ALFALFA Survey of the Leo Region

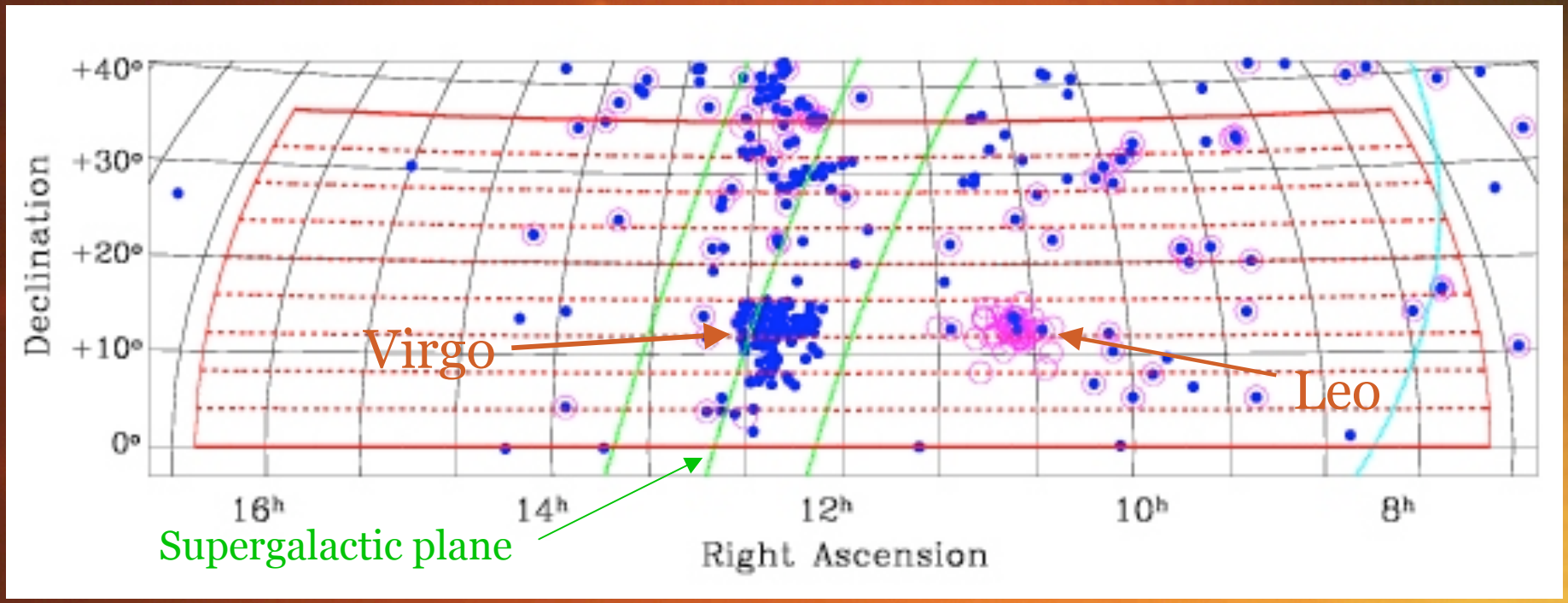
Sabrina Stierwalt

ALFALFA Workshop

June 23, 2006

Cornell University

ALFALFA: Spring Sky

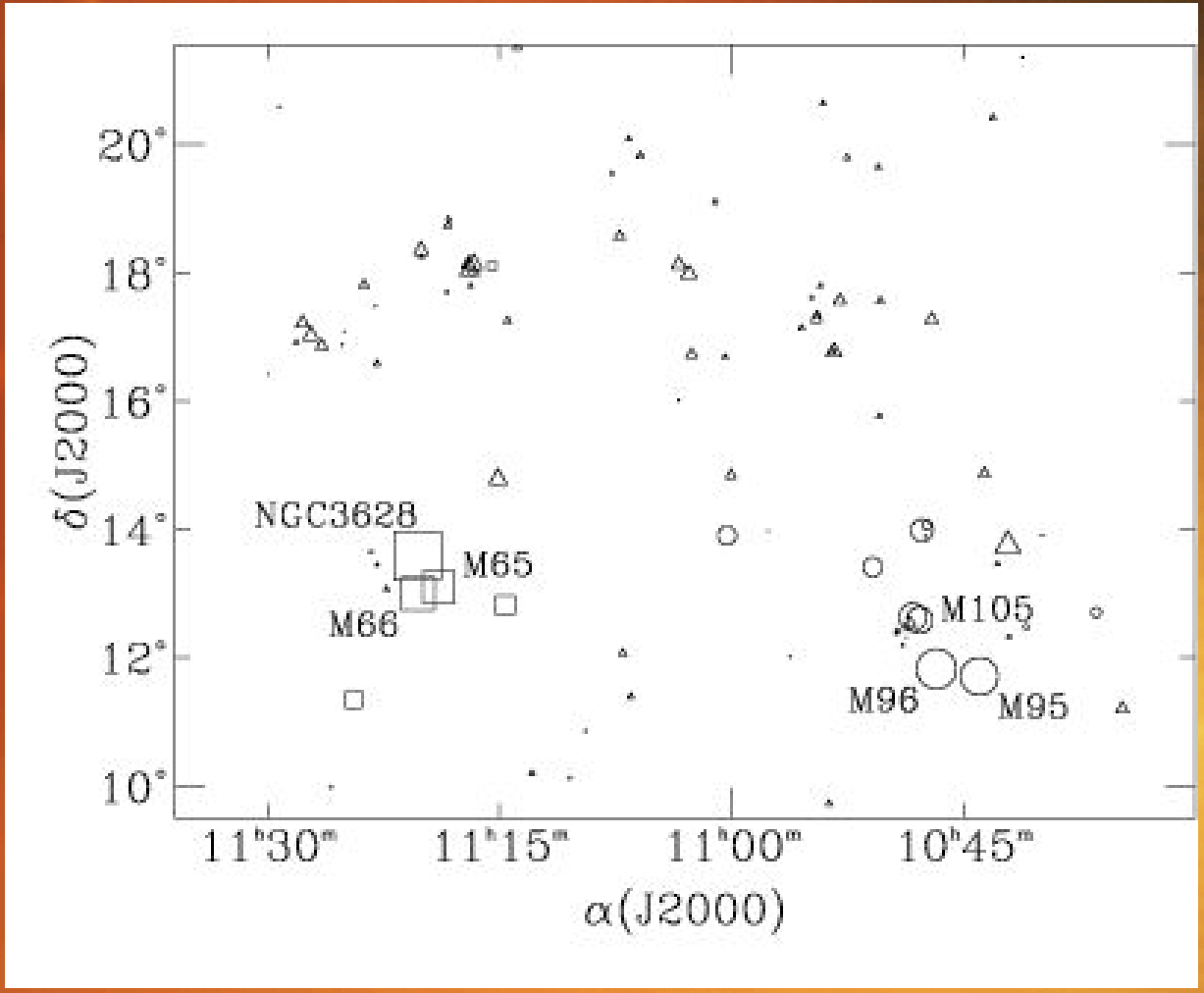


Leo Group

- **RA: 09^h45^m to 11^h45^m**
- **Dec: 8° to 16°**

Quick Tour of the Leo Region

- □ Likely M66 group member
- ○ Likely M96 group member
- △ Likely Leo II member



Plot from Schneider's *Leo Group* in *Encyclopedia of Astronomy & Astrophysics*

Leo I Group

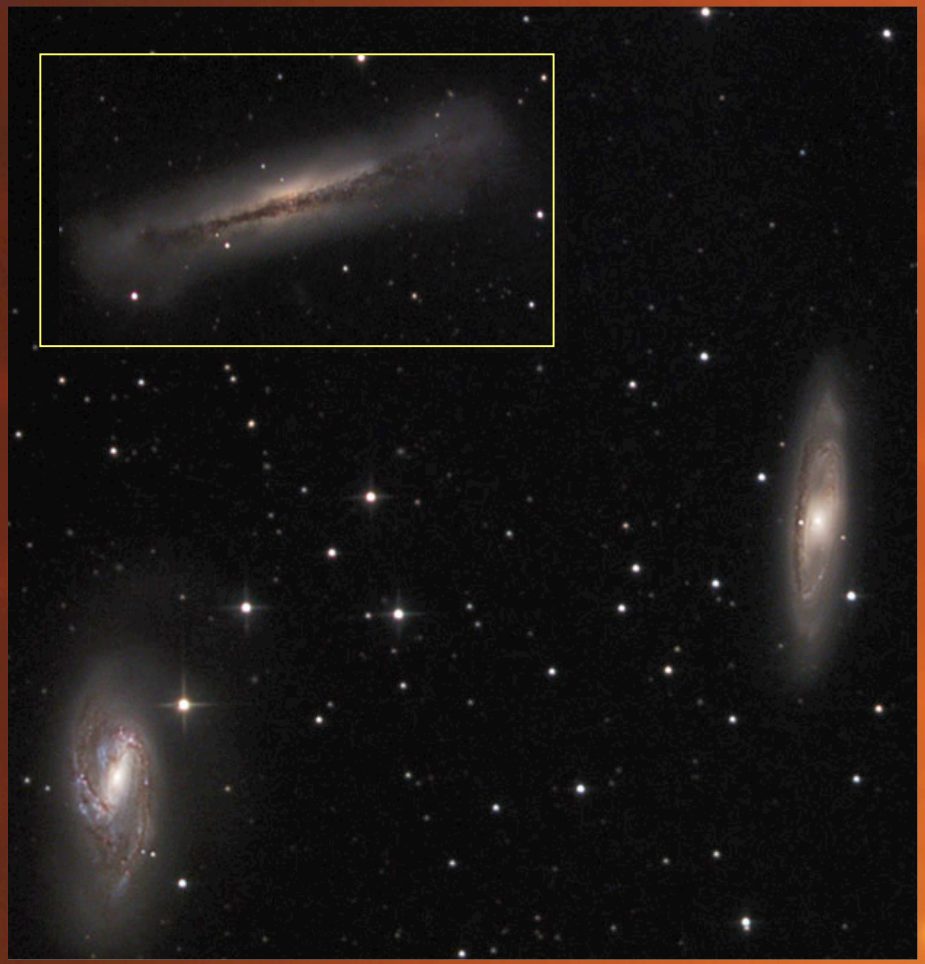
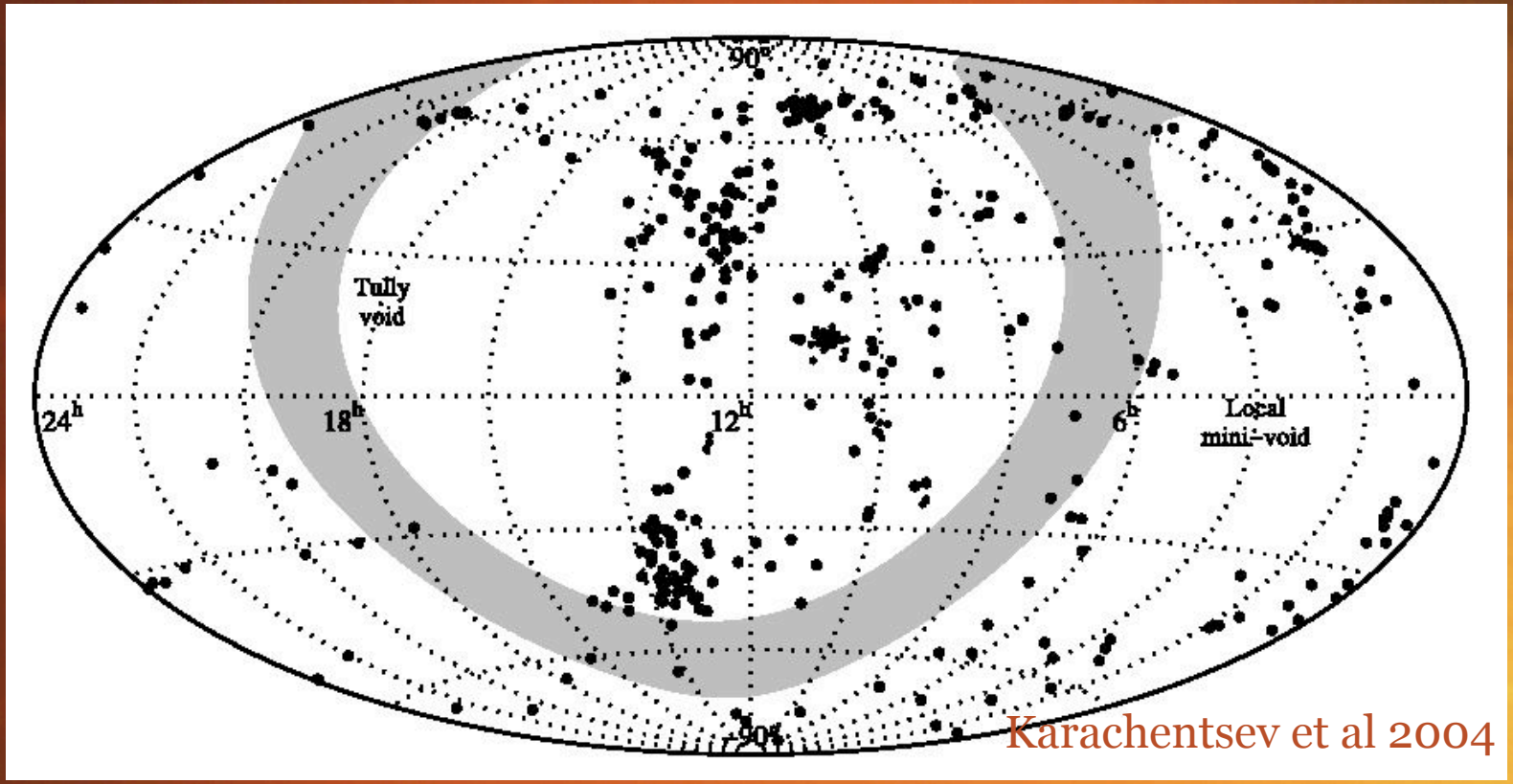


Image Credit: NOAO

- Proximity allows for study of low-mass, low-surface brightness galaxies
- Attractive opportunity for studying the HIMF in an intermediate density environment
- Interesting environment because has low velocity dispersion (~130 km/s) but a local density enhancement high enough to support presence of E/So galaxies

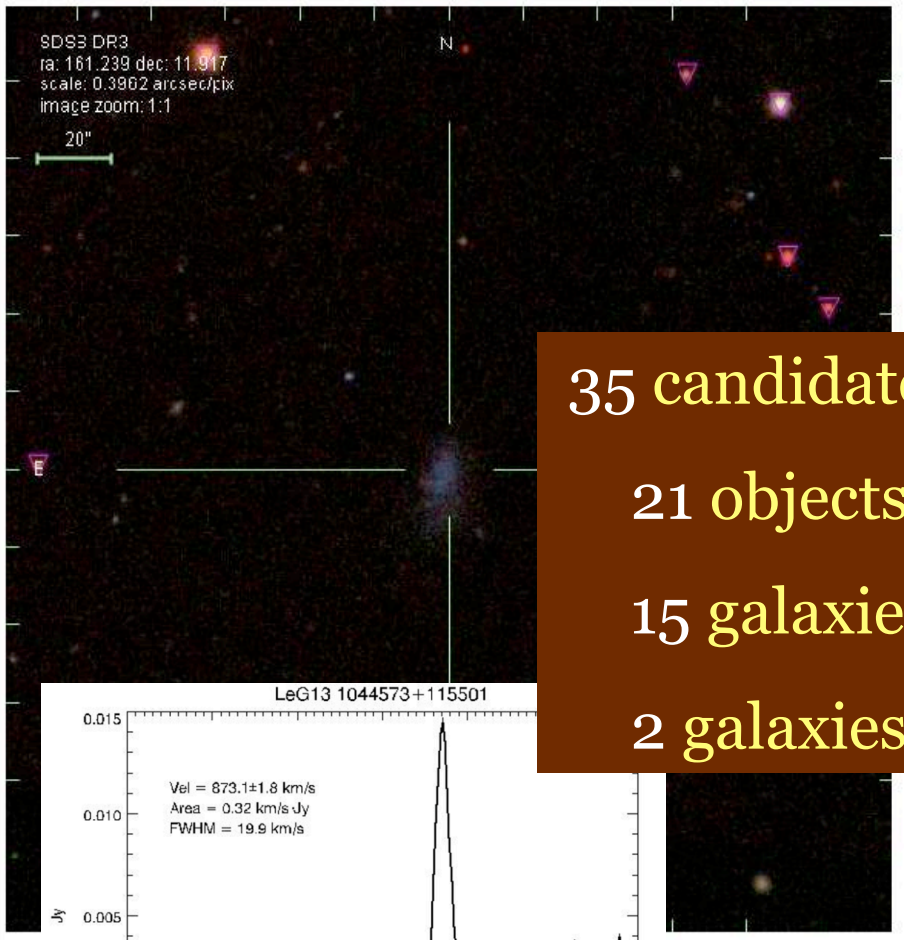
K & K's Catalog of Nearby Galaxies

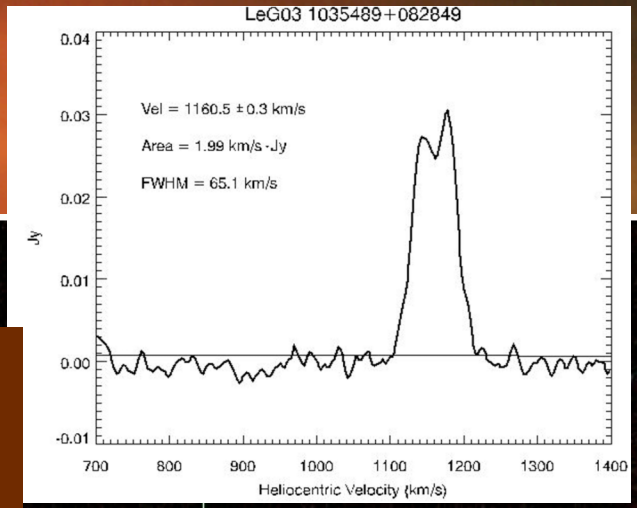


Karachentsev et al 2004

- 451 galaxies with D ≤ 10 Mpc or v_{LG} < 550 km/s
- 35 dwarf galaxy candidates identified via visual inspection of POSS-II/ESO/Serc plates

Optically-Selected Sample





35 candidates observed

21 objects detected

15 galaxies in Leo I

2 galaxies in Leo II

HI-Selected Sample (ALFALFA)

- 208 hours of observing time in 240 deg^2
- Of the 21 (LBW-detected) dwarf galaxy candidates from the optically-selected sample, 15 found in ALFALFA (6 required longer integration times)
- List of many new dwarf galaxy candidates being added to every day

