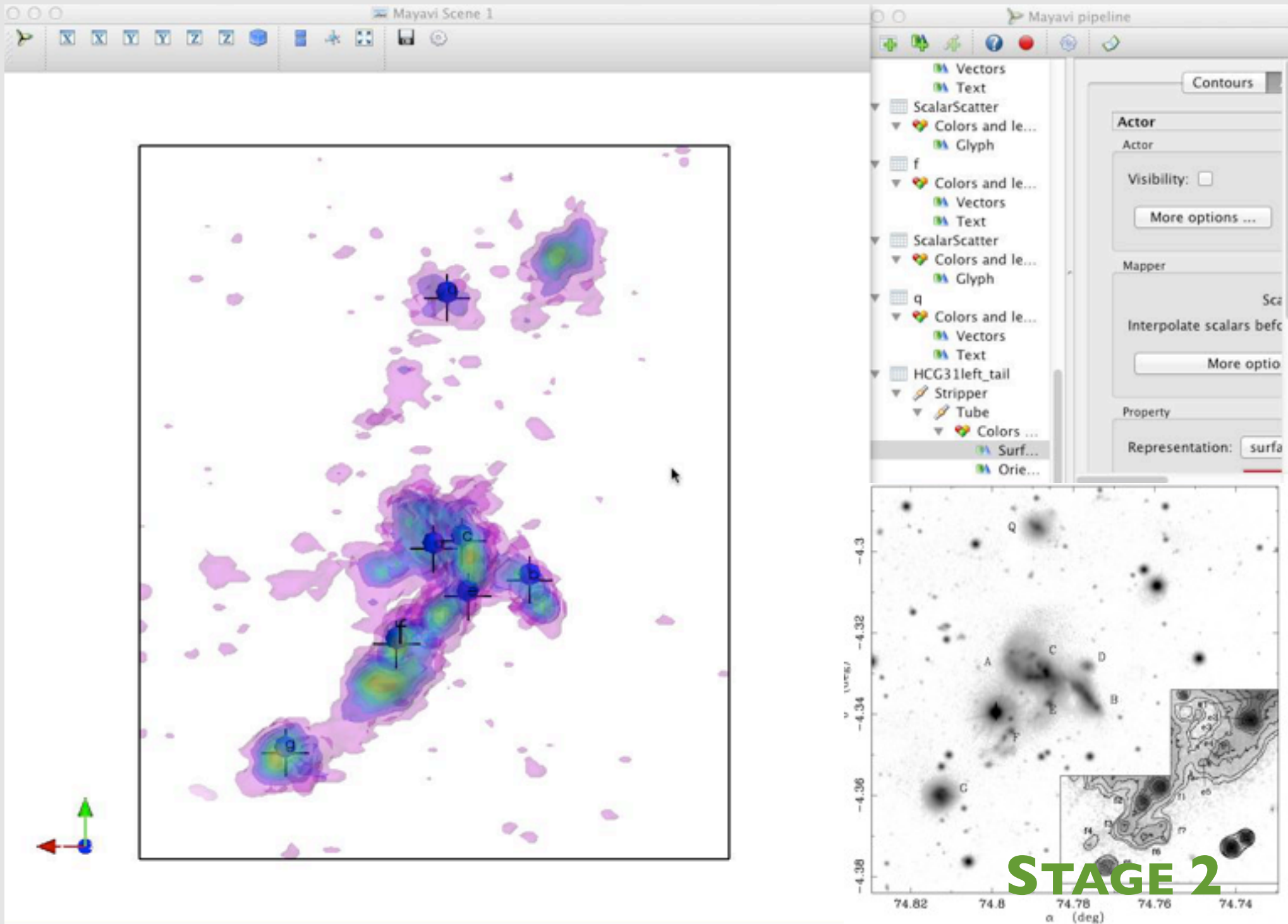
HCG 88

DEC -5

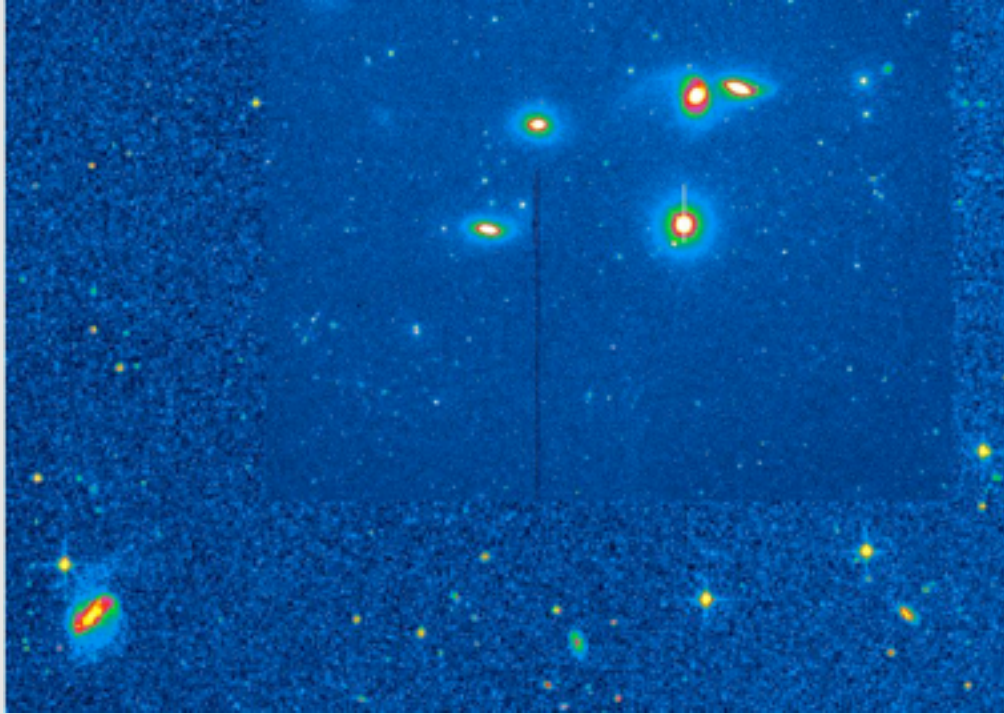
HCG88a	Sb
HCG88b	SBa
HCG88c	SABbc
HCG88d	Sc



STAGE I



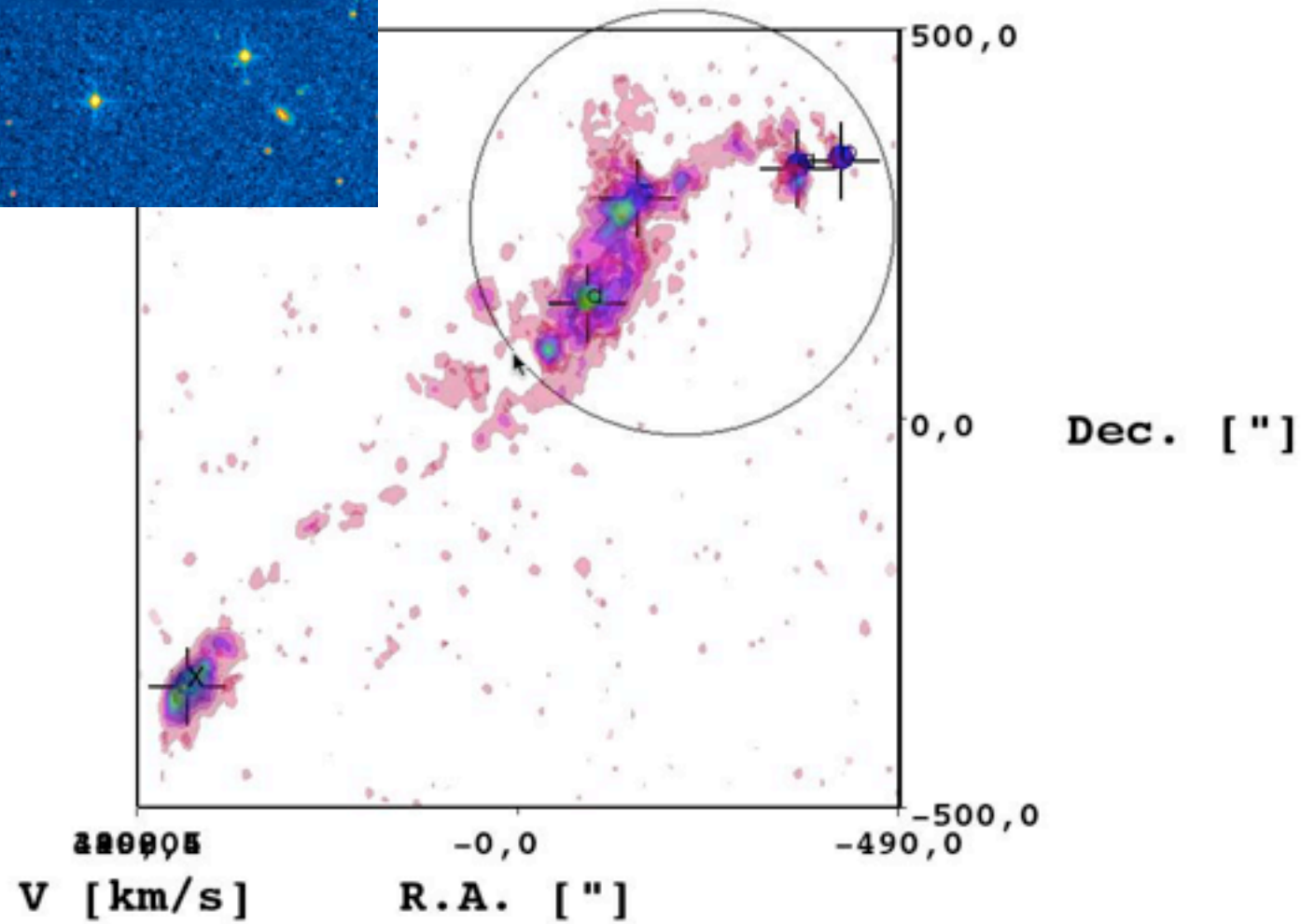
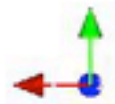
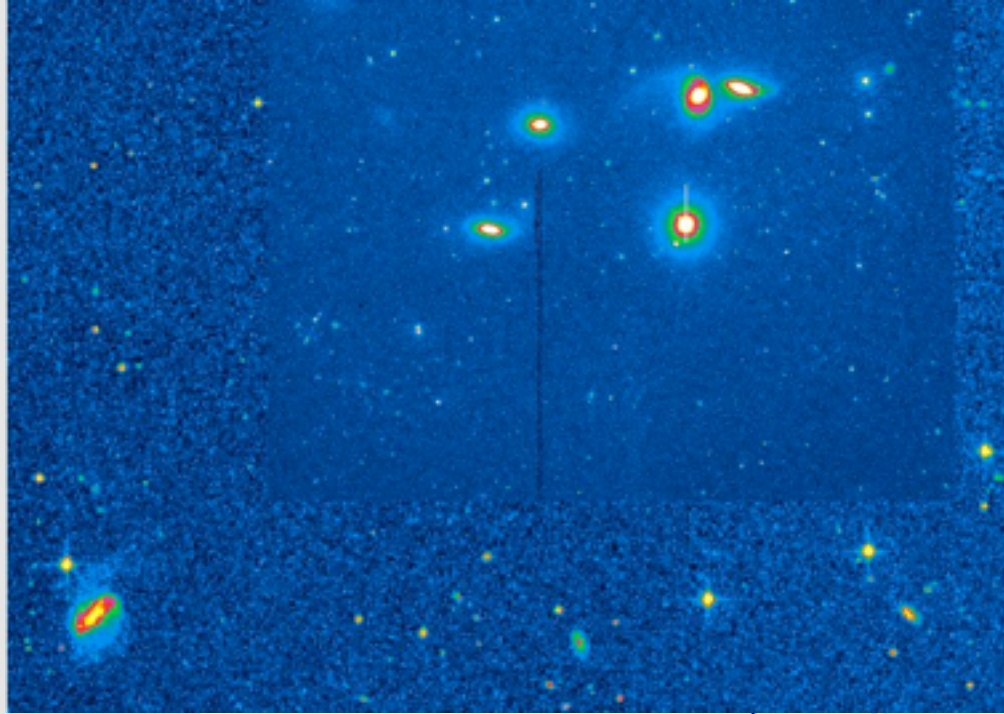
HCG 16, DEC -10