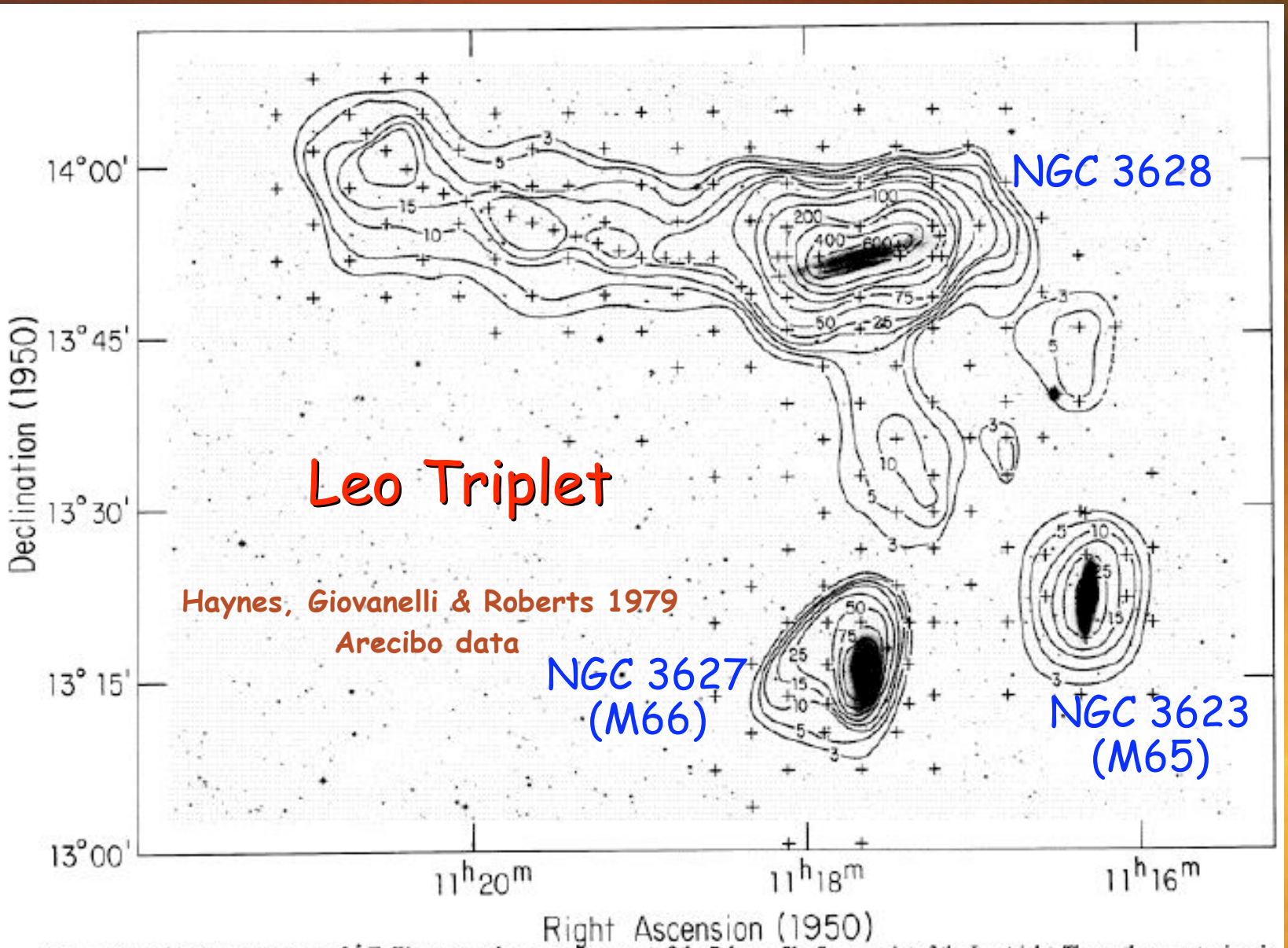
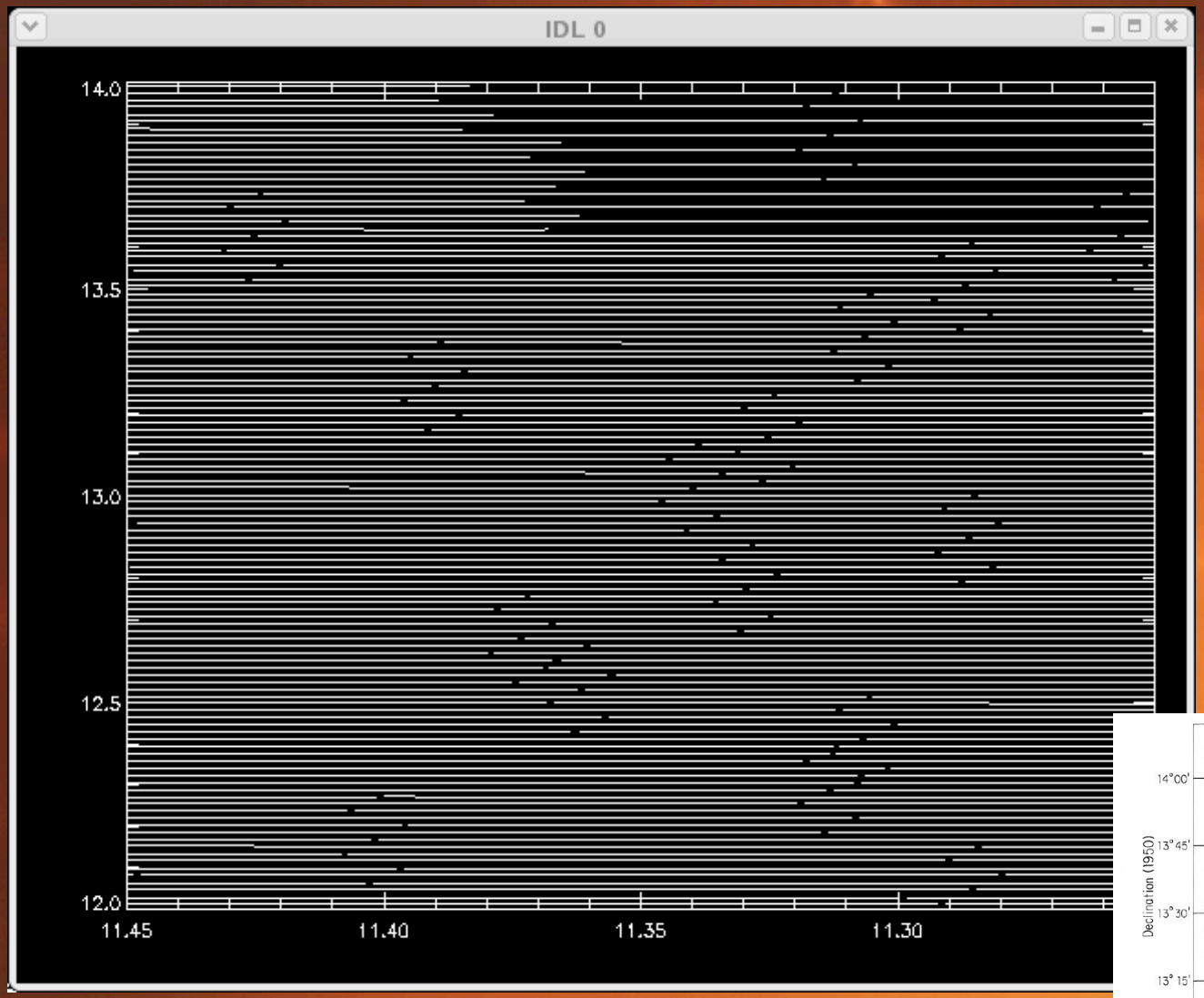


FIG. 1.—Neutral hydrogen contours of $\int T_A dV$ superposed on an enlargement of the Palomar Sky Survey print of the Leo triplet. The northernmost galaxy is NGC 3628; the southernmost is NGC 3627; the westernmost is NGC 3623. Crosses mark the sampling points of the Arecibo observations. The long appendage extending eastward from NGC 3628 is referred to as the plume; the extension in the region between the three galaxies is the bridge.

HAYNES *et al.* (*see* page 84)

ALFALFA Coverage of Triplet



RA=11:15-11:27
Dec=12:0-14:0
Cz=1125-452
step of 26 km/s

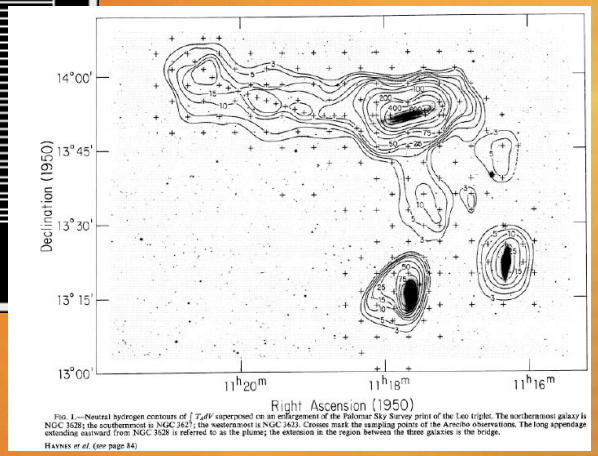
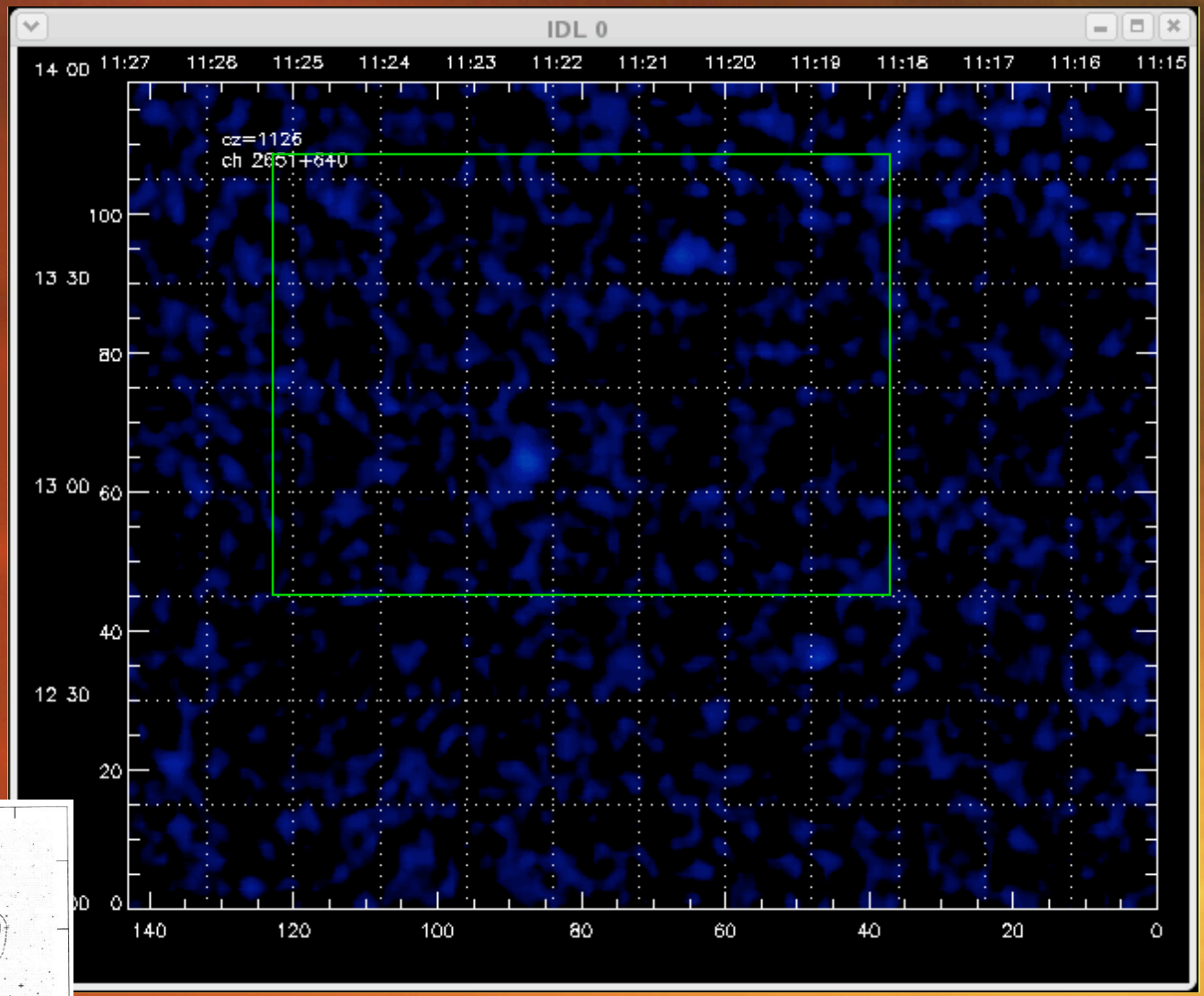


FIG. 1.—Neutral hydrogen contours of [7.6 cm superposed on an enlargement of the Palomar Sky Survey print of the Leo triplet. The northernmost galaxy is NGC 3628; the southernmost is NGC 3627; the easternmost is NGC 3623. Crosses mark the sampling points of the Arecibo observations. The long appendage extending eastward from NGC 3628 is referred to as the plume; the extension in the region between the three galaxies is the bridge.

HAYNES *et al.* (*see page 84*)



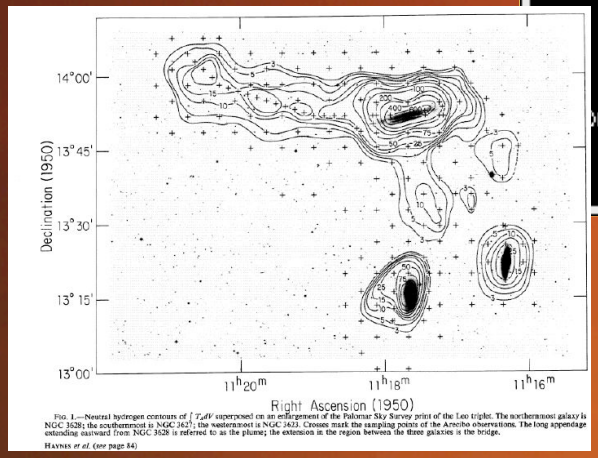
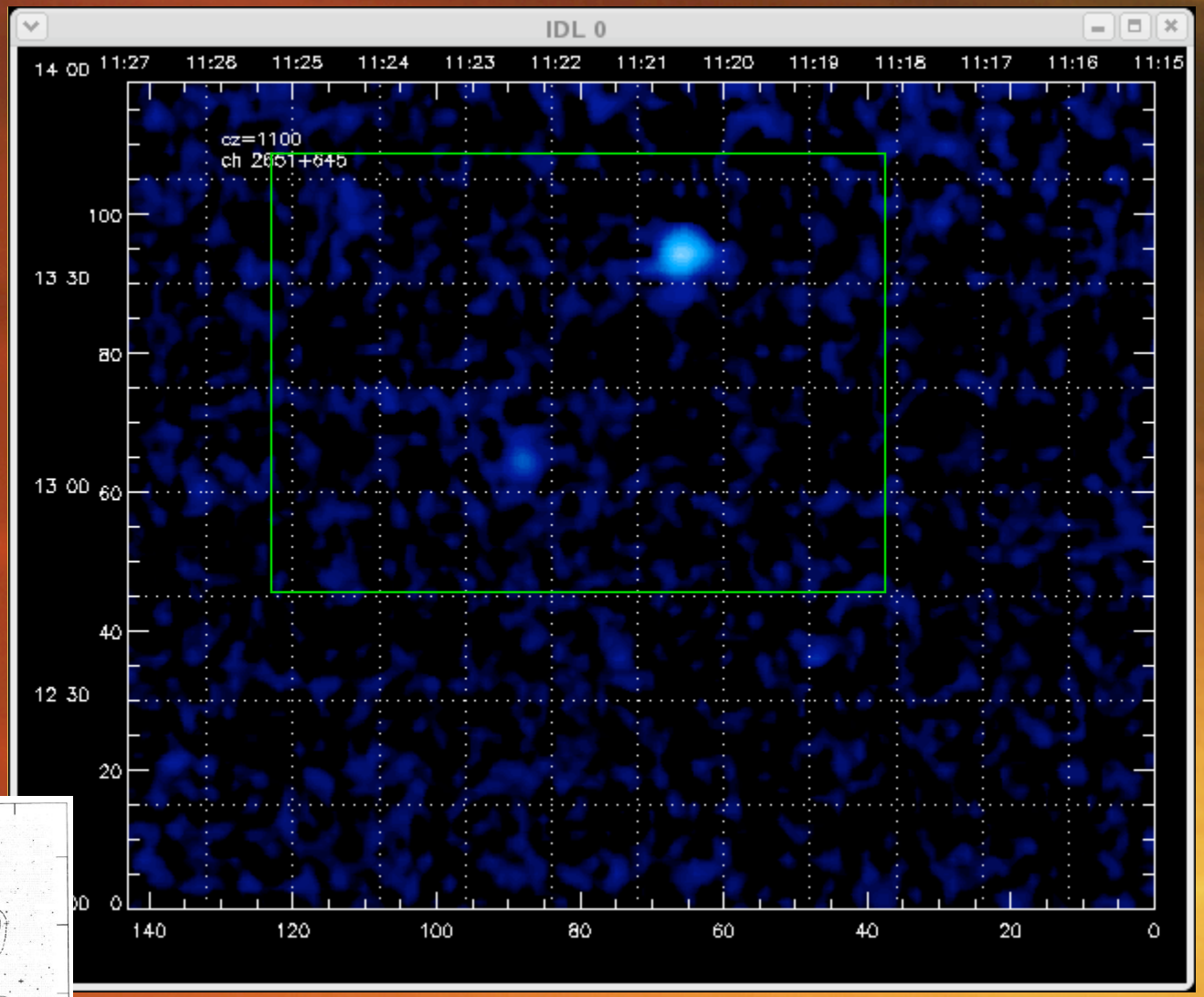


FIG. 1.—Neutral hydrogen contours of *[T_AdV* superposed on an enlargement of the Palomar Sky Survey print of the Leo triplet. The northernmost galaxy is NGC 3628; the southernmost is NGC 3627; the westernmost is NGC 3623. Crosses mark the sampling points of the Arecibo observations. The long appendage extending eastward from NGC 3628 is referred to as the plume; the extension in the region between the three galaxies is the bridge.

HAYNES *et al.* (*see* page 84)

Step = 26 km/s



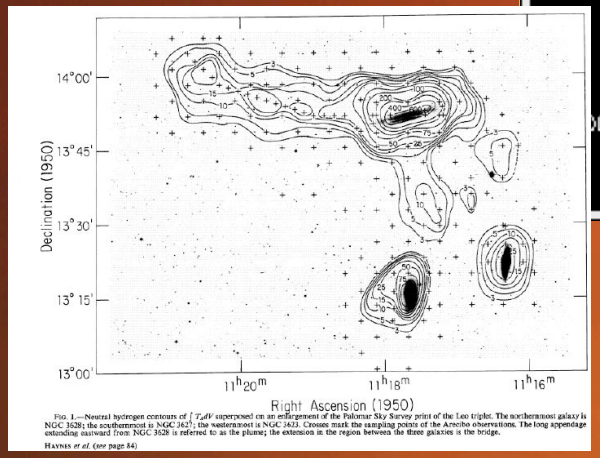
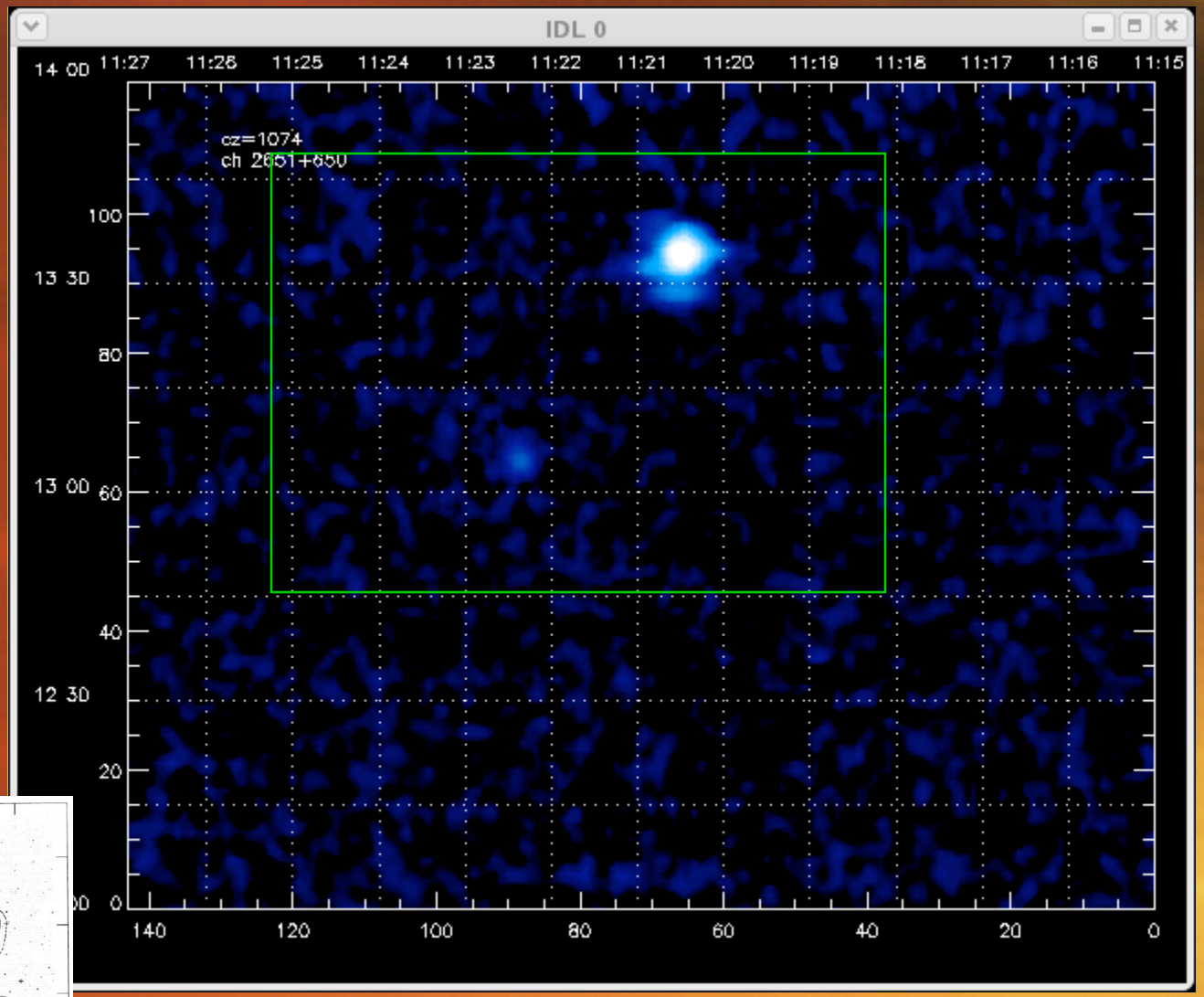


FIG. 1.—Neutral hydrogen contours of *[TeX* superposed on an enlargement of the Palomar Sky Survey print of the Leo triplet. The northernmost galaxy is NGC 3628; the southernmost is NGC 3627; the westernmost is NGC 3623. Crosses mark the sampling points of the Arecibo observations. The long appendage extending eastward from NGC 3628 is referred to as the plume; the extension in the region between the three galaxies is the bridge.