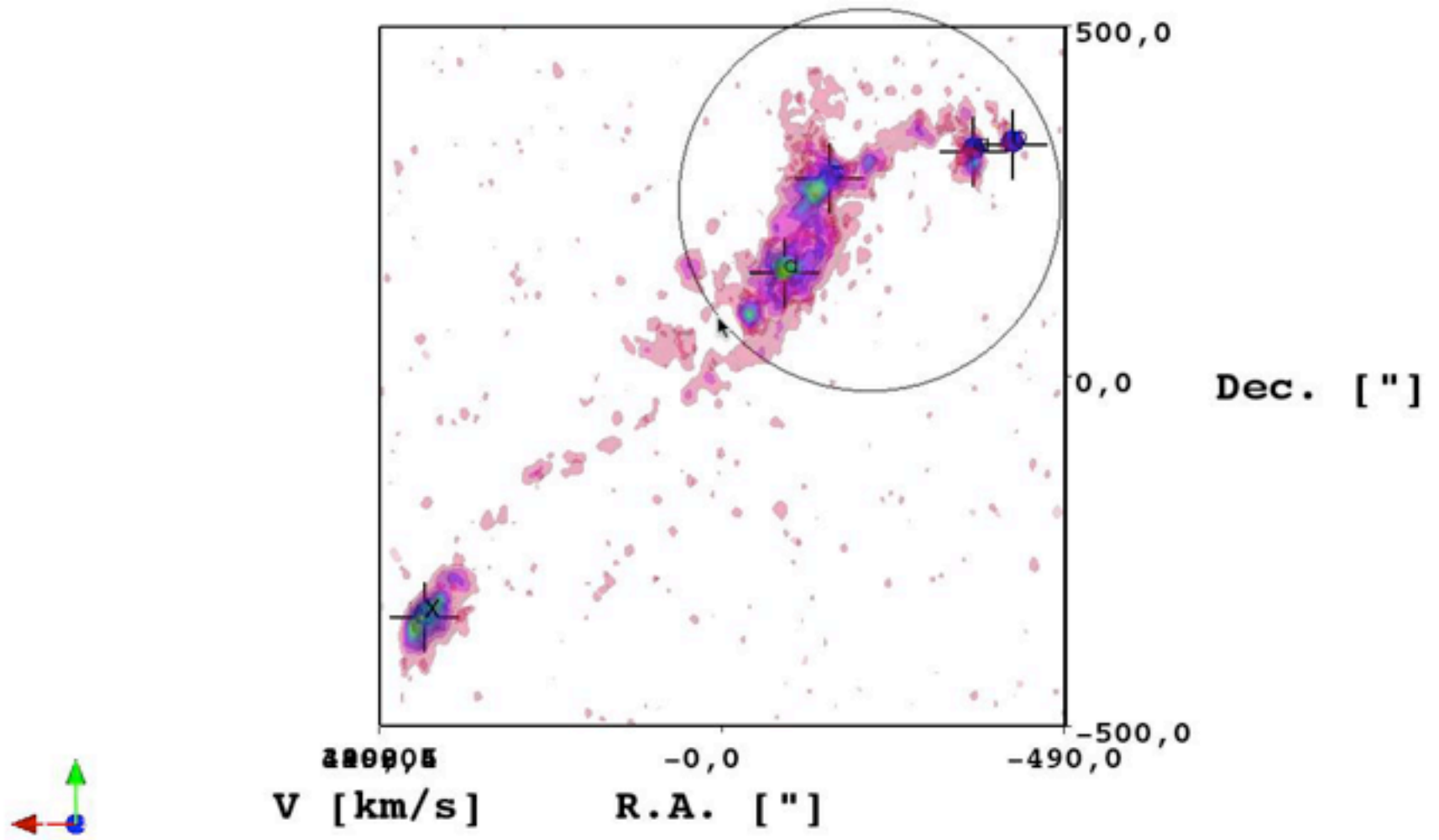
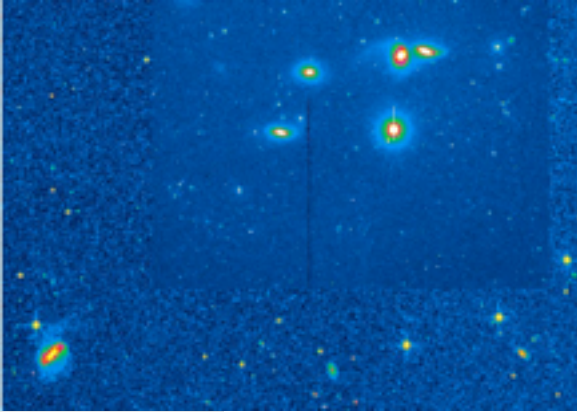
STAGE 2