HAYNES *et al.* (*see* page 84)



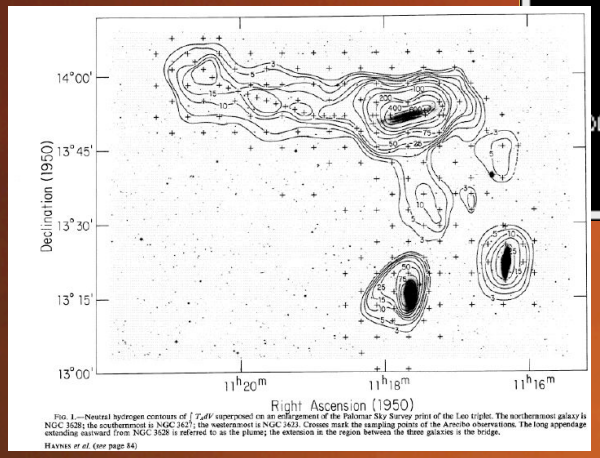
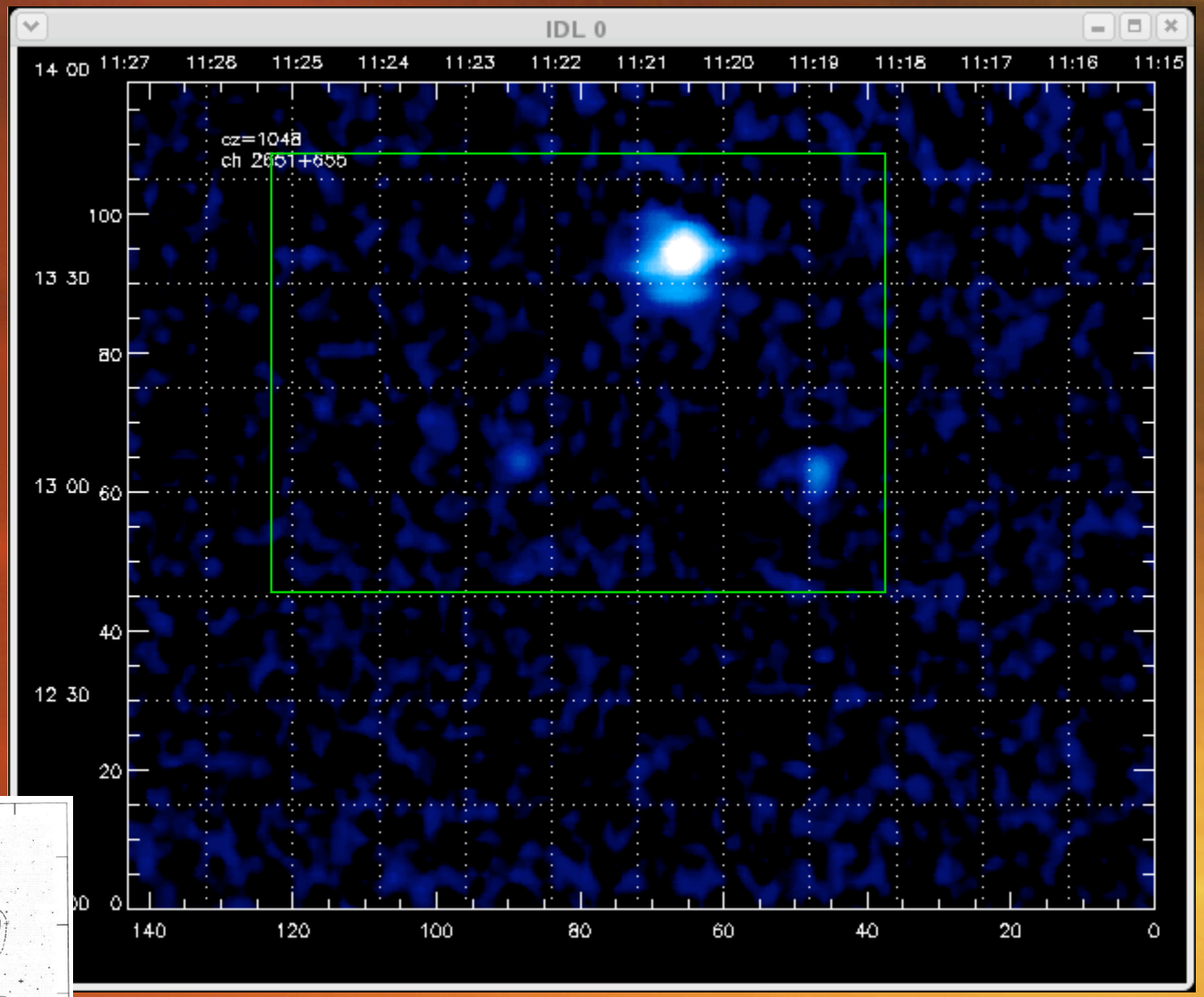


FIG. 1.—Neutral hydrogen contours of *[TeX* superposed on an enlargement of the Palomar Sky Survey print of the Leo triplet. The northernmost galaxy is NGC 3628; the southernmost is NGC 3627; the easternmost is NGC 3623. Crosses mark the sampling points of the Arecibo observations. The long appendage extending eastward from NGC 3628 is referred to as the plume; the extension in the region between the three galaxies is the bridge.

HAYNES *et al.* (*see* page 84)



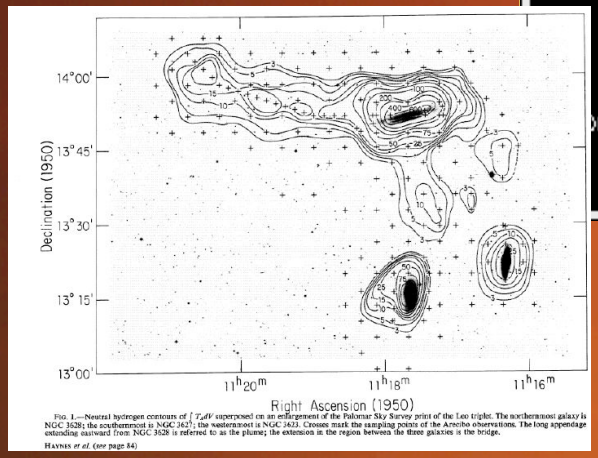
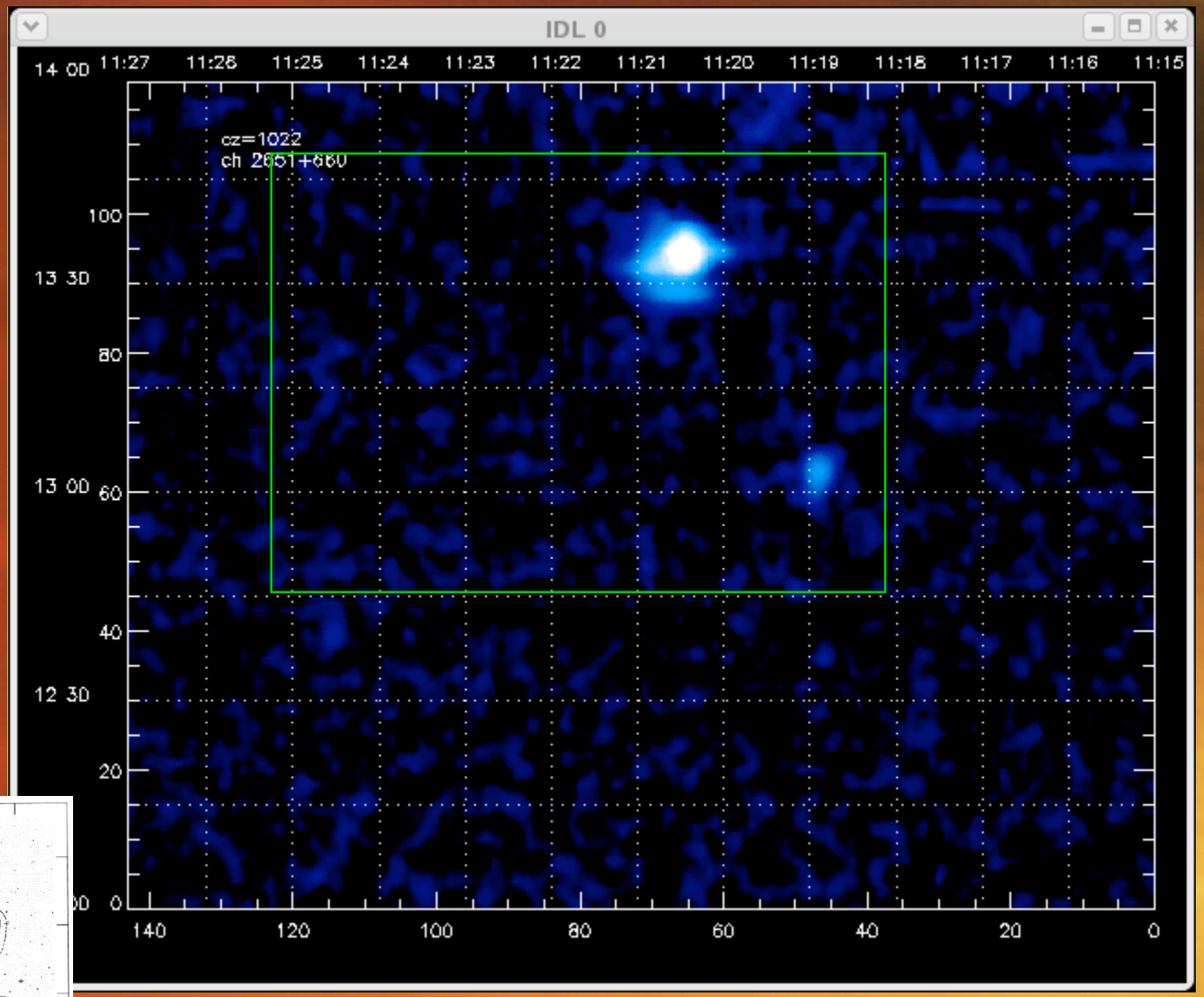


FIG. 1.—Neutral hydrogen contours of *[TeX* superposed on an enlargement of the Palomar Sky Survey print of the Leo triplet. The northernmost galaxy is NGC 3628; the southernmost is NGC 3627; the westernmost is NGC 3623. Crosses mark the sampling points of the Arecibo observations. The long appendage extending eastward from NGC 3628 is referred to as the plume; the extension in the region between the three galaxies is the bridge.

HAYNES *et al.* (*see* page 84)



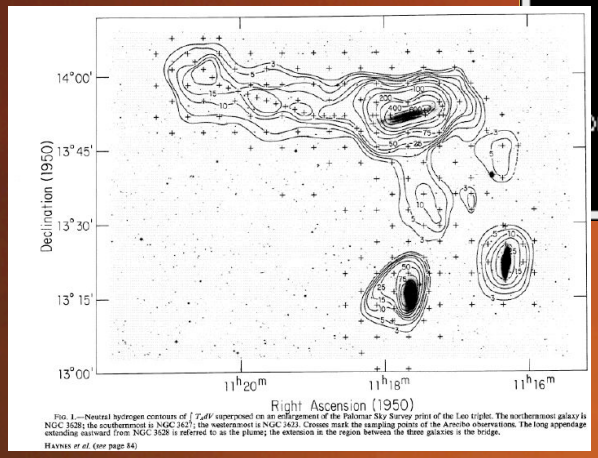
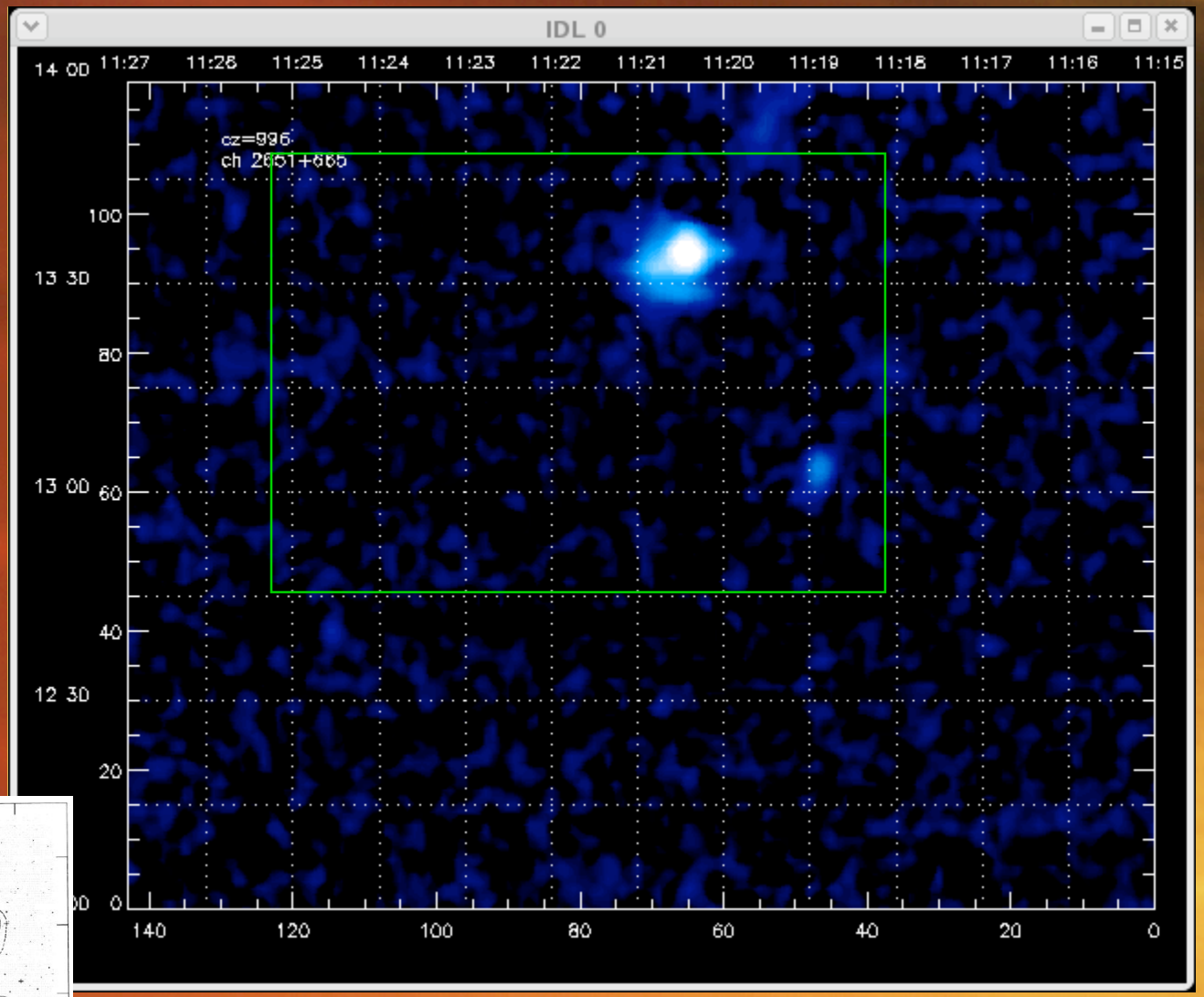


FIG. 1.—Neutral hydrogen contours of *[T_AV* superposed on an enlargement of the Palomar Sky Survey print of the Leo triplet. The northernmost galaxy is NGC 3628; the southernmost is NGC 3627; the westernmost is NGC 3623. Crosses mark the sampling points of the Arecibo observations. The long appendage extending eastward from NGC 3628 is referred to as the plume; the extension in the region between the three galaxies is the bridge.

HAYNES *et al.* (*see* page 84)



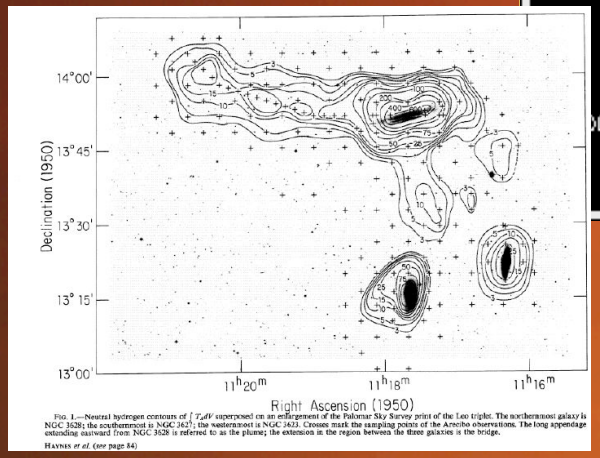
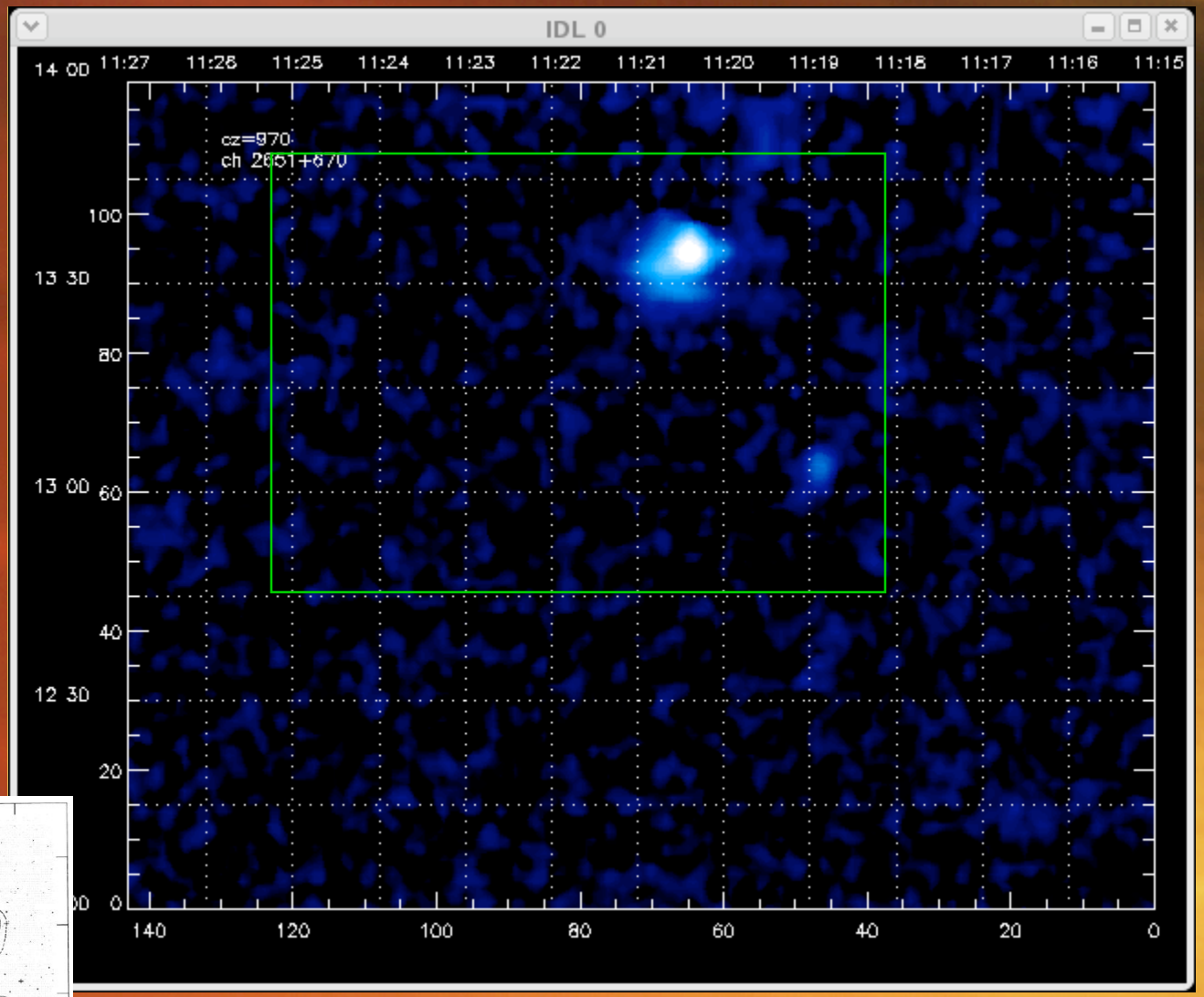


FIG. 1.—Neutral hydrogen contours of *[TeX* superposed on an enlargement of the Palomar Sky Survey print of the Leo triplet. The northernmost galaxy is NGC 3628; the southernmost is NGC 3627; the westernmost is NGC 3623. Crosses mark the sampling points of the Arecibo observations. The long appendage extending eastward from NGC 3628 is referred to as the plume; the extension in the region between the three galaxies is the bridge.