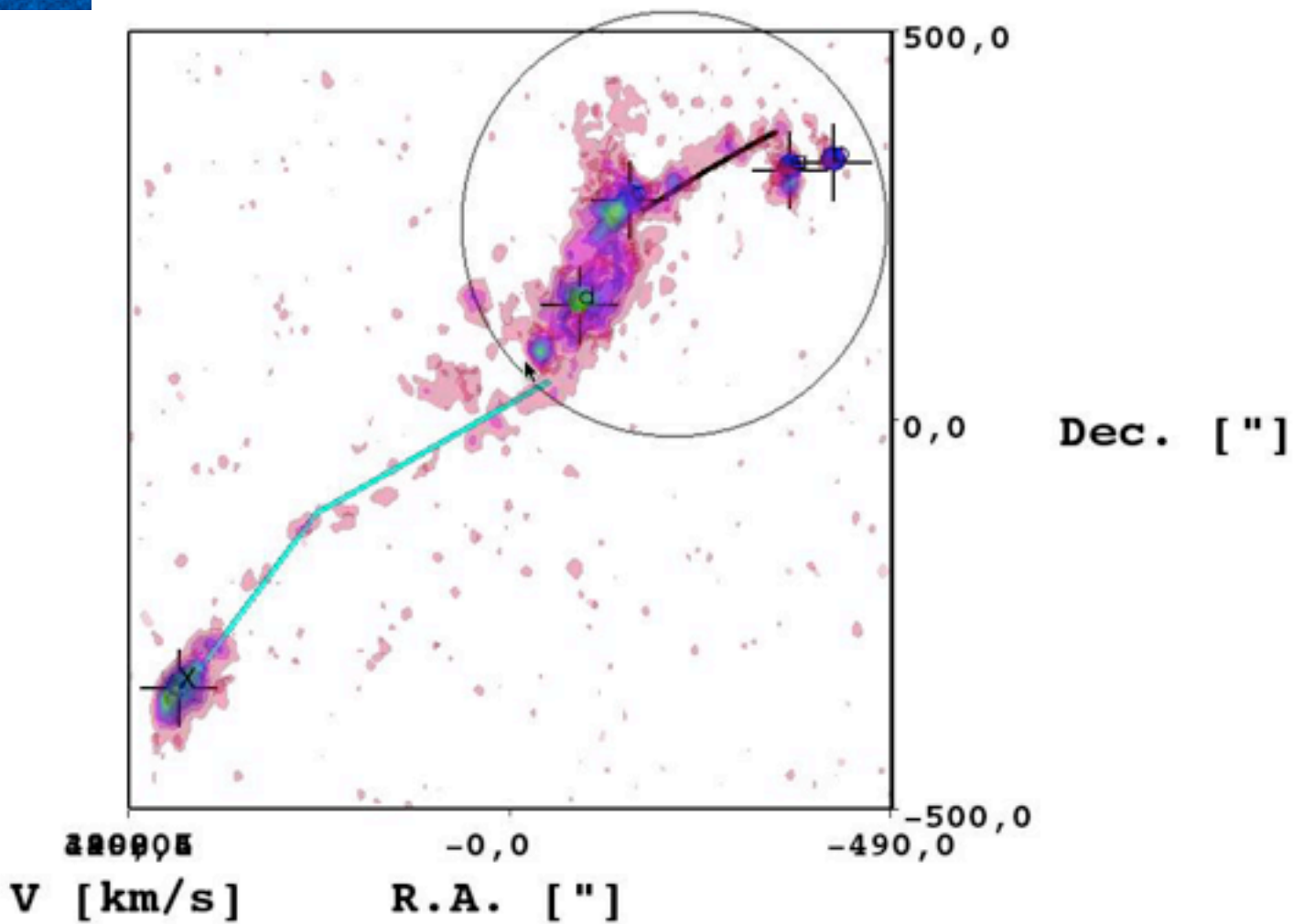
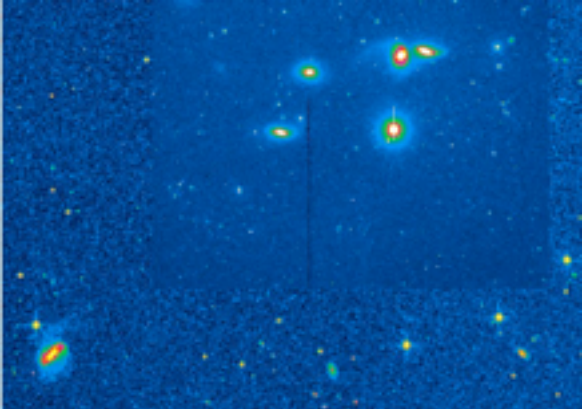
HCG 16, DEC -10