HAYNES *et al.* (*see* page 84)



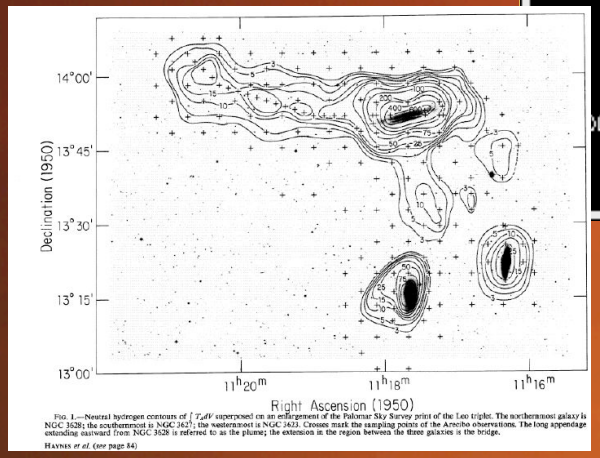
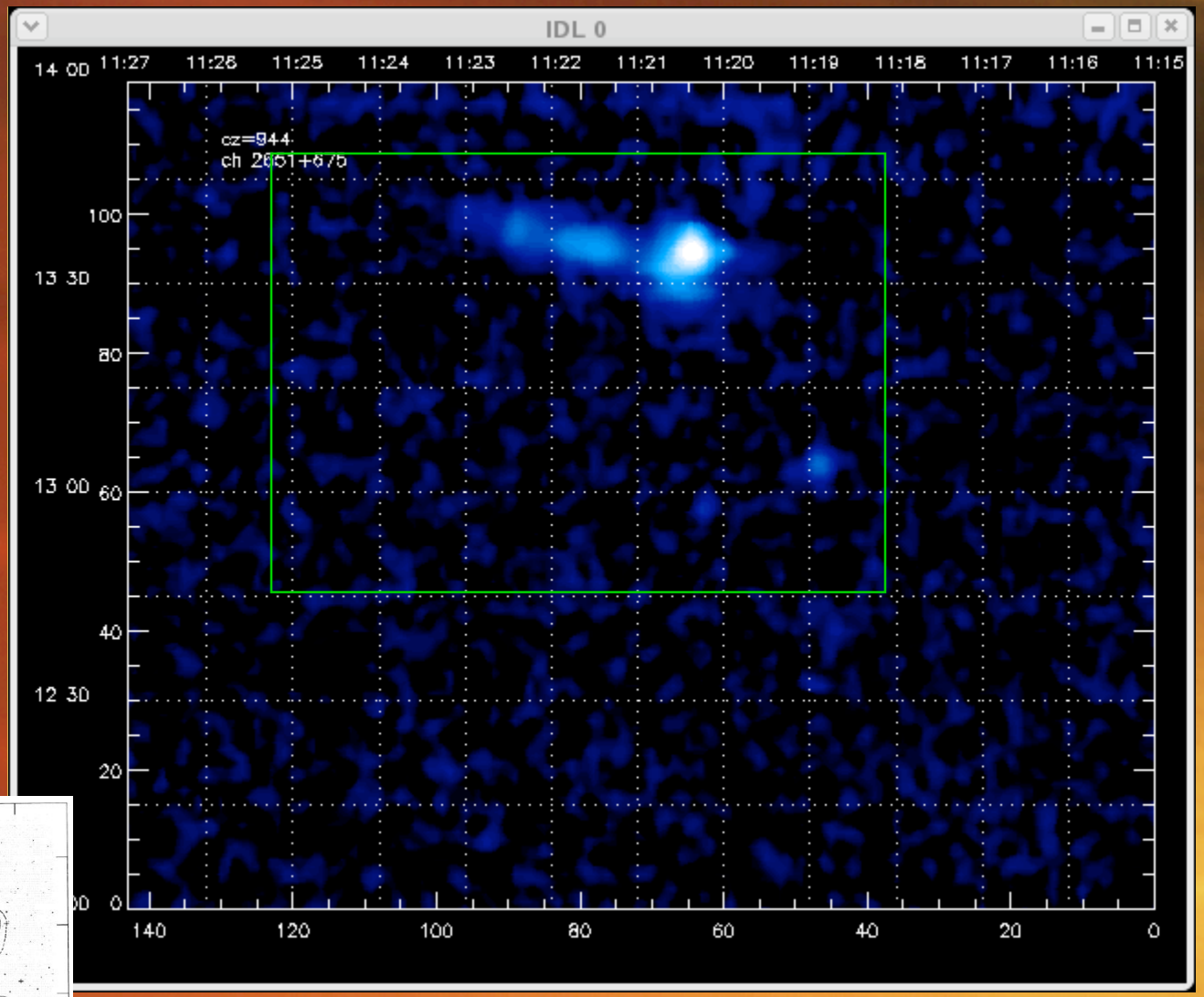


FIG. 1.—Neutral hydrogen contours of *[TeX* superposed on an enlargement of the Palomar Sky Survey print of the Leo triplet. The northernmost galaxy is NGC 3628; the southernmost is NGC 3627; the westernmost is NGC 3623. Crosses mark the sampling points of the Arecibo observations. The long appendage extending eastward from NGC 3628 is referred to as the plume; the extension in the region between the three galaxies is the bridge.

HAYNES *et al.* (*see* page 84)



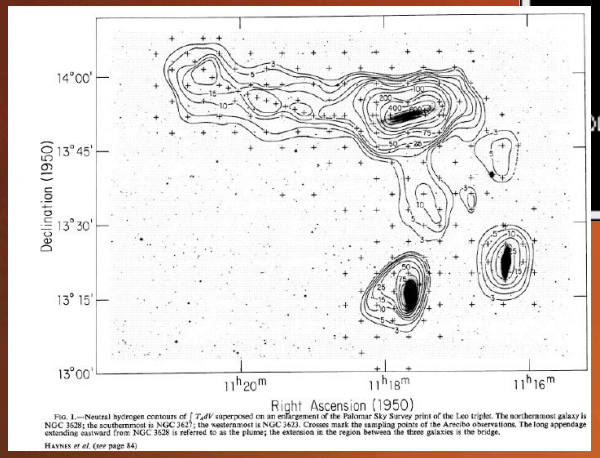
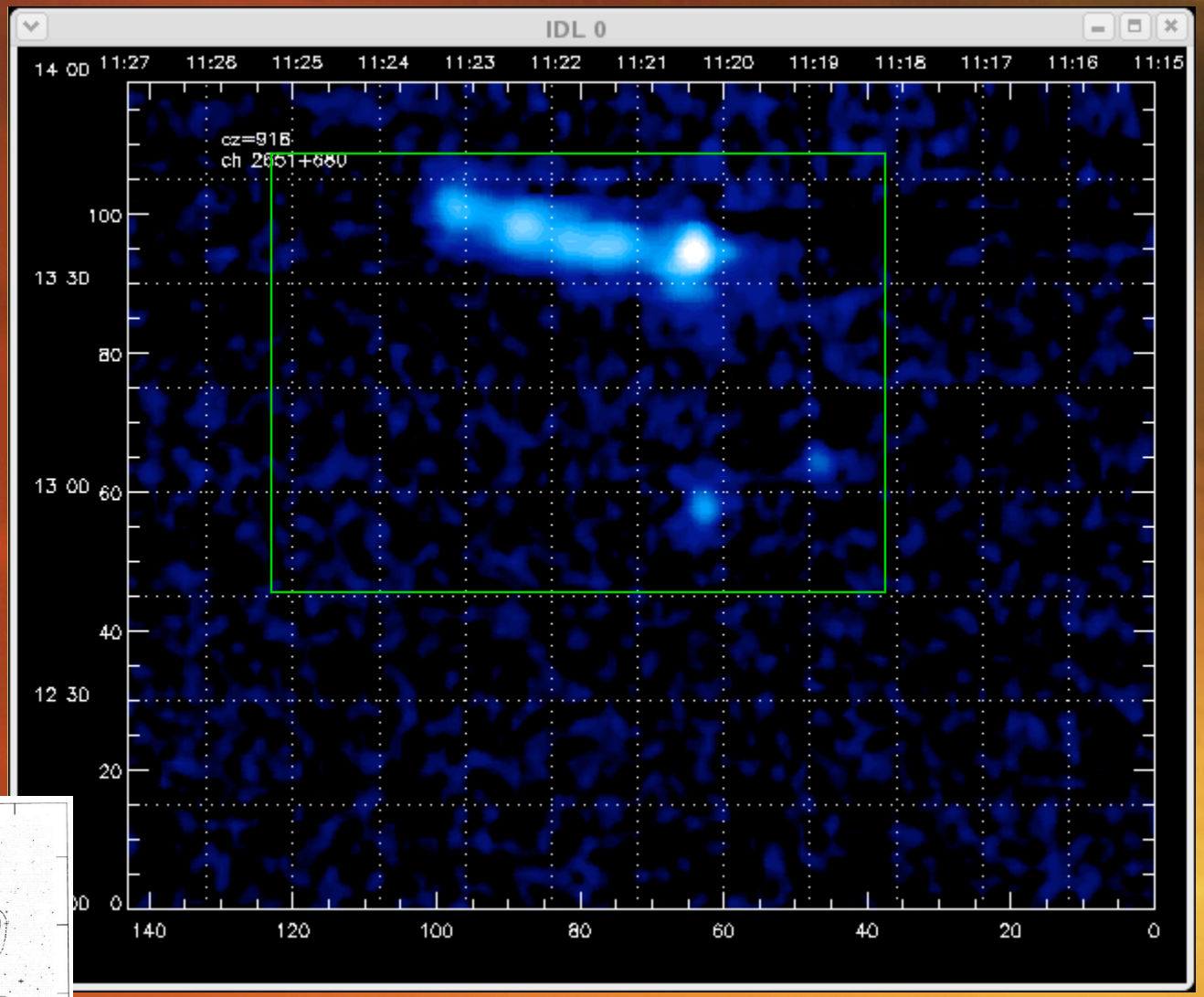


FIG. 1.—Neutral hydrogen contours of $I_{\nu}dV$ superposed on an enlargement of the Palomar Sky Survey print of the Leo triplet. The northernmost galaxy is NGC 3628; the southernmost is NGC 3627; the westernmost is NGC 3623. Crosses mark the sampling points of the Arecibo observations. The long appendage extending eastward from NGC 3628 is referred to as the plume; the extension in the region between the three galaxies is the bridge.

HAYNES *et al.* (*see* page 84)



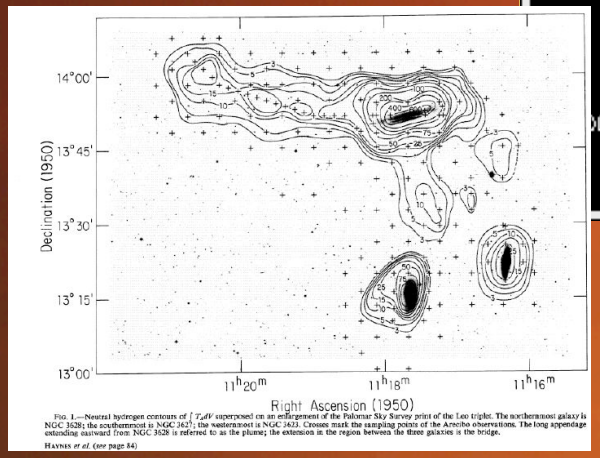
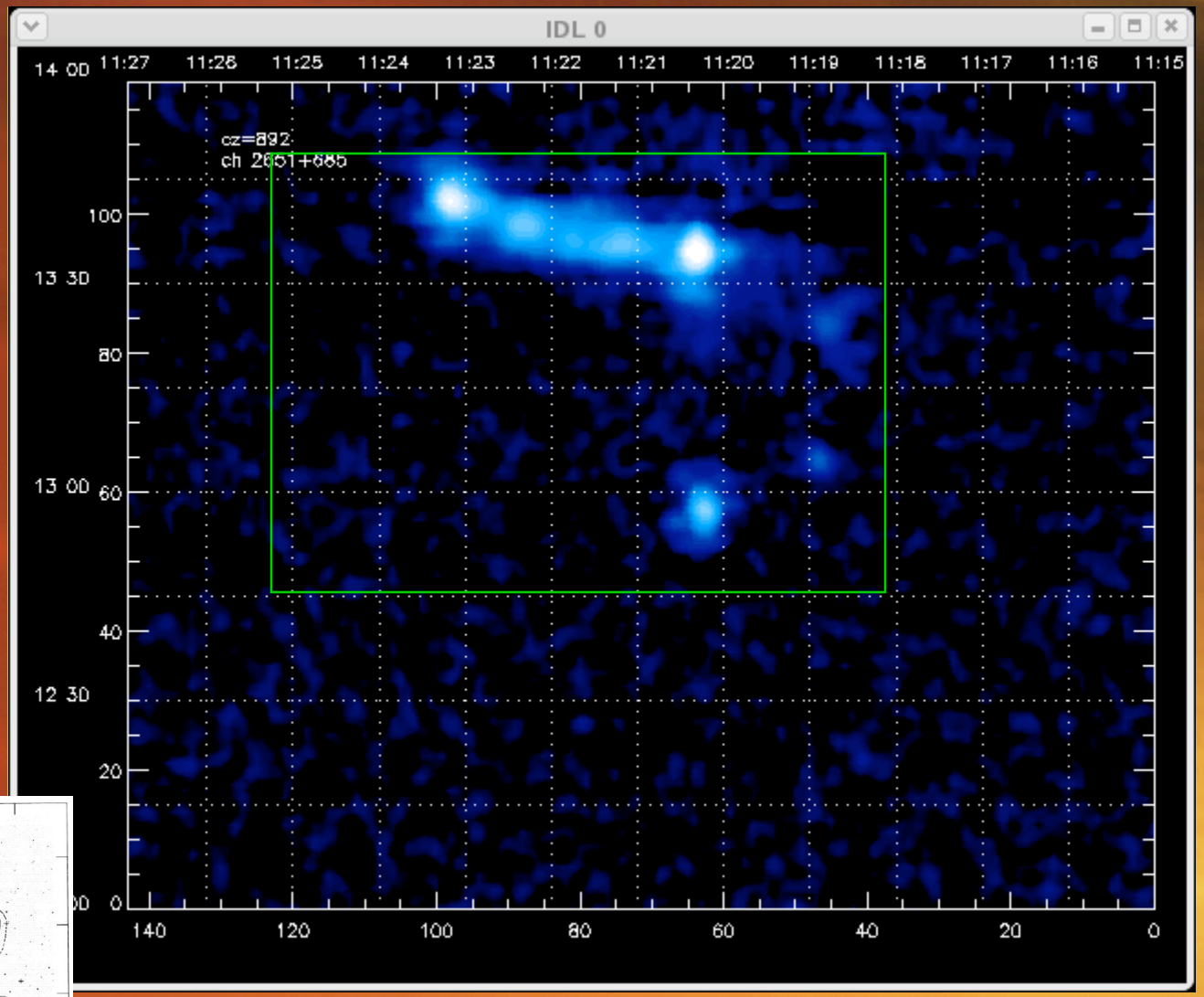


FIG. 1.—Neutral hydrogen contours of *[TeX* superposed on an enlargement of the Palomar Sky Survey print of the Leo triplet. The northernmost galaxy is NGC 3628; the southernmost is NGC 3627; the easternmost is NGC 3623. Crosses mark the sampling points of the Arecibo observations. The long appendage extending eastward from NGC 3628 is referred to as the plume; the extension in the region between the three galaxies is the bridge.

HAYNES *et al.* (*see* page 84)



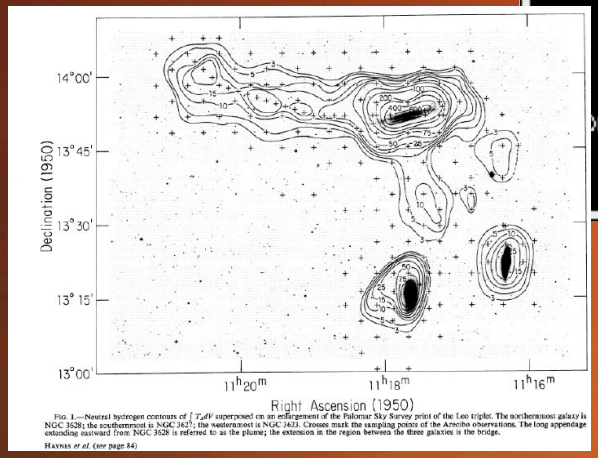
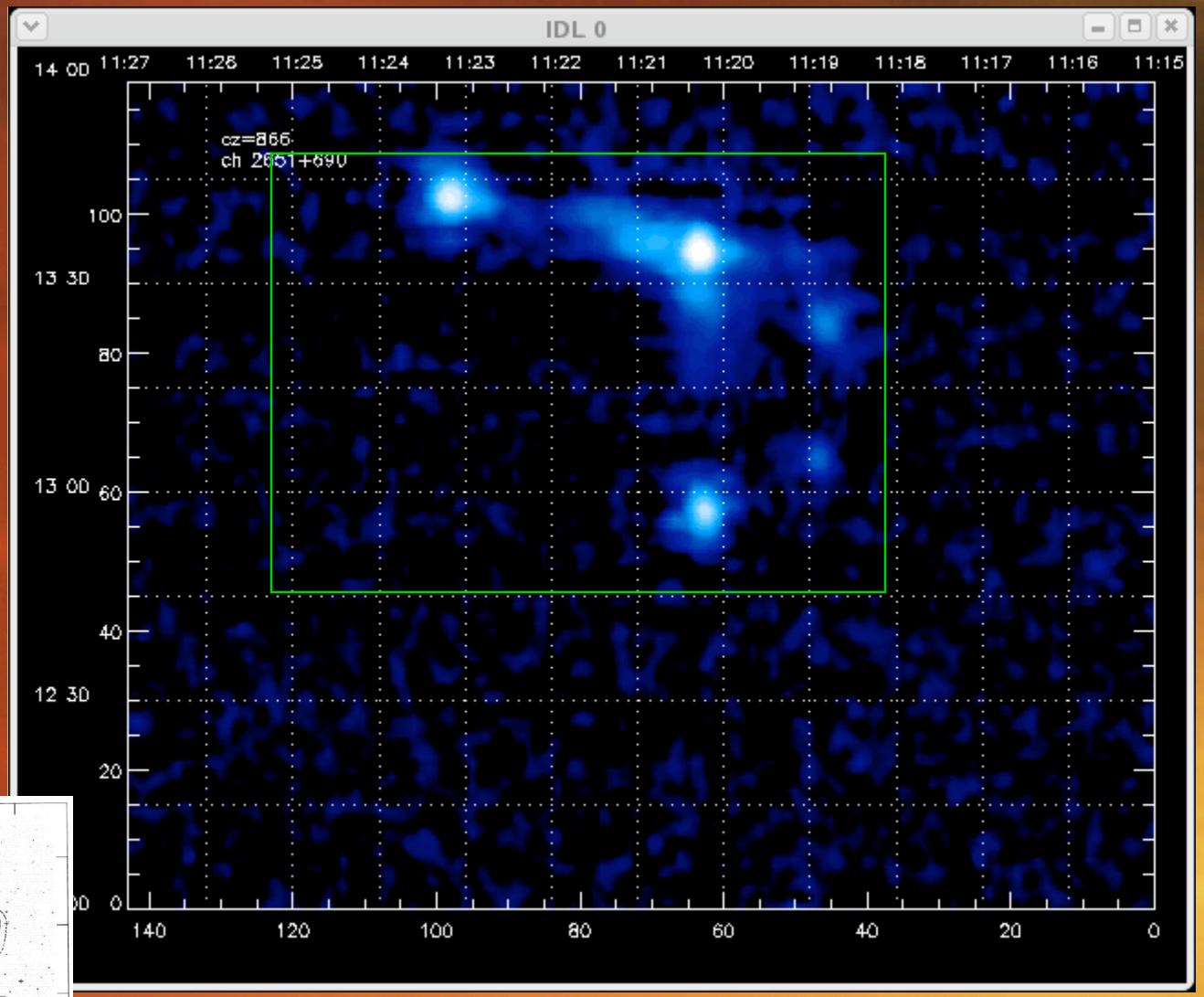


FIG. 1.—Neutral hydrogen contours of *[TeX* superposed on an enlargement of the Palomar Sky Survey print of the Leo triplet. The northernmost galaxy is NGC 3628; the southernmost is NGC 3627; the easternmost is NGC 3623. Crosses mark the sampling points of the Arecibo observations. The long appendage extending eastward from NGC 3628 is referred to as the plume; the extension in the region between the three galaxies is the bridge.

HAYNES *et al.* (*see* page 84)



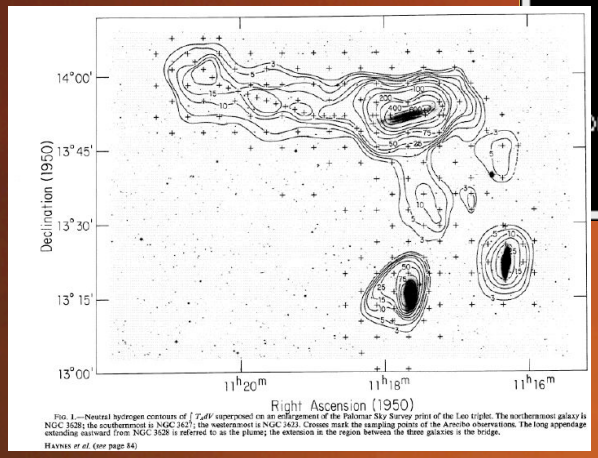
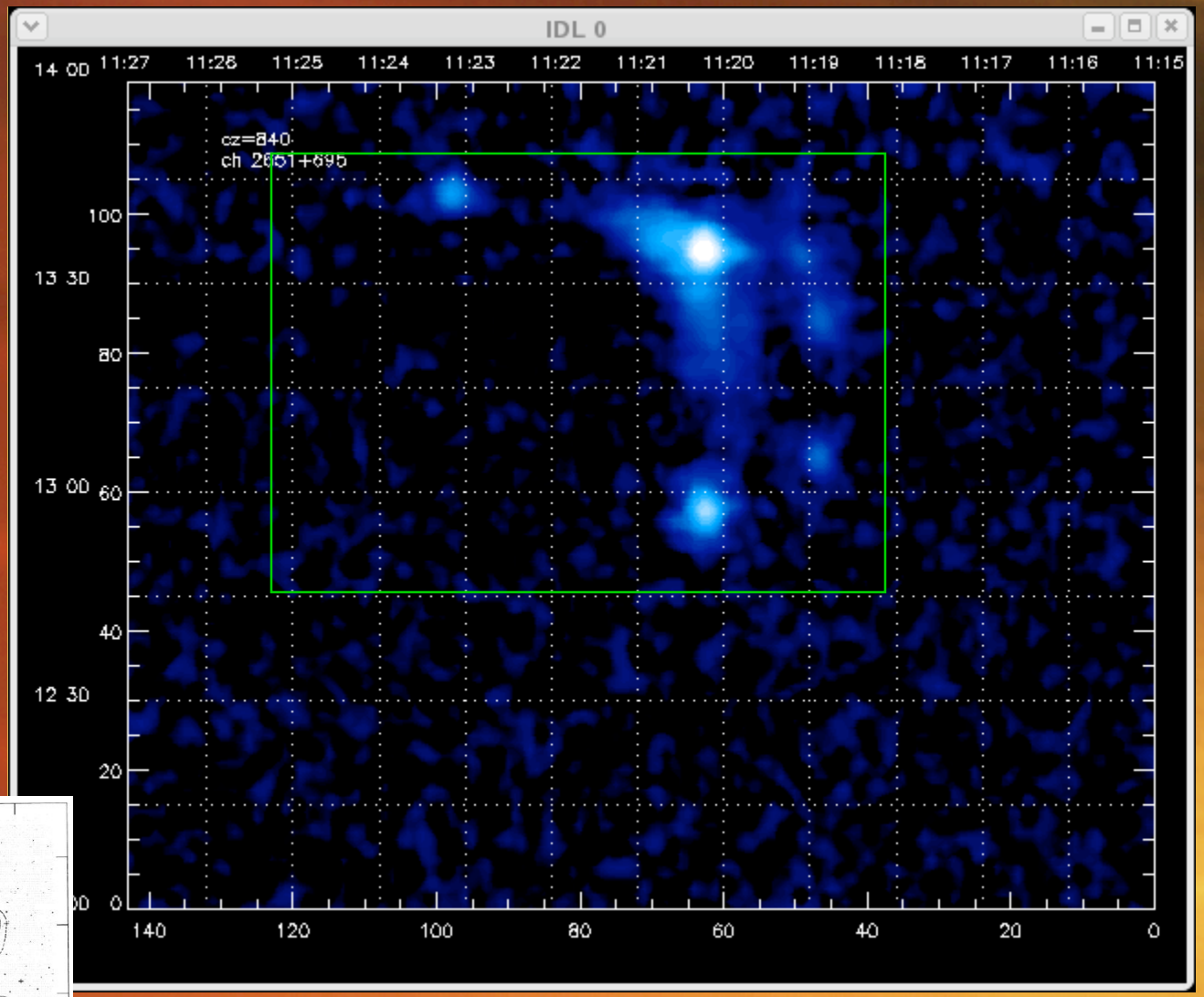


FIG. 1.—Neutral hydrogen contours of *[TeX* superposed on an enlargement of the Palomar Sky Survey print of the Leo triplet. The northernmost galaxy is NGC 3628; the southernmost is NGC 3627; the westernmost is NGC 3623. Crosses mark the sampling points of the Arecibo observations. The long appendage extending eastward from NGC 3628 is referred to as the plume; the extension in the region between the three galaxies is the bridge.