Mayavi Scene 1

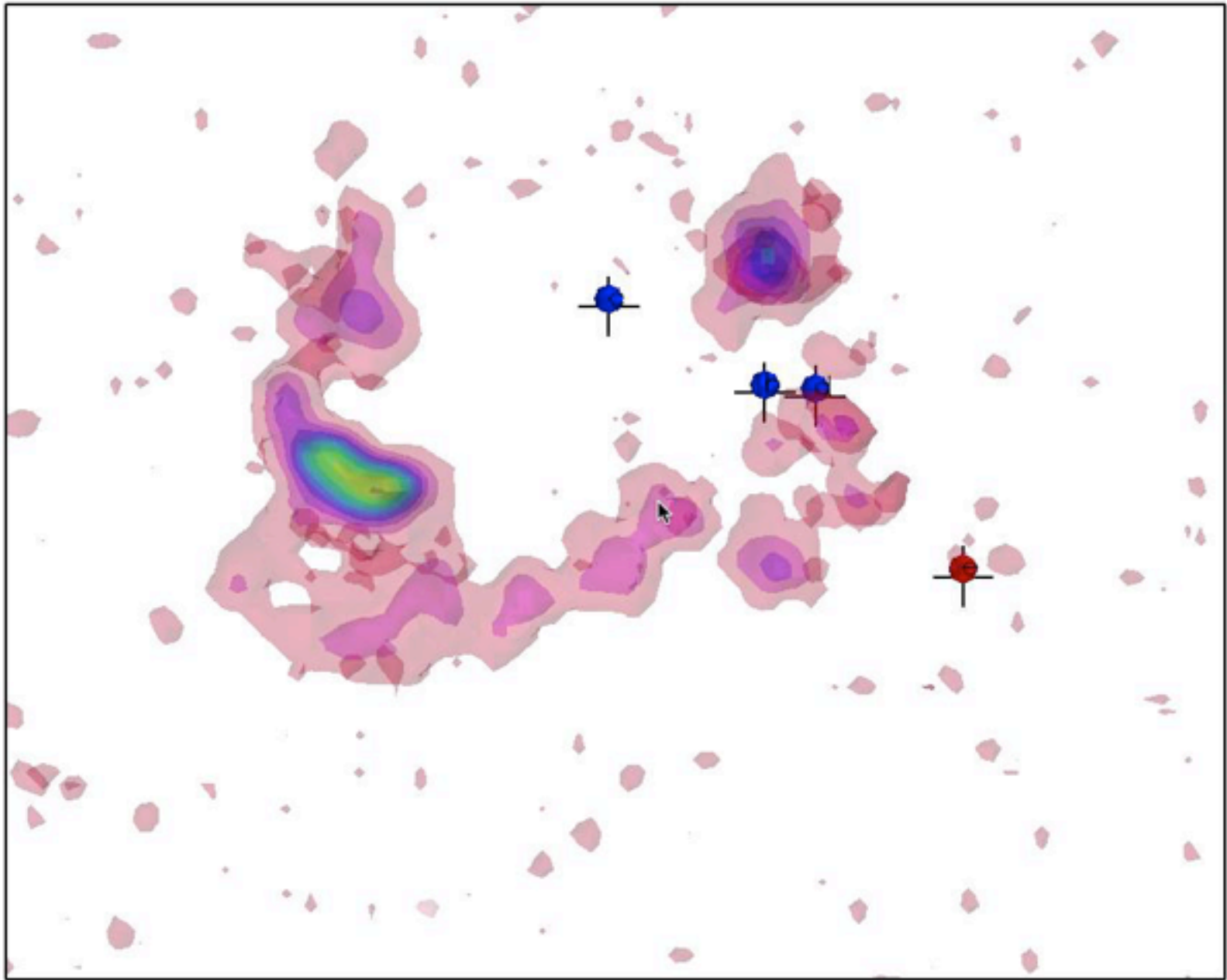


HCG 16, DEC -10

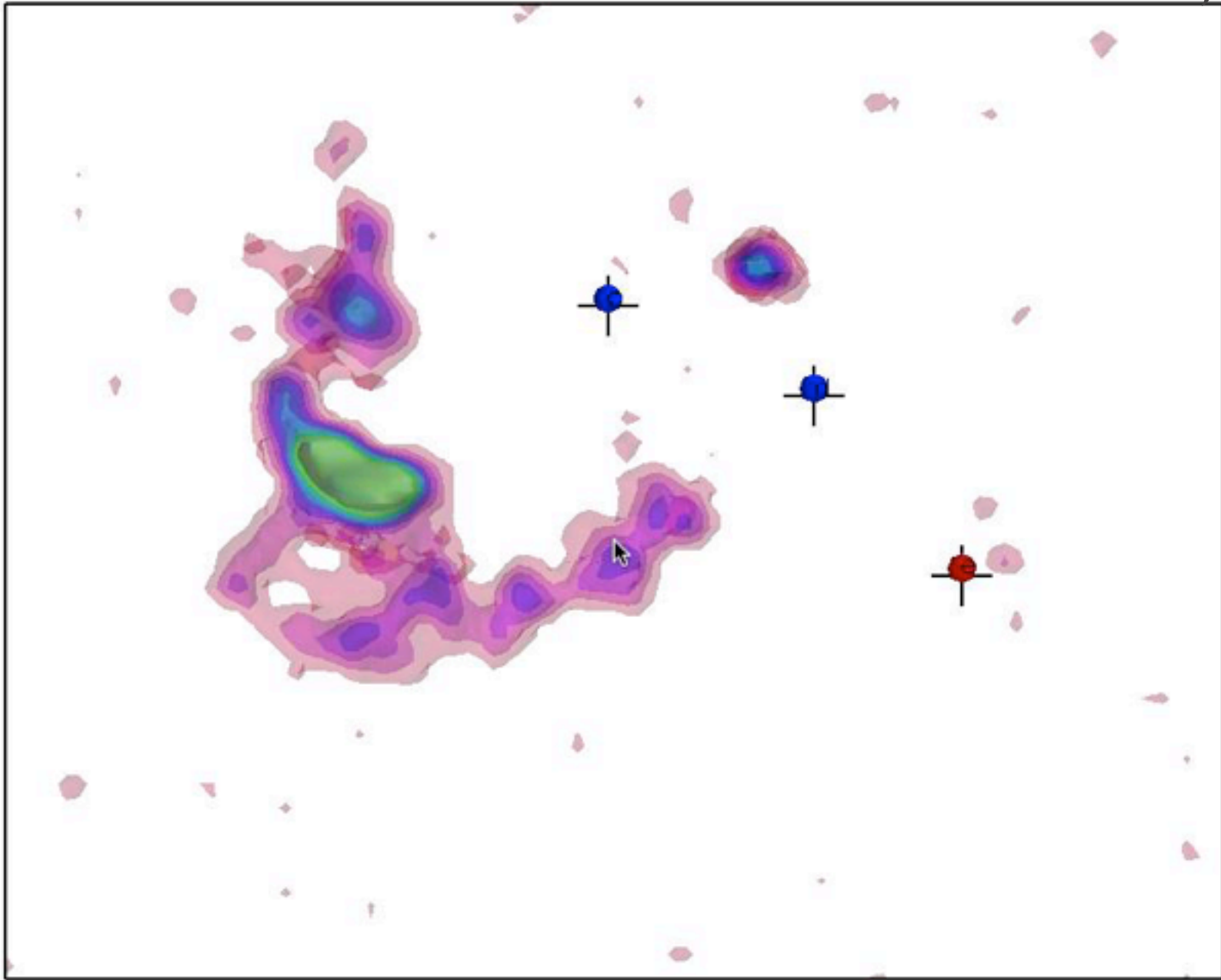




STAGE 2

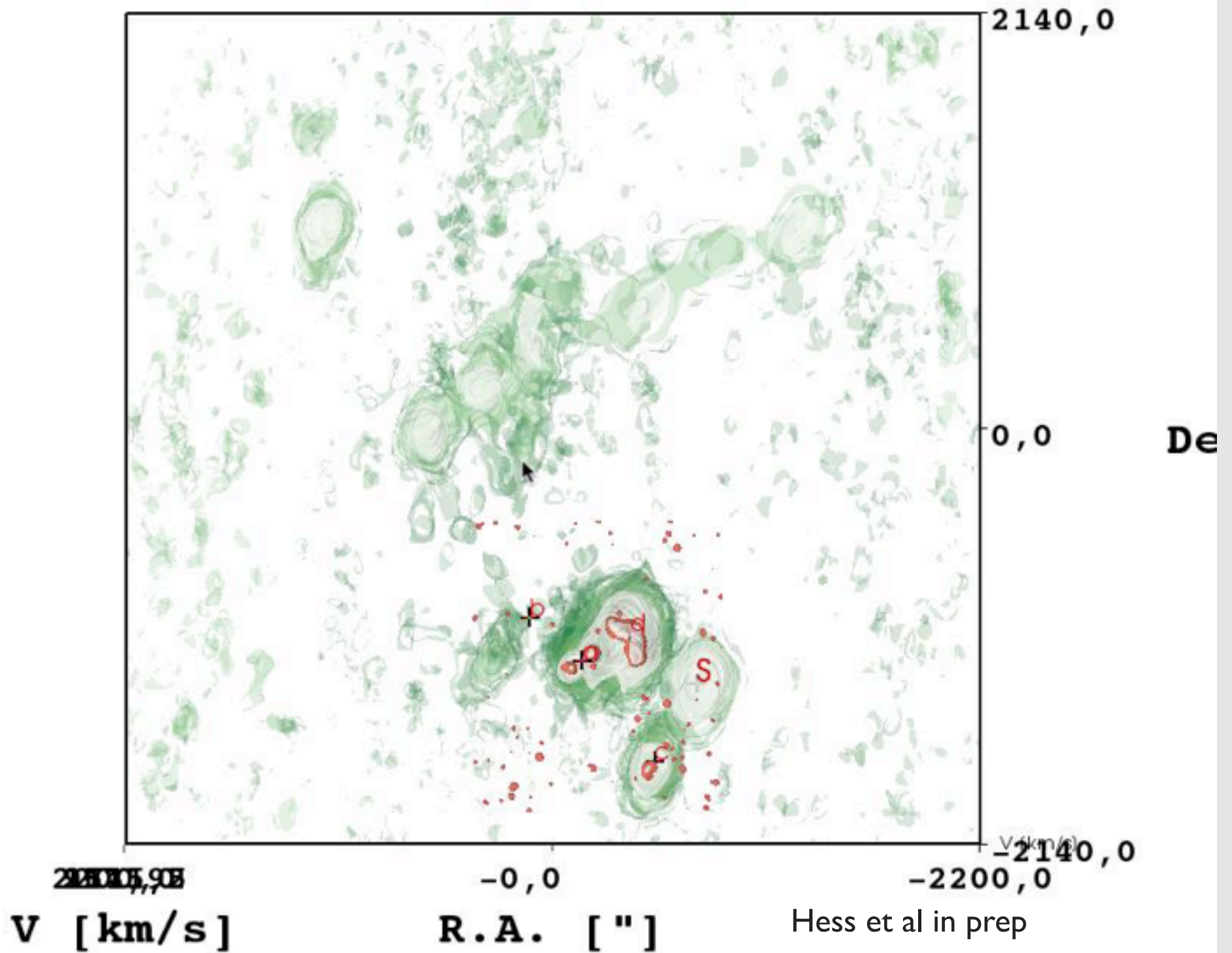


STAGE 3

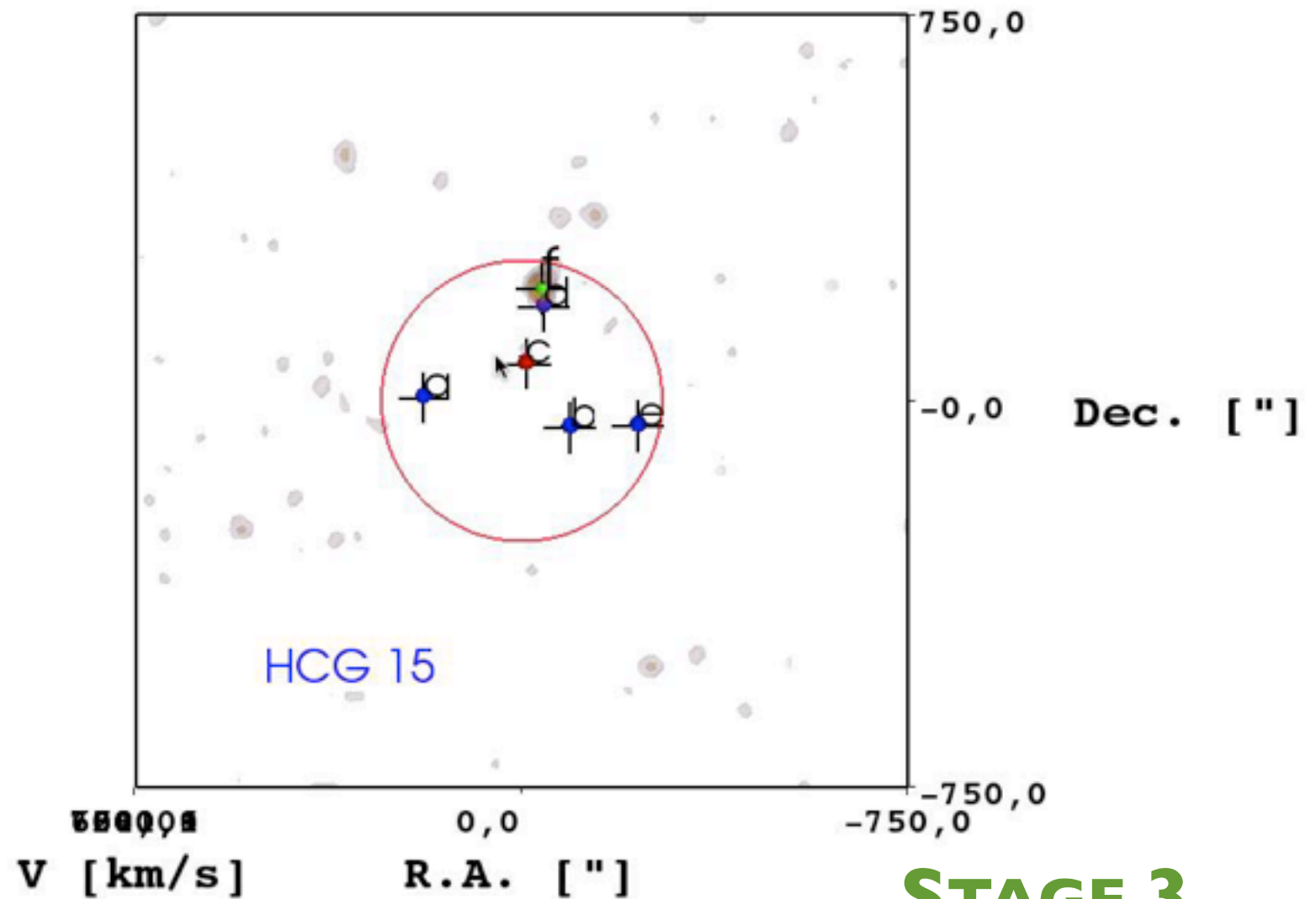


STAGE 3

HCG 44 KAT7 / VLA



HCG 15, DEC +2

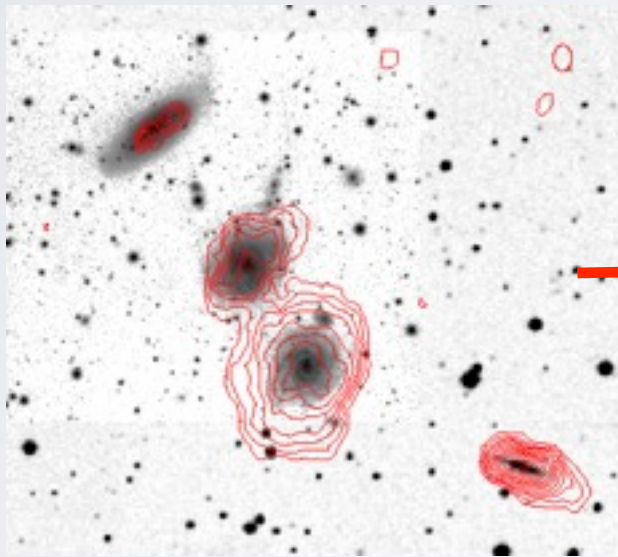


STAGE 3

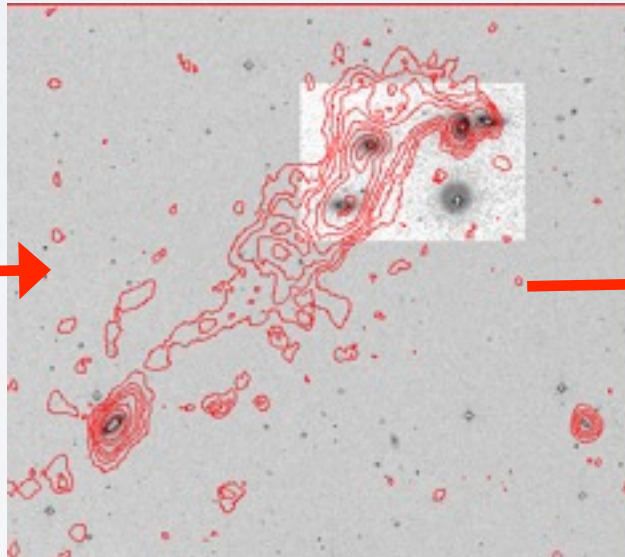
COMPACT GROUPS OF GALAXIES

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