HAYNES *et al.* (*see* page 84)



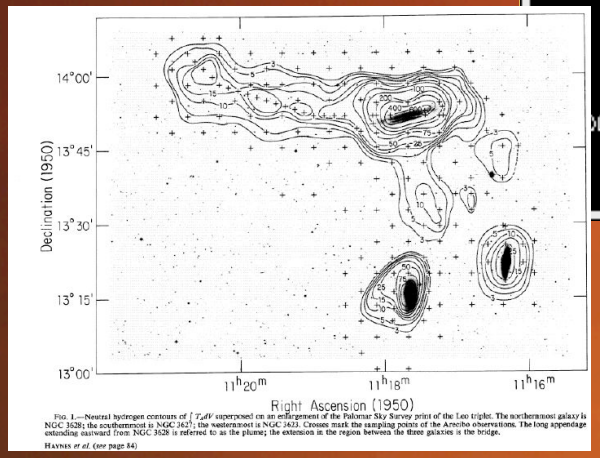
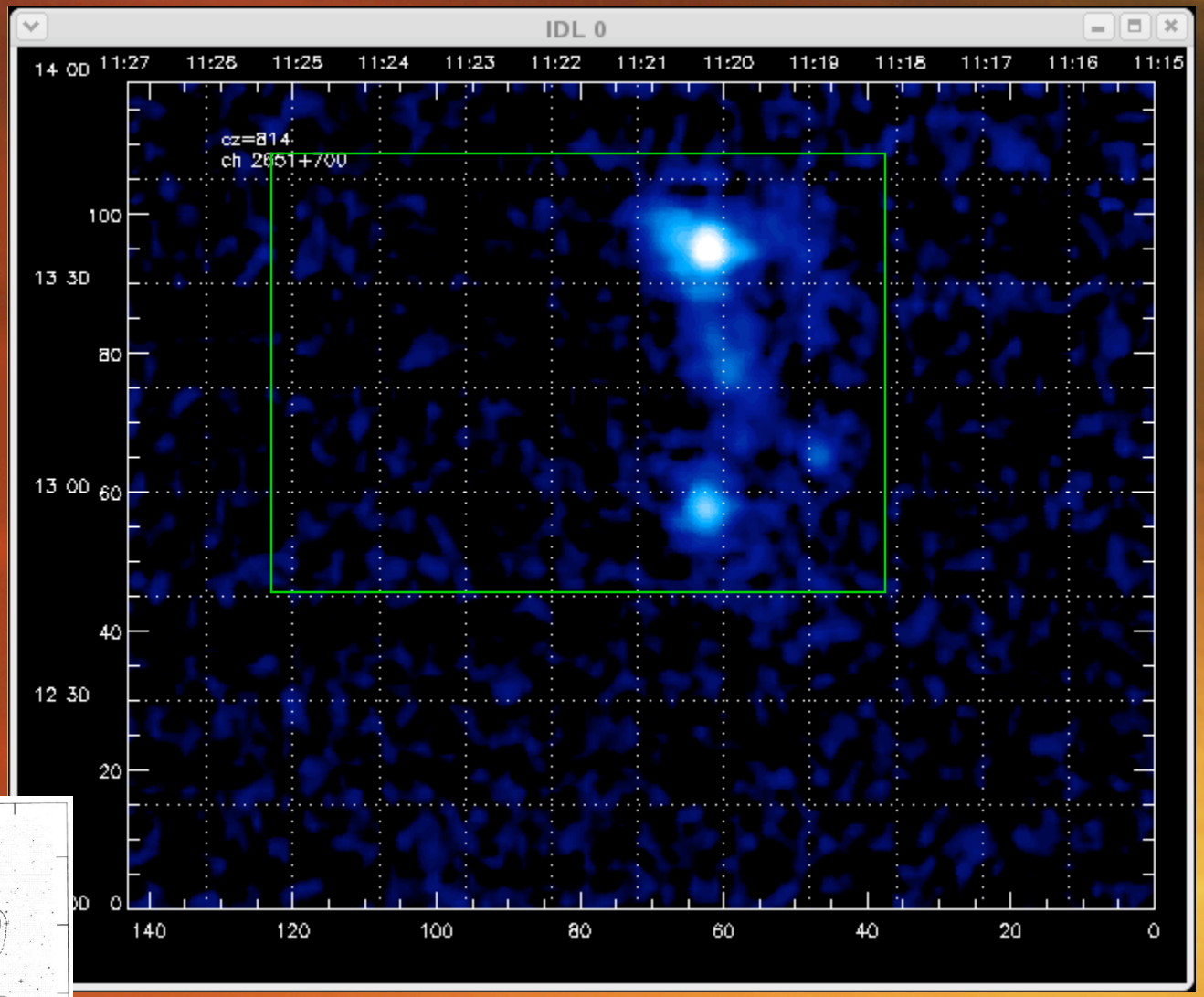


FIG. 1.—Neutral hydrogen contours of *[TeX* superposed on an enlargement of the Palomar Sky Survey print of the Leo triplet. The northernmost galaxy is NGC 3628; the southernmost is NGC 3627; the easternmost is NGC 3623. Crosses mark the sampling points of the Arecibo observations. The long appendage extending eastward from NGC 3628 is referred to as the plume; the extension in the region between the three galaxies is the bridge.

HAYNES *et al.* (*see* page 84)



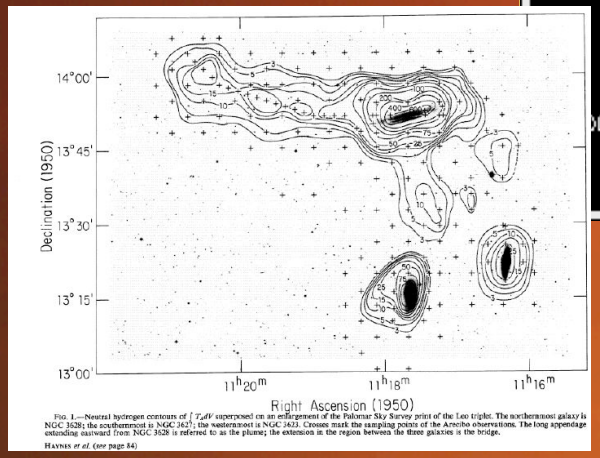
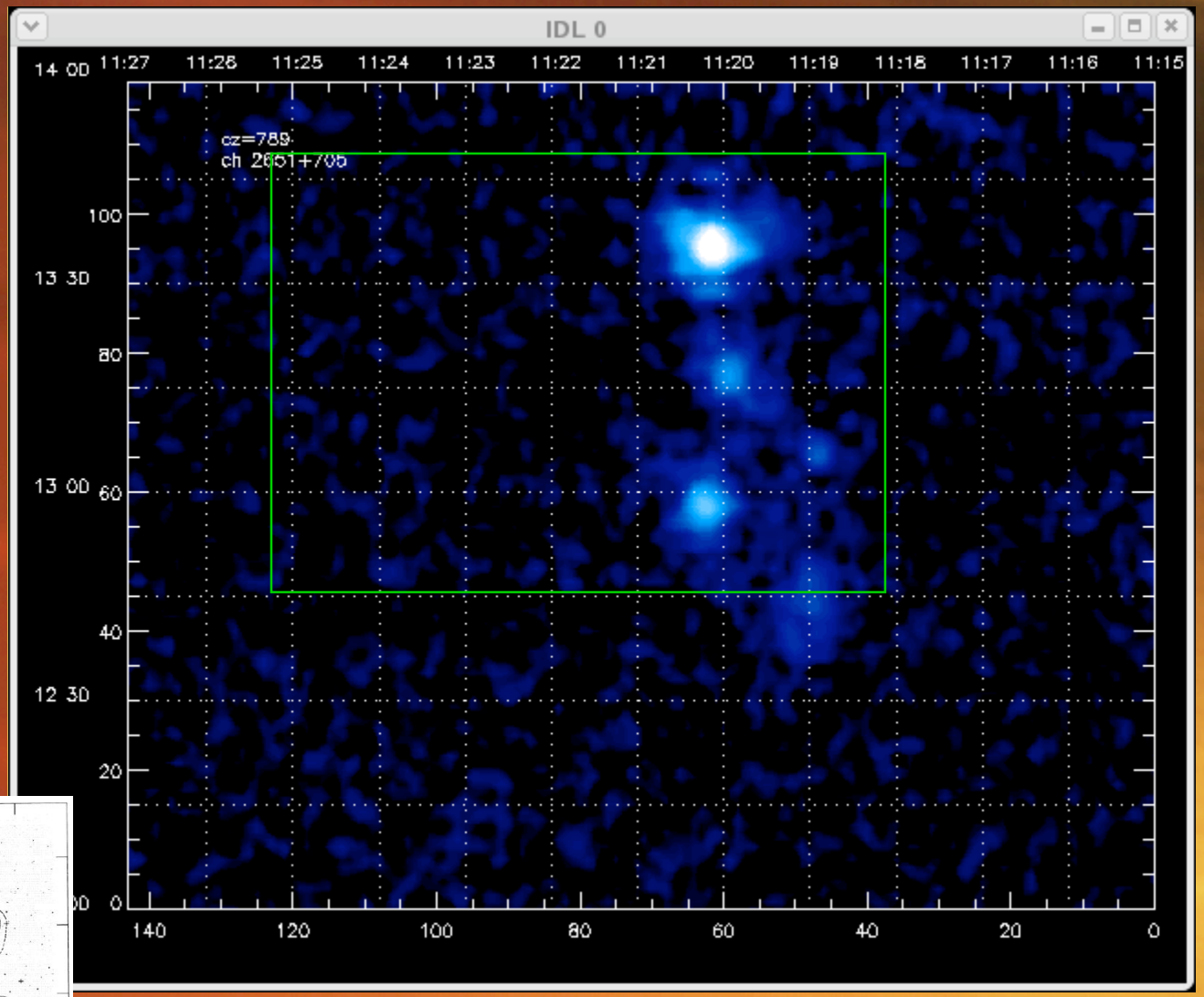


FIG. 1.—Neutral hydrogen contours of *[TeV* superposed on an enlargement of the Palomar Sky Survey print of the Leo triplet. The northernmost galaxy is NGC 3628; the southernmost is NGC 3627; the westernmost is NGC 3623. Crosses mark the sampling points of the Arecibo observations. The long appendage extending eastward from NGC 3628 is referred to as the plume; the extension in the region between the three galaxies is the bridge.

HAYNES *et al.* (*see* page 84)



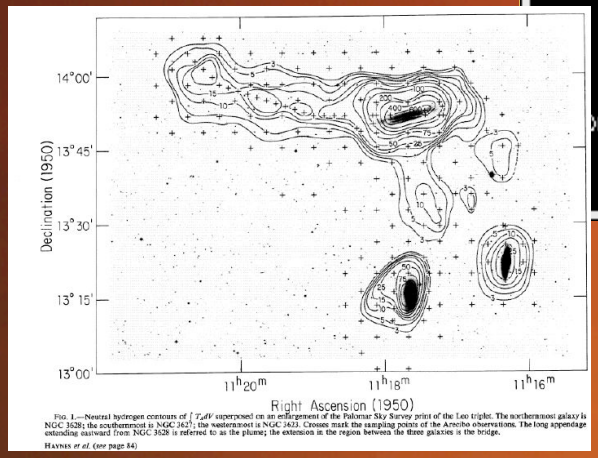
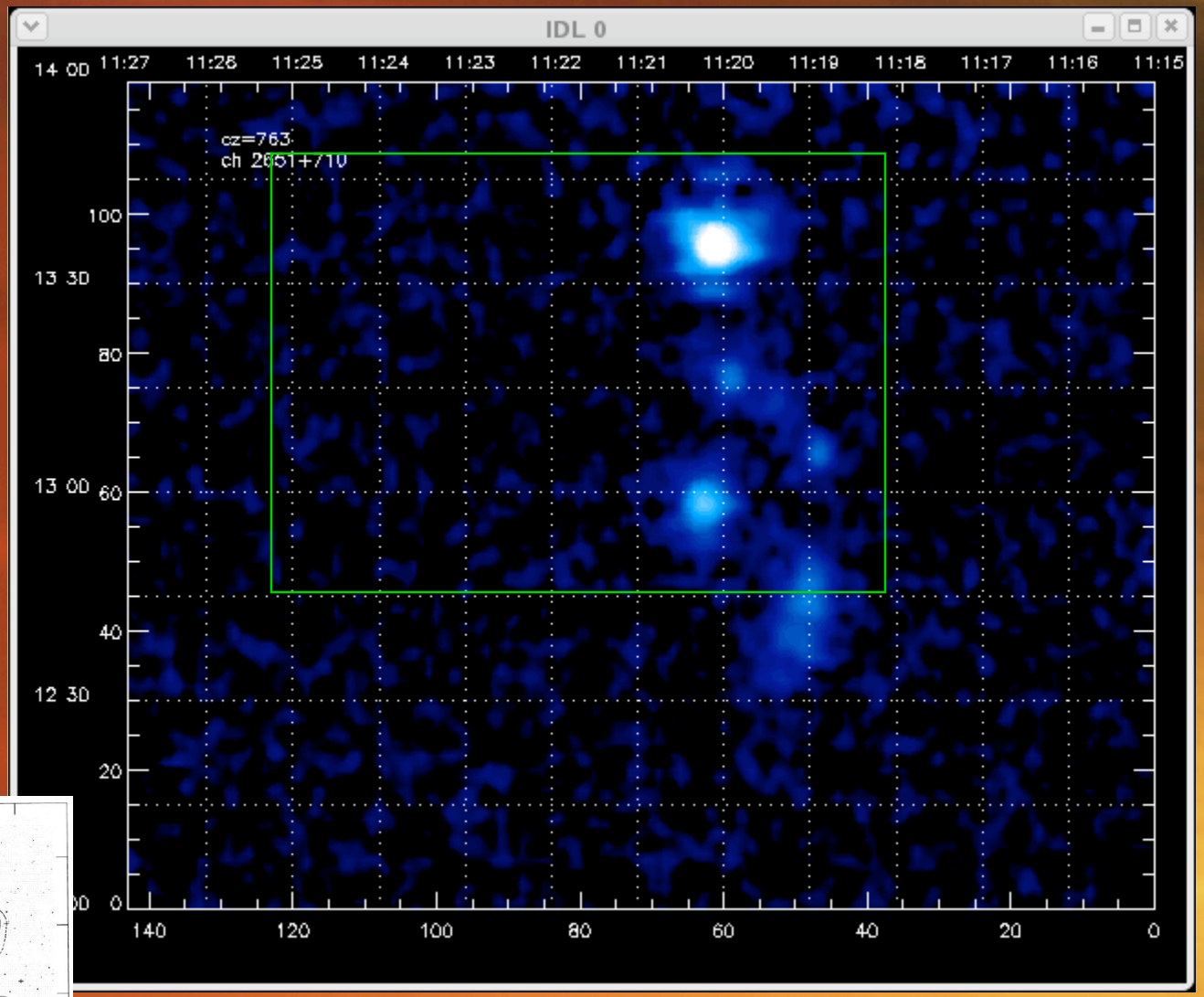


FIG. 1.—Neutral hydrogen contours of *[TaM* superposed on an enlargement of the Palomar Sky Survey print of the Leo triplet. The northernmost galaxy is NGC 3628; the southernmost is NGC 3627; the easternmost is NGC 3623. Crosses mark the sampling points of the Arecibo observations. The long appendage extending eastward from NGC 3628 is referred to as the plume; the extension in the region between the three galaxies is the bridge.

HAYNES *et al.* (*see* page 84)



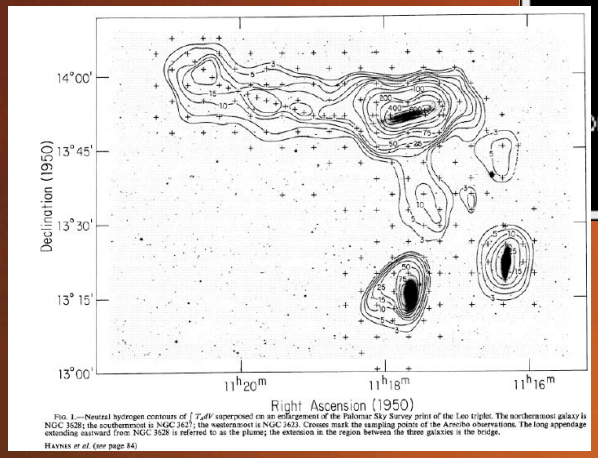
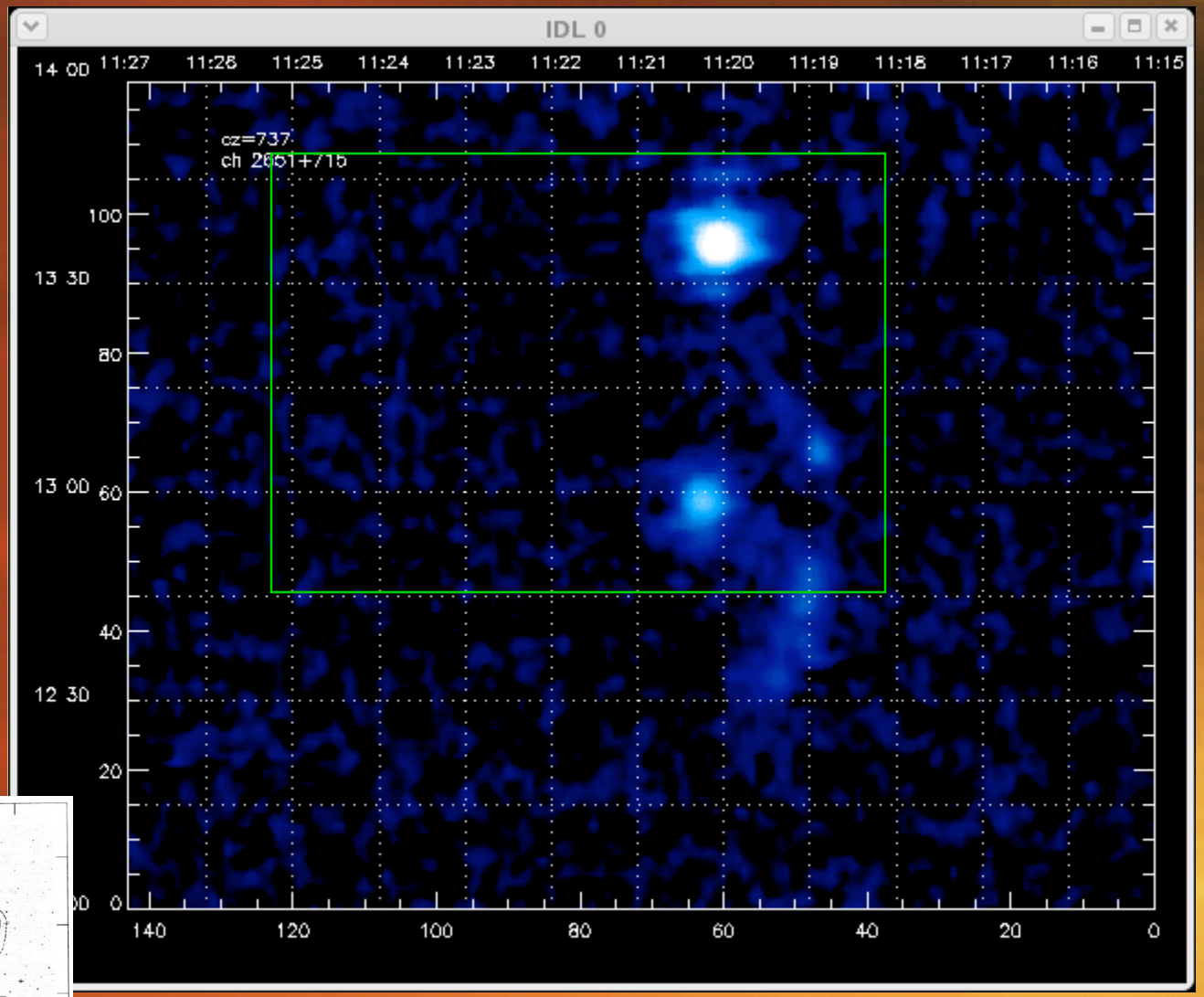


FIG. 1.—Neutral hydrogen contours of *[TeX* superposed on an enlargement of the Palomar Sky Survey print of the Leo triplet. The northernmost galaxy is NGC 3628; the southernmost is NGC 3627; the easternmost is NGC 3623. Crosses mark the sampling points of the Arecibo observations. The long appendage extending eastward from NGC 3628 is referred to as the plume; the extension in the region between the three galaxies is the bridge.