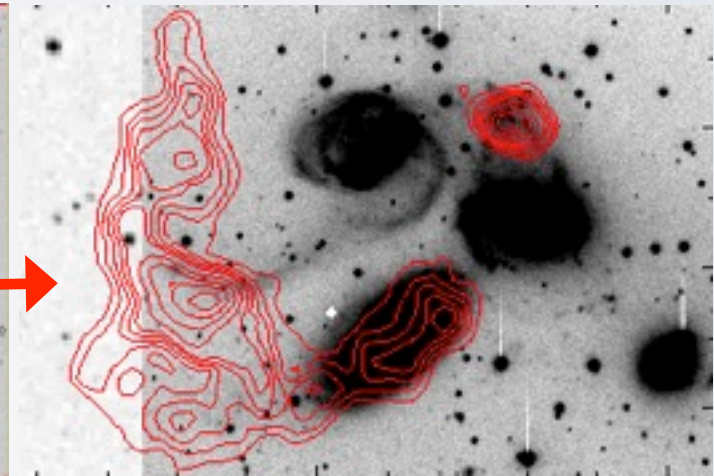
Phase 1: Low
level of interaction



Phase 2: Gas in
tidal features



Phase 3. No HI in the
galaxies



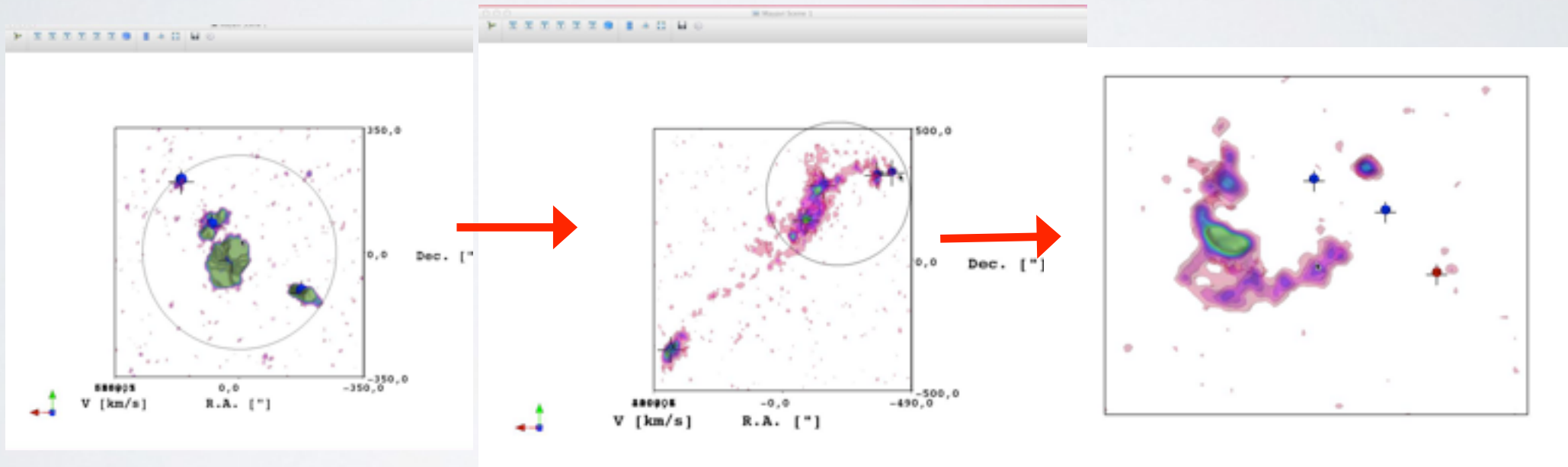
COMPACT GROUPS OF GALAXIES

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



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:

- coordinates 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