HAYNES *et al.* (*see* page 84)



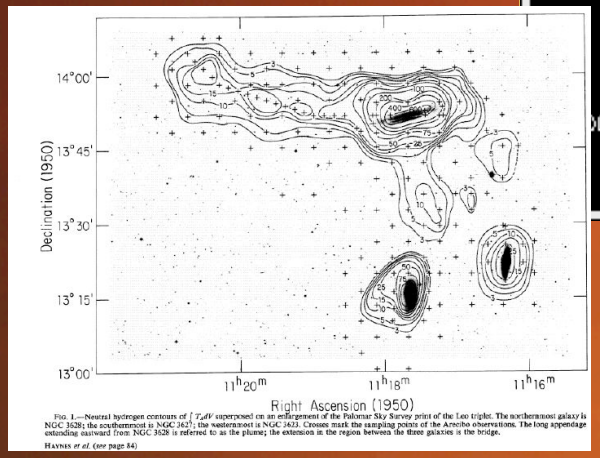
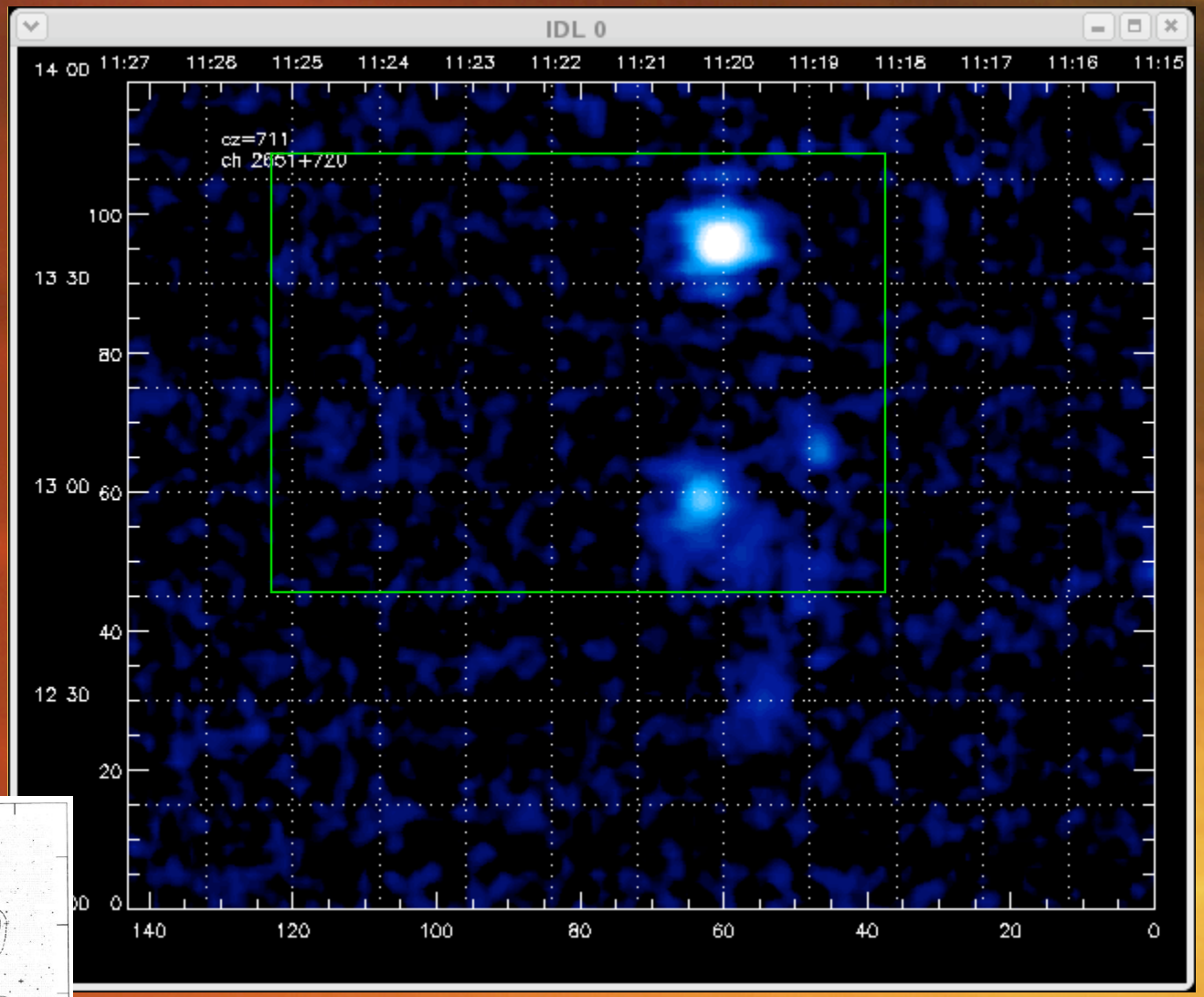


FIG. 1.—Neutral hydrogen contours of *[TeX* superposed on an enlargement of the Palomar Sky Survey print of the Leo triplet. The northernmost galaxy is NGC 3628; the southernmost is NGC 3627; the westernmost is NGC 3623. Crosses mark the sampling points of the Arecibo observations. The long appendage extending eastward from NGC 3628 is referred to as the plume; the extension in the region between the three galaxies is the bridge.

HAYNES *et al.* (*see* page 84)



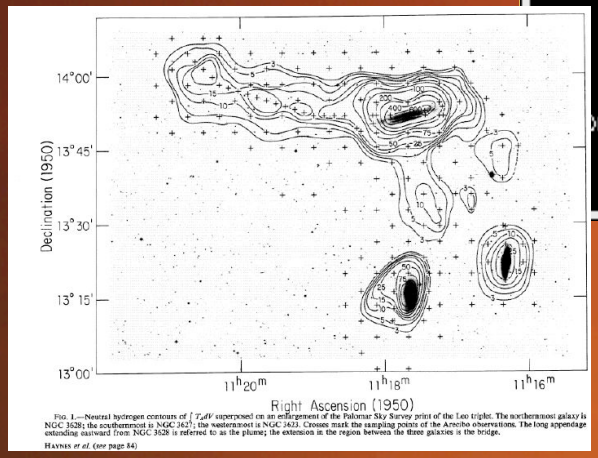
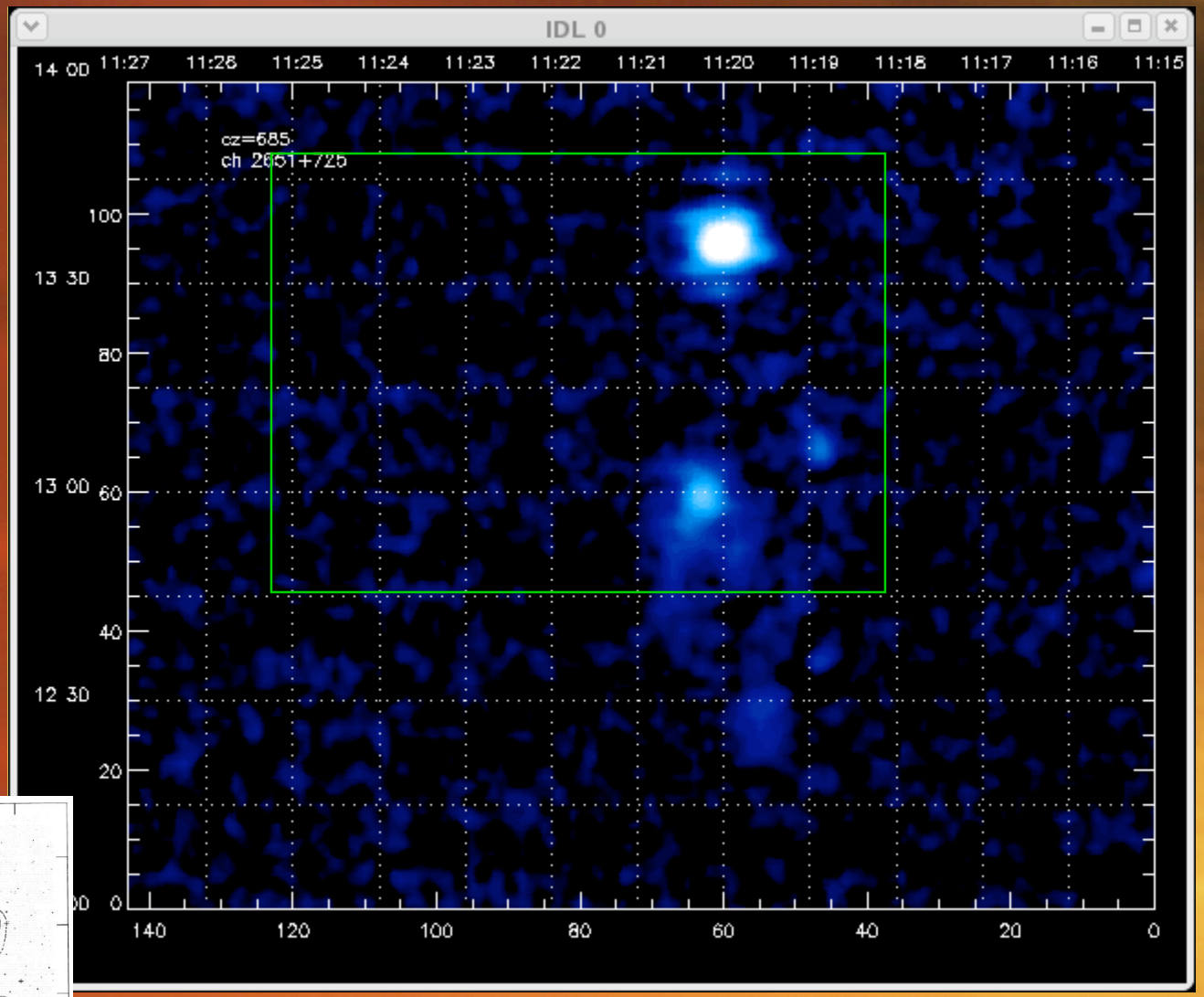


FIG. 1.—Neutral hydrogen contours of *[TeX* superposed on an enlargement of the Palomar Sky Survey print of the Leo triplet. The northernmost galaxy is NGC 3628; the southernmost is NGC 3627; the easternmost is NGC 3623. Crosses mark the sampling points of the Arecibo observations. The long appendage extending eastward from NGC 3628 is referred to as the plume; the extension in the region between the three galaxies is the bridge.

HAYNES *et al.* (*see* page 84)



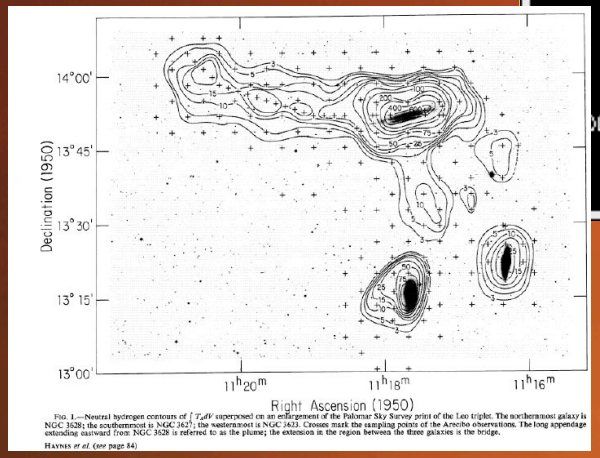
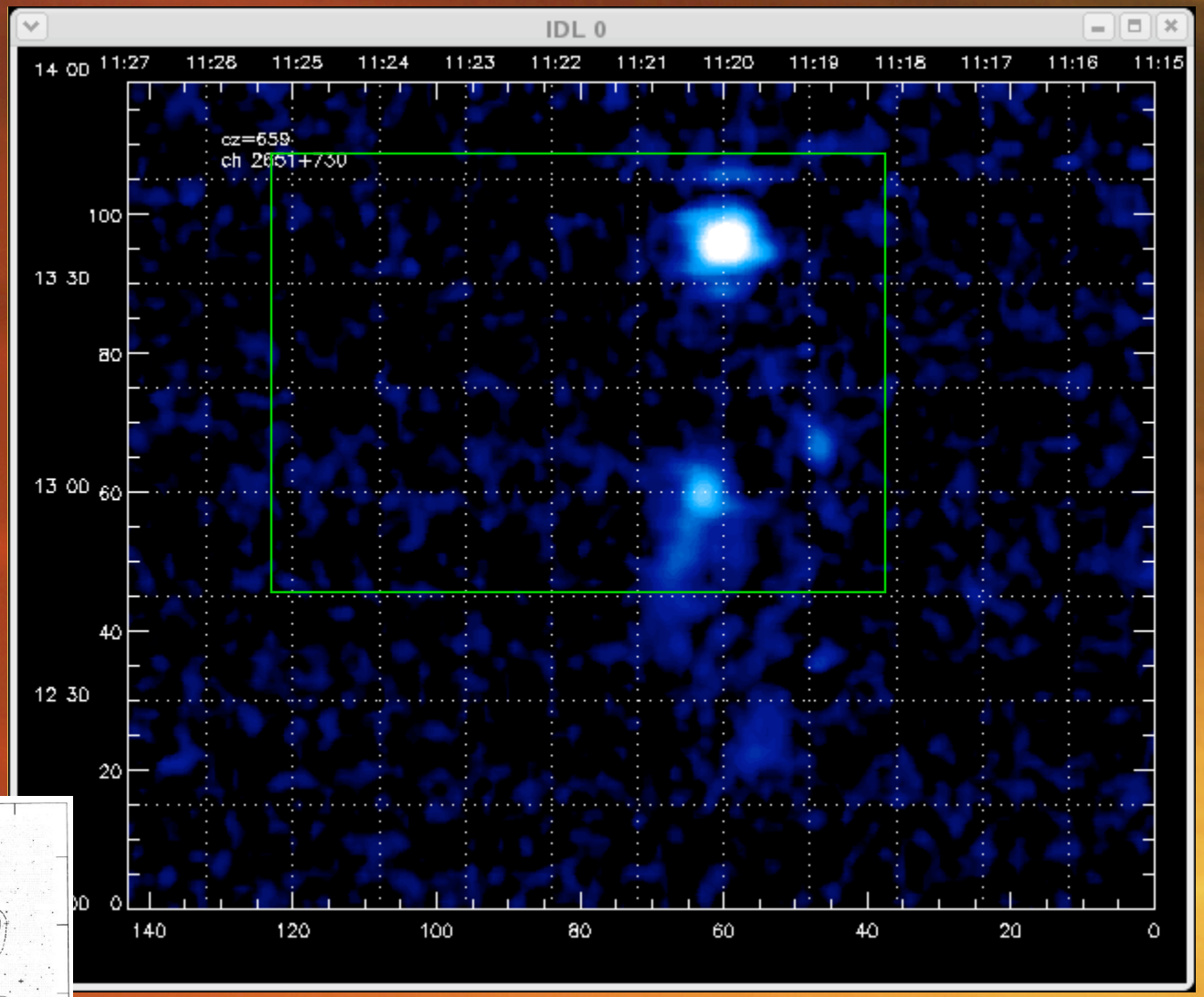


FIG. 1.—Neutral hydrogen contours of *[TeX* superposed on an enlargement of the Palomar Sky Survey print of the Leo triplet. The northernmost galaxy is NGC 3628; the southernmost is NGC 3627; the easternmost is NGC 3623. Crosses mark the sampling points of the Arecibo observations. The long appendage extending eastward from NGC 3628 is referred to as the plume; the extension in the region between the three galaxies is the bridge.

HAYNES *et al.* (*see* page 84)



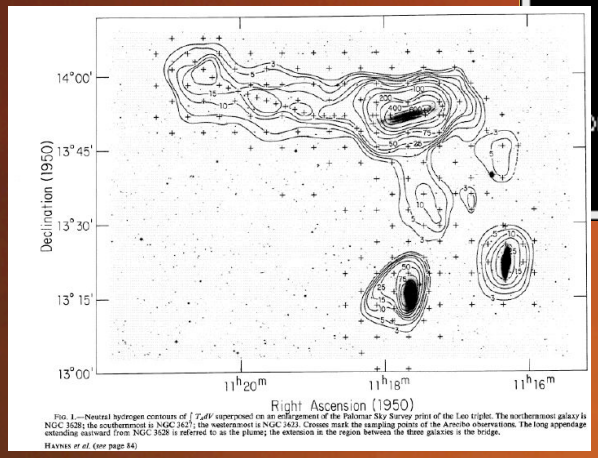
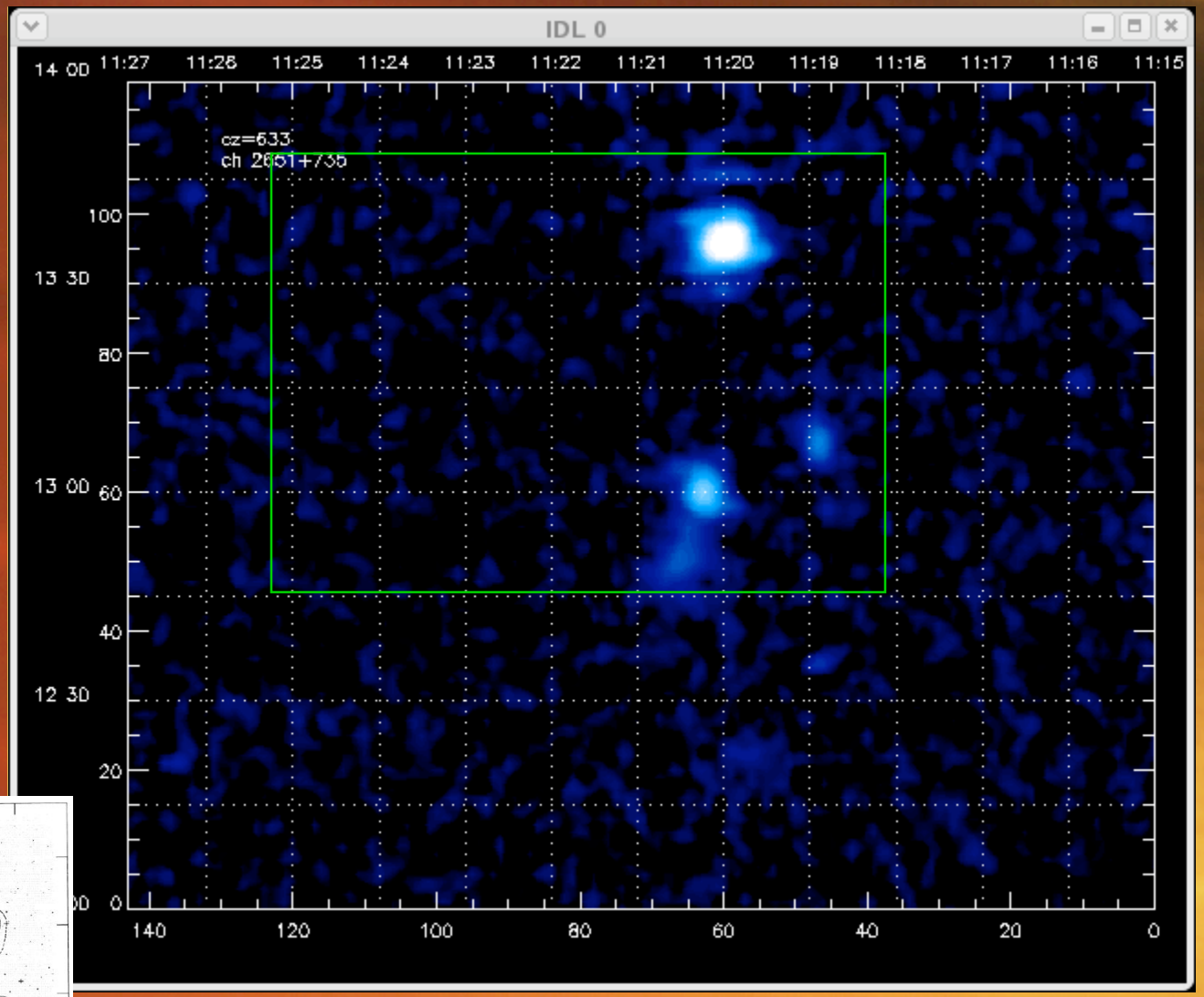


FIG. 1.—Neutral hydrogen contours of *[TeX* superposed on an enlargement of the Palomar Sky Survey print of the Leo triplet. The northernmost galaxy is NGC 3628; the southernmost is NGC 3627; the easternmost is NGC 3623. Crosses mark the sampling points of the Arecibo observations. The long appendage extending eastward from NGC 3628 is referred to as the plume; the extension in the region between the three galaxies is the bridge.

HAYNES *et al.* (*see* page 84)



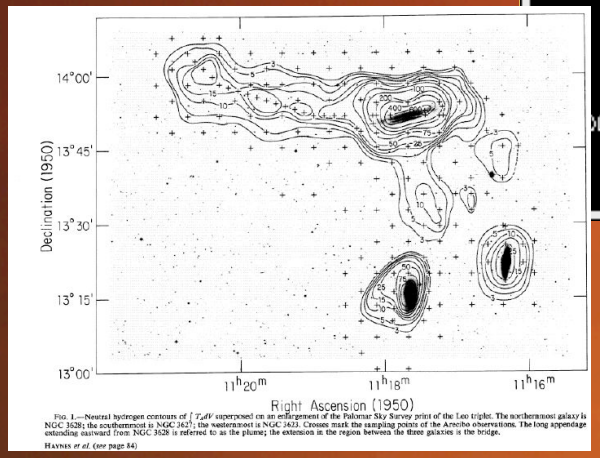
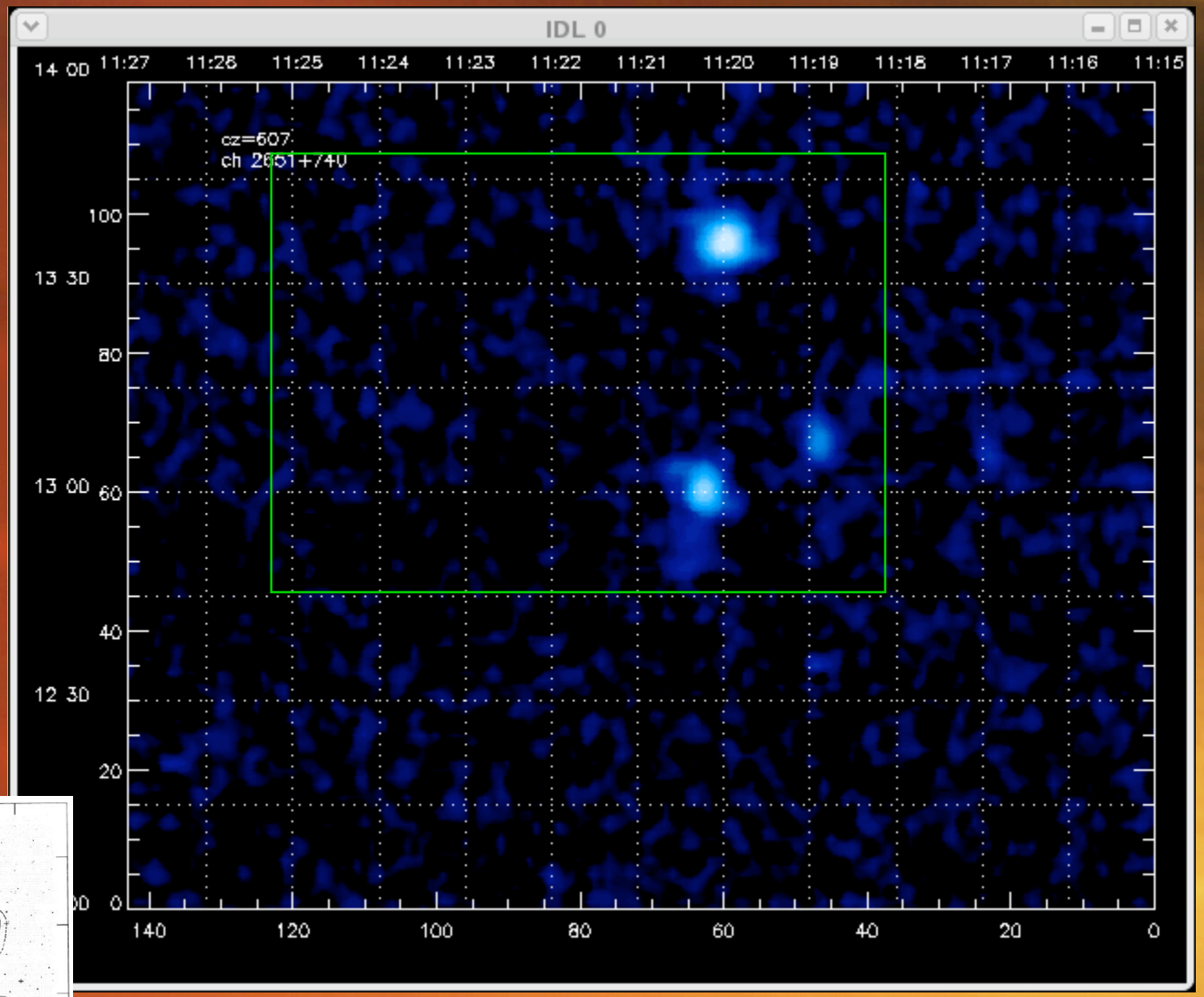


FIG. 1.—Neutral hydrogen contours of *[TeX* superposed on an enlargement of the Palomar Sky Survey print of the Leo triplet. The northernmost galaxy is NGC 3628; the southernmost is NGC 3627; the westernmost is NGC 3623. Crosses mark the sampling points of the Arecibo observations. The long appendage extending eastward from NGC 3628 is referred to as the plume; the extension in the region between the three galaxies is the bridge.

HAYNES *et al.* (*see* page 84)



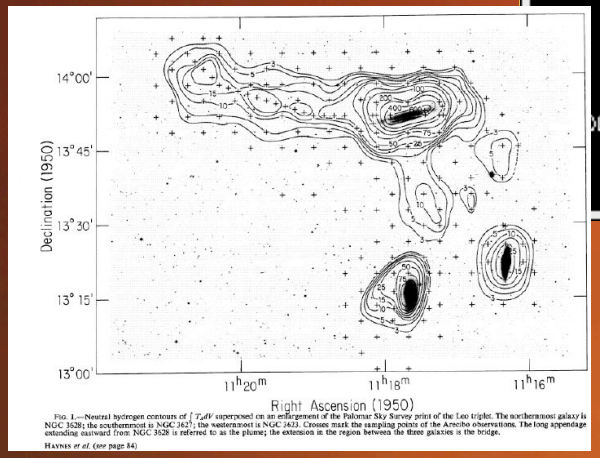
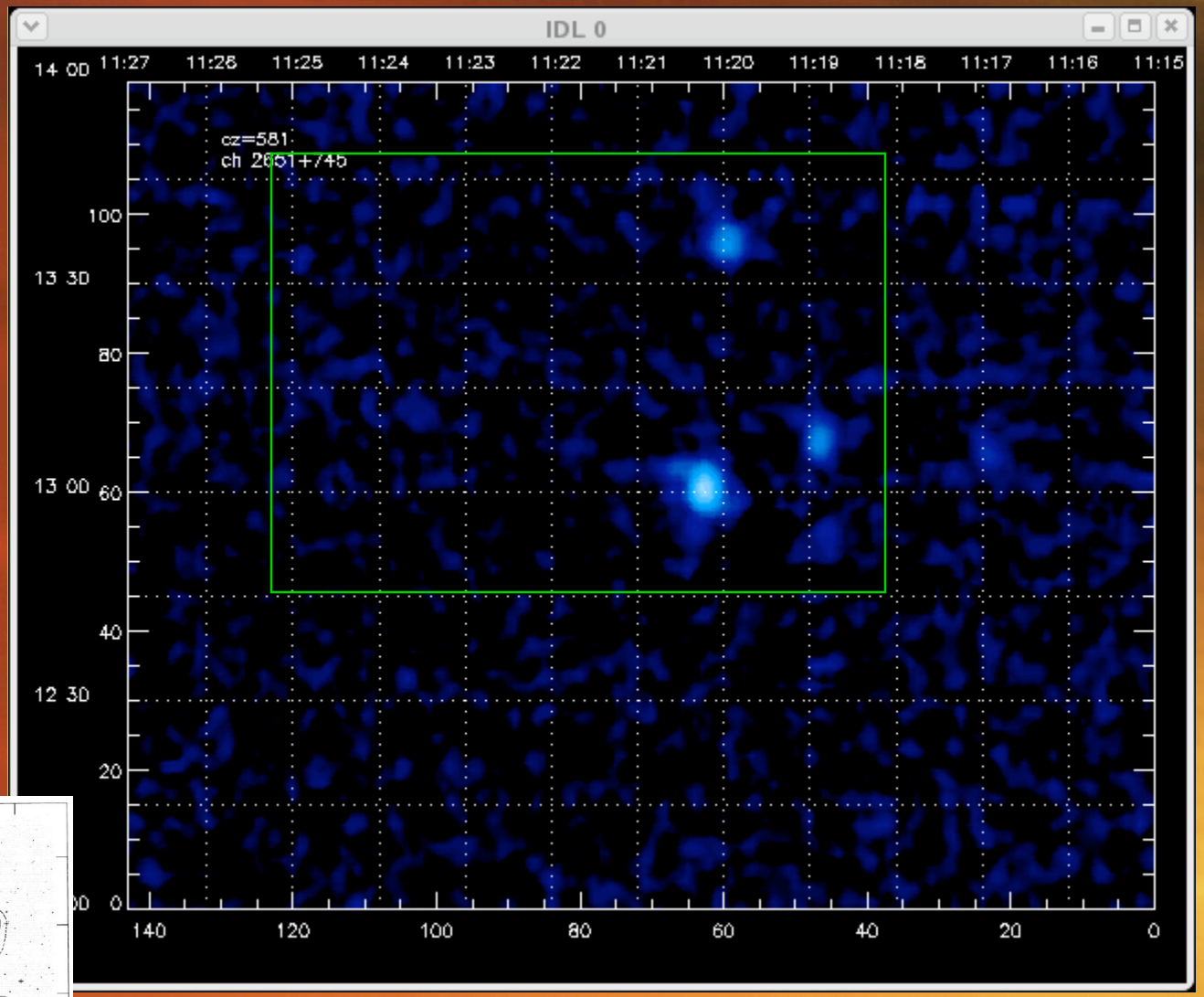


FIG. 1.—Neutral hydrogen contours of *[T_AdV* superposed on an enlargement of the Palomar Sky Survey print of the Leo triplet. The northernmost galaxy is NGC 3628; the southernmost is NGC 3627; the easternmost is NGC 3623. Crosses mark the sampling points of the Arecibo observations. The long appendage extending eastward from NGC 3628 is referred to as the plume; the extension in the region between the three galaxies is the bridge.

HAYNES *et al.* (*see* page 84)



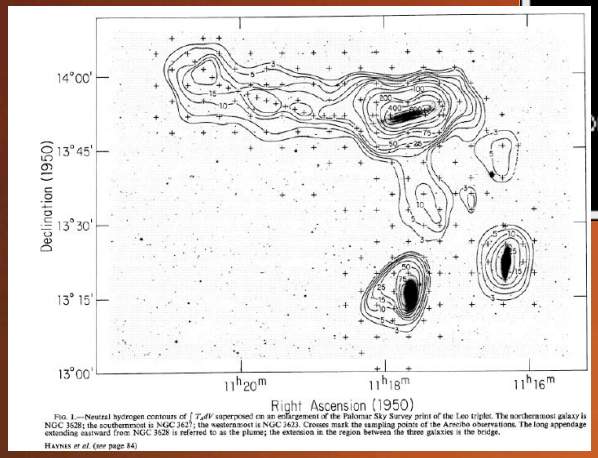
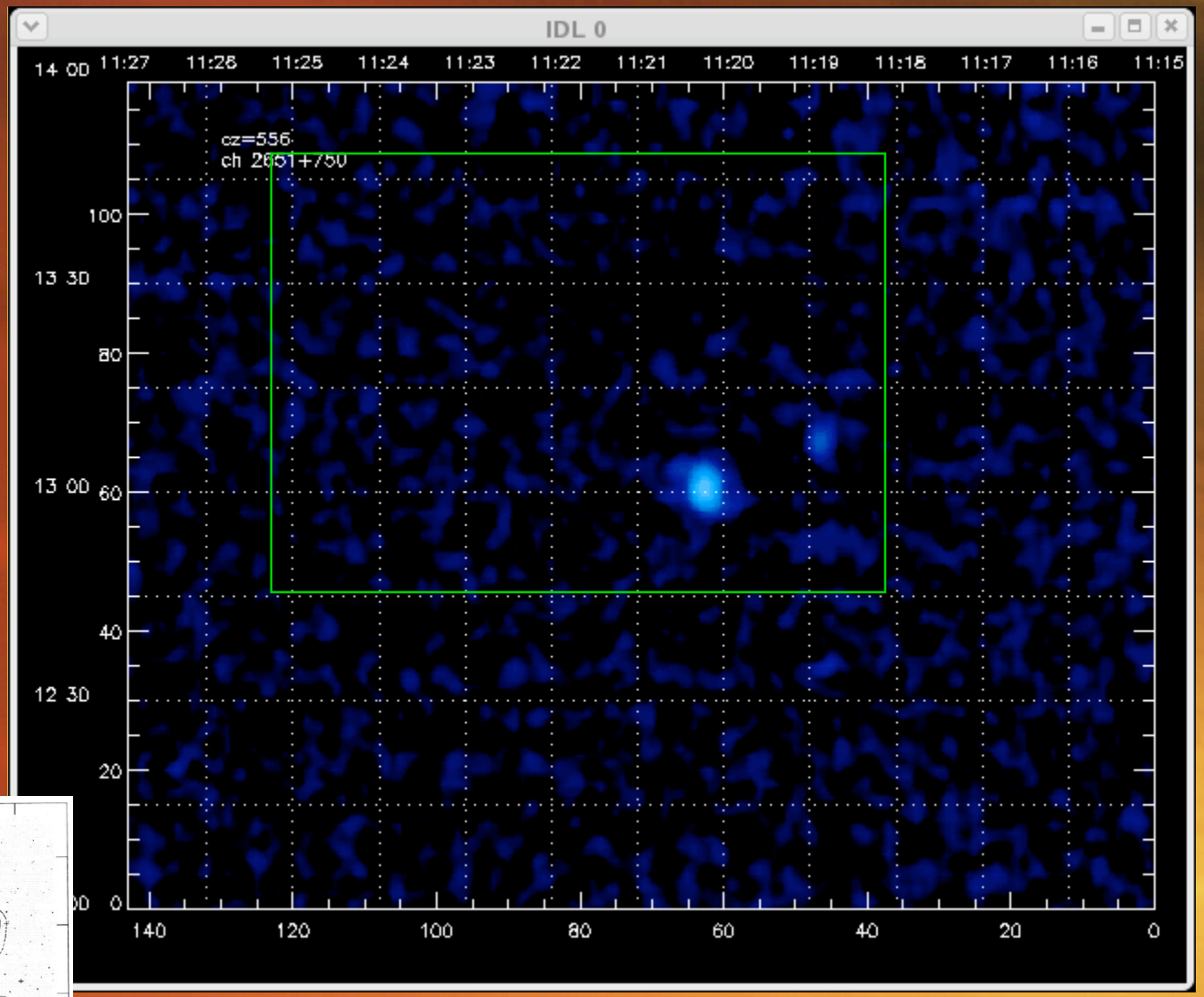


FIG. 1.—Neutral hydrogen contours of *[TeX* superposed on an enlargement of the Palomar Sky Survey print of the Leo triplet. The northernmost galaxy is NGC 3628; the southernmost is NGC 3627; the easternmost is NGC 3623. Crosses mark the sampling points of the Arecibo observations. The long appendage extending eastward from NGC 3628 is referred to as the plume; the extension in the region between the three galaxies is the bridge.

HAYNES *et al.* (*see* page 84)



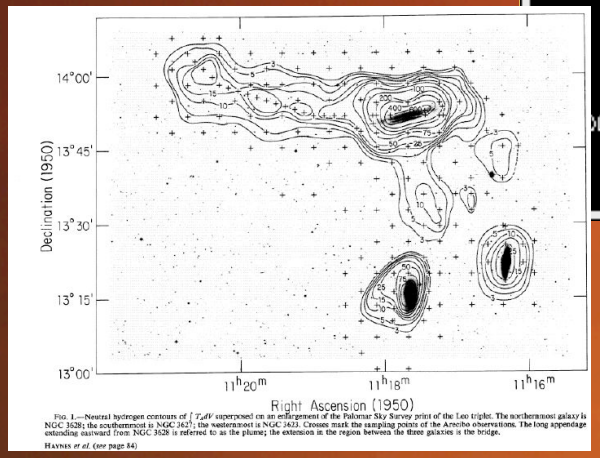
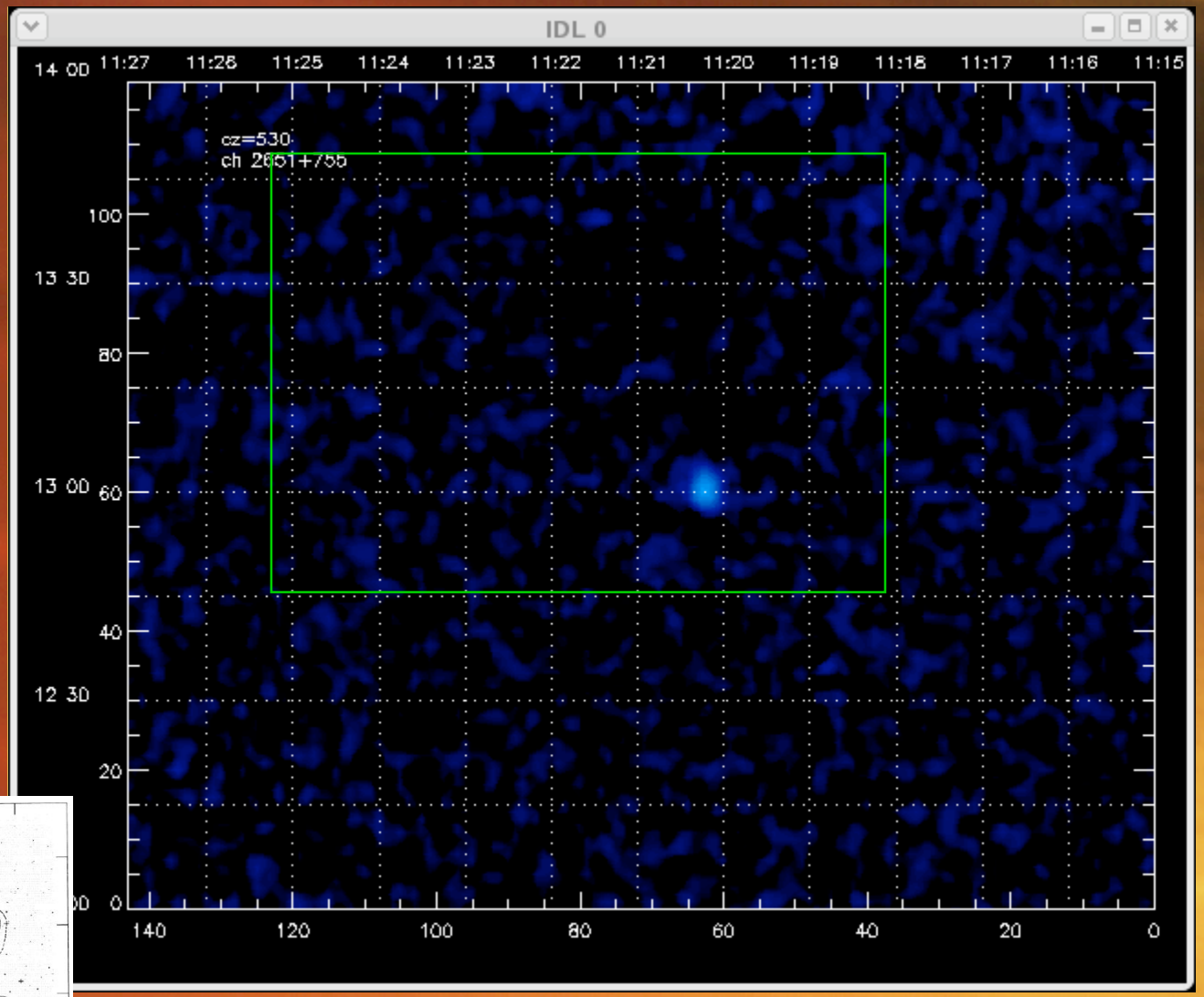


FIG. 1.—Neutral hydrogen contours of *[TeX* superposed on an enlargement of the Palomar Sky Survey print of the Leo triplet. The northernmost galaxy is NGC 3628; the southernmost is NGC 3627; the westernmost is NGC 3623. Crosses mark the sampling points of the Arecibo observations. The long appendage extending eastward from NGC 3628 is referred to as the plume; the extension in the region between the three galaxies is the bridge.

HAYNES *et al.* (*see* page 84)



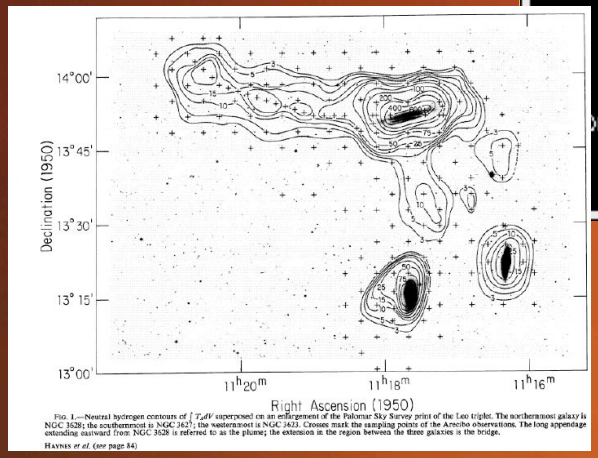
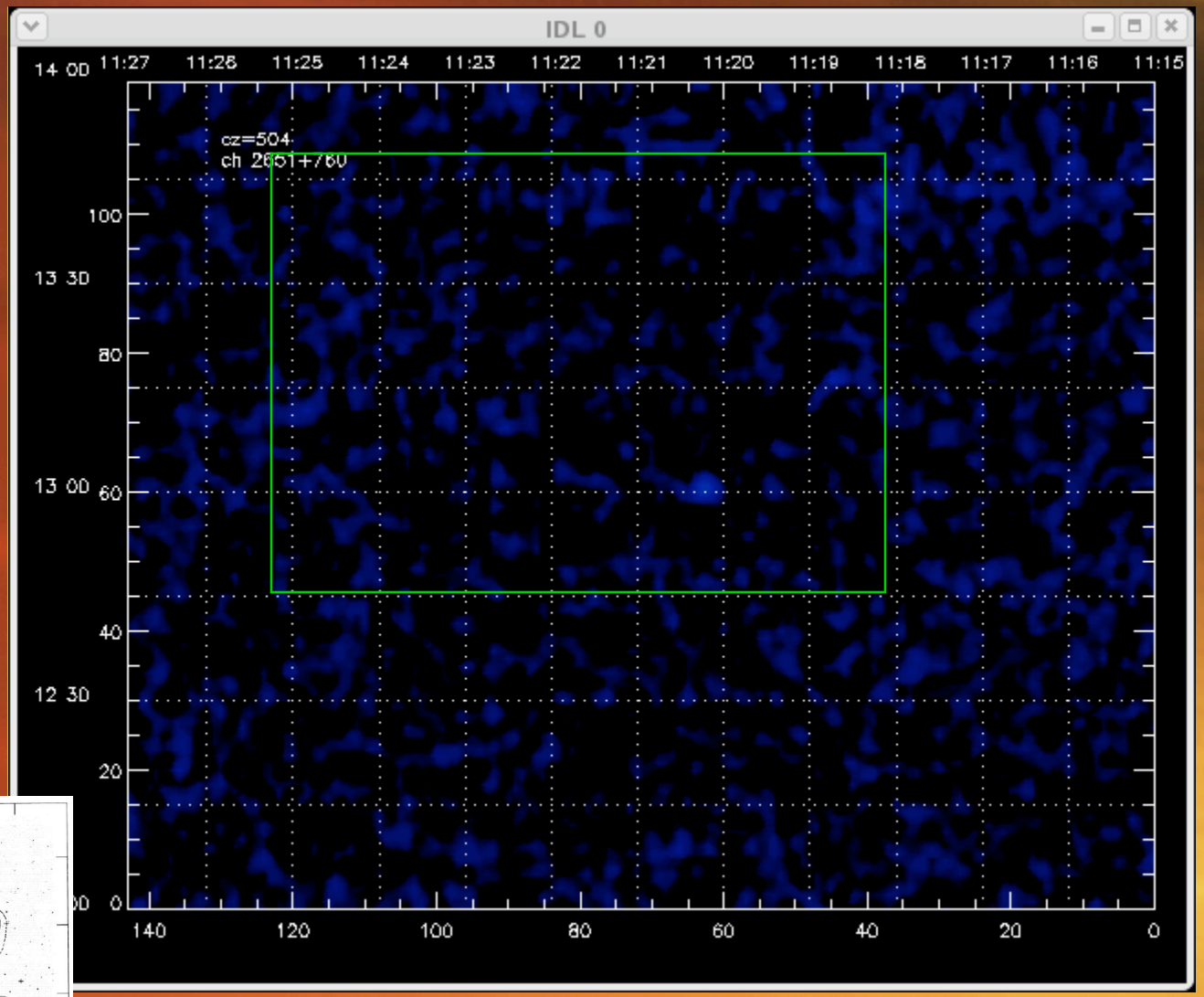


FIG. 1.—Neutral hydrogen contours of *[TeX* superposed on an enlargement of the Palomar Sky Survey print of the Leo triplet. The northernmost galaxy is NGC 3628; the southernmost is NGC 3627; the easternmost is NGC 3623. Crosses mark the sampling points of the Arecibo observations. The long appendage extending eastward from NGC 3628 is referred to as the plume; the extension in the region between the three galaxies is the bridge.

HAYNES *et al.* (*see* page 84)



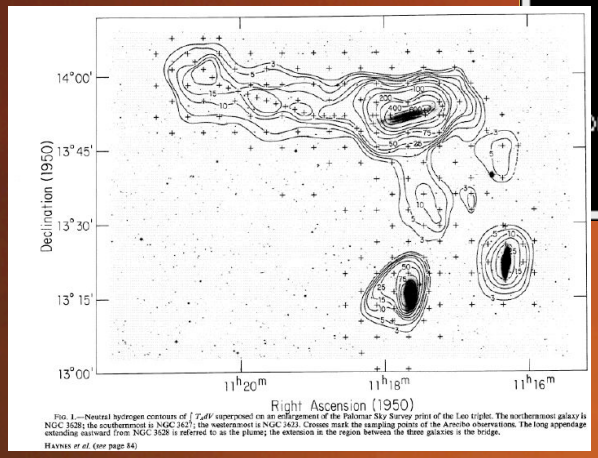
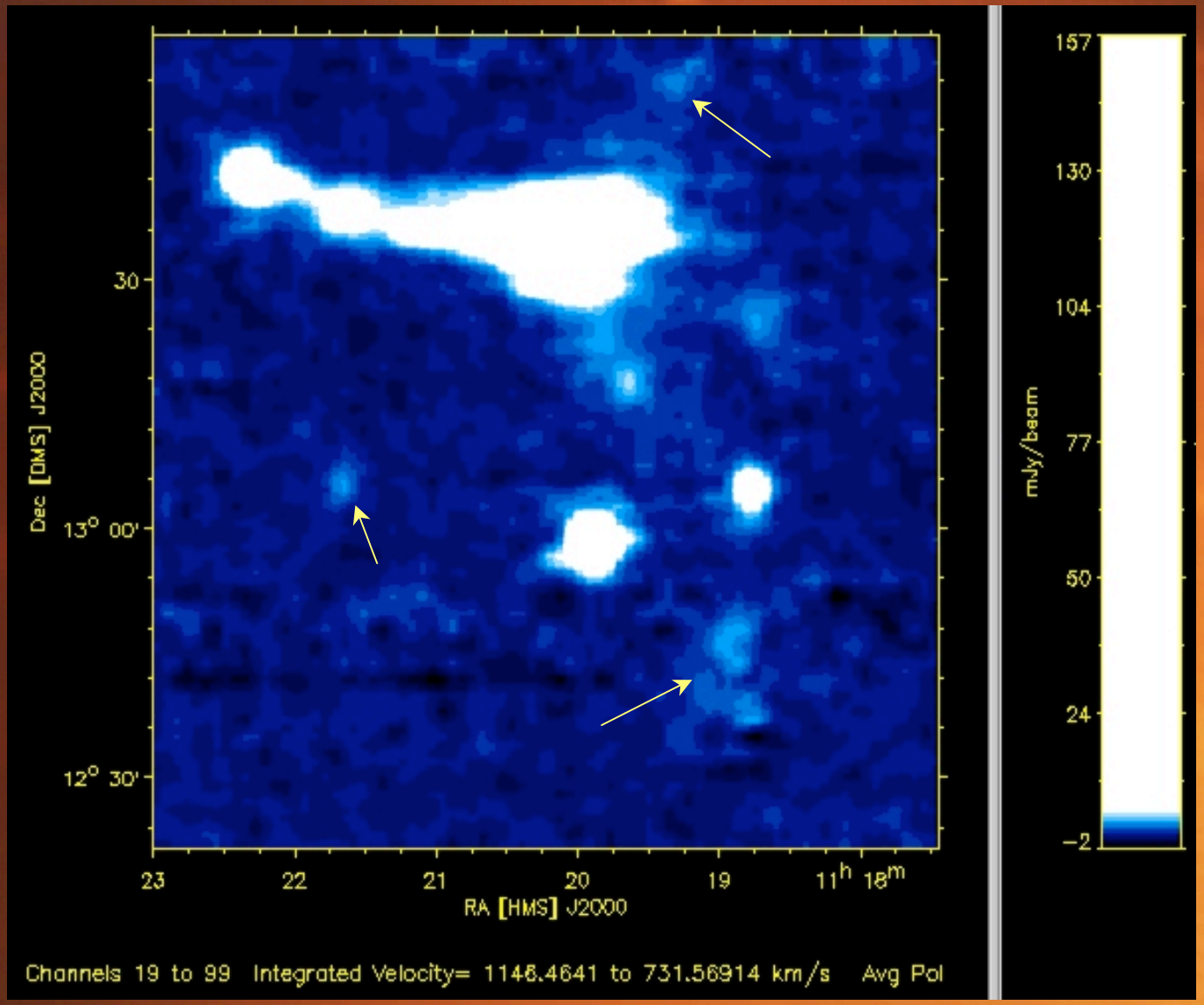


FIG. 1.—Neutral hydrogen contours of *[TeX* superposed on an enlargement of the Palomar Sky Survey print of the Leo triplet. The northernmost galaxy is NGC 3628; the southernmost is NGC 3627; the westernmost is NGC 3623. Crosses mark the sampling points of the Arecibo observations. The long appendage extending eastward from NGC 3628 is referred to as the plume; the extension in the region between the three galaxies is the bridge.

HAYNES *et al.* (*see* page 84)

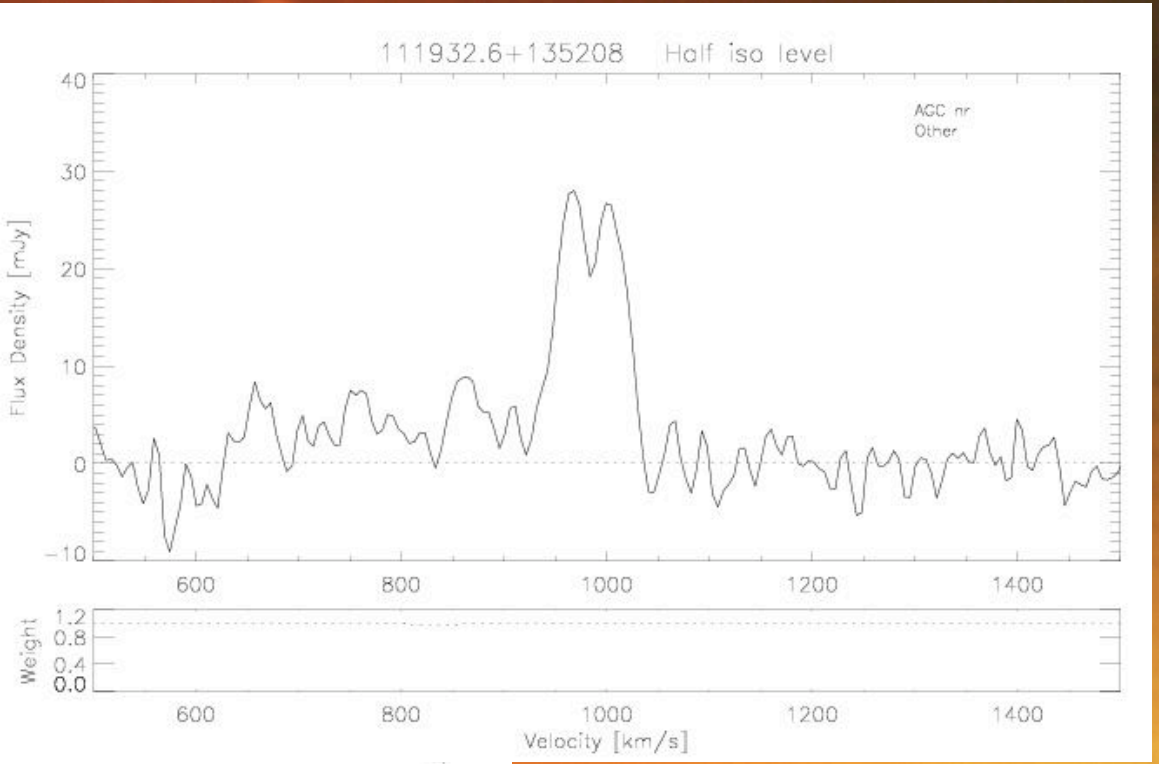
The Leo Triplet in ALFALFA



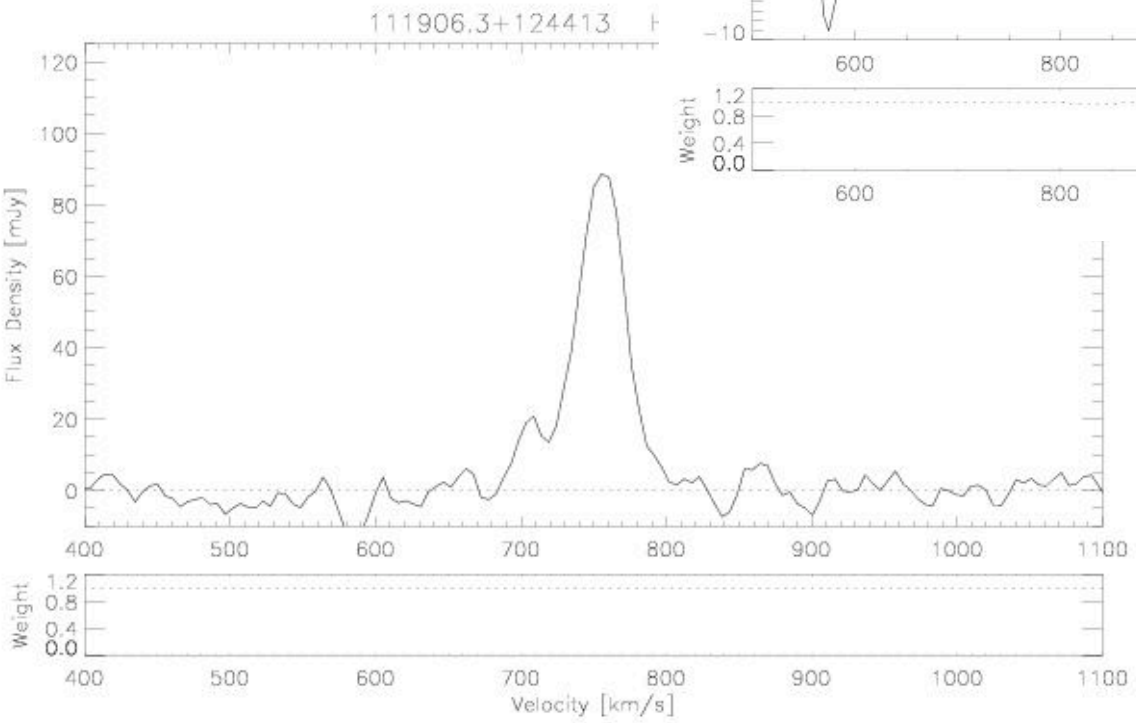
Arrows indicate new HI gas clouds not seen in previous HI mappings of the region by Haynes, Giovanelli & Roberts in 1979

HI Clouds (No Optical Counterparts)

Northern cloud

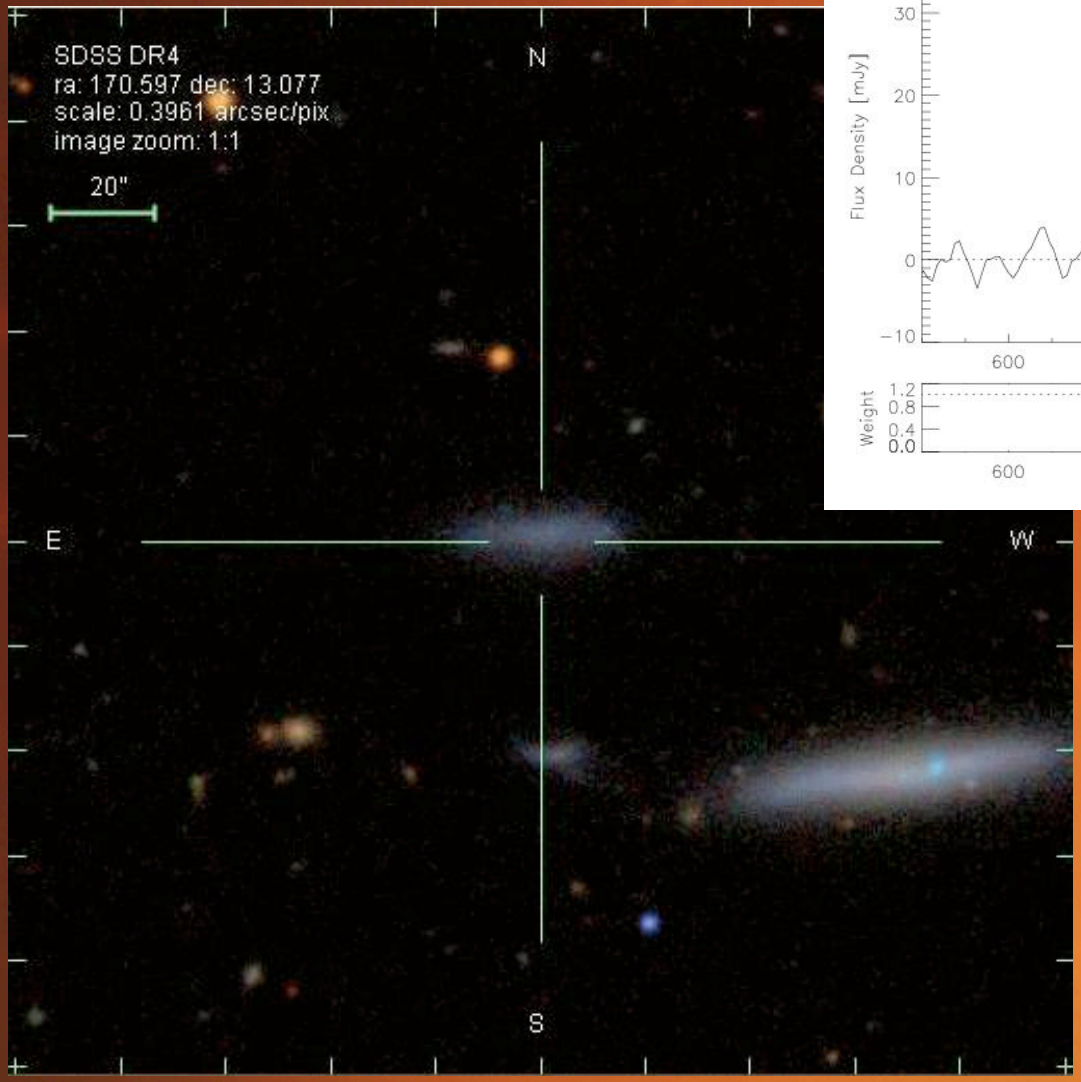


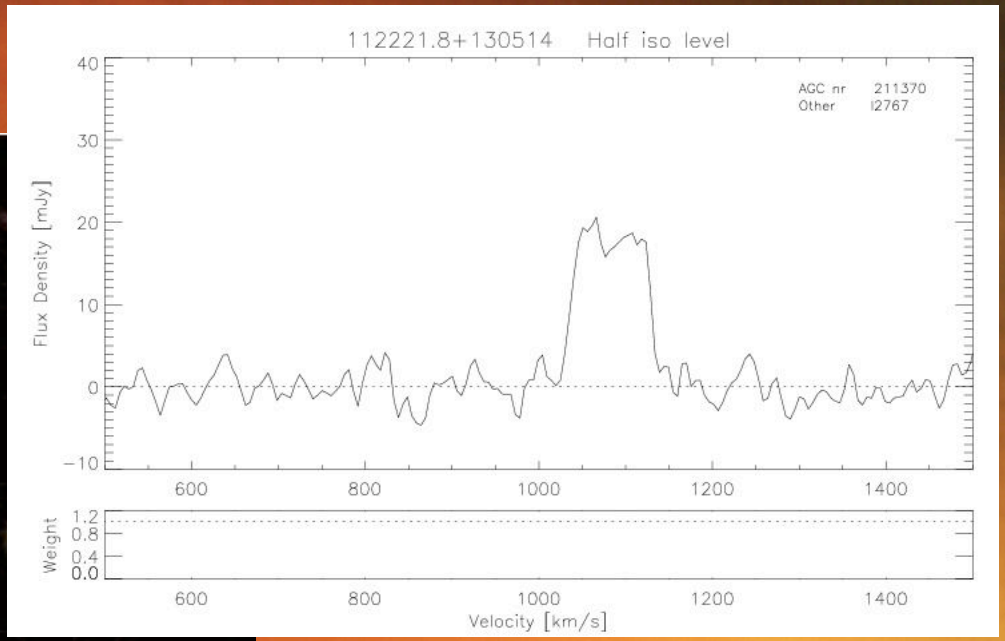
Southern cloud



Spectra extracted using LOVEDATA's GalFlux Program (tune back in on Saturday …)

New Dwarf Galaxy!





V = 1083 km/s

W50 = 93 km/s

F_{peak} = 20.6 mJy

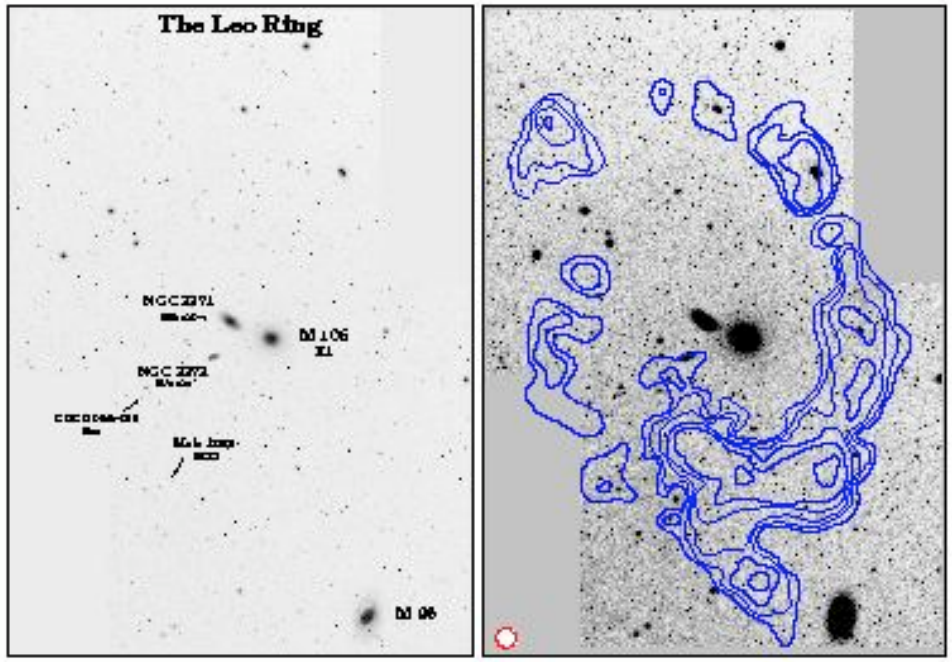
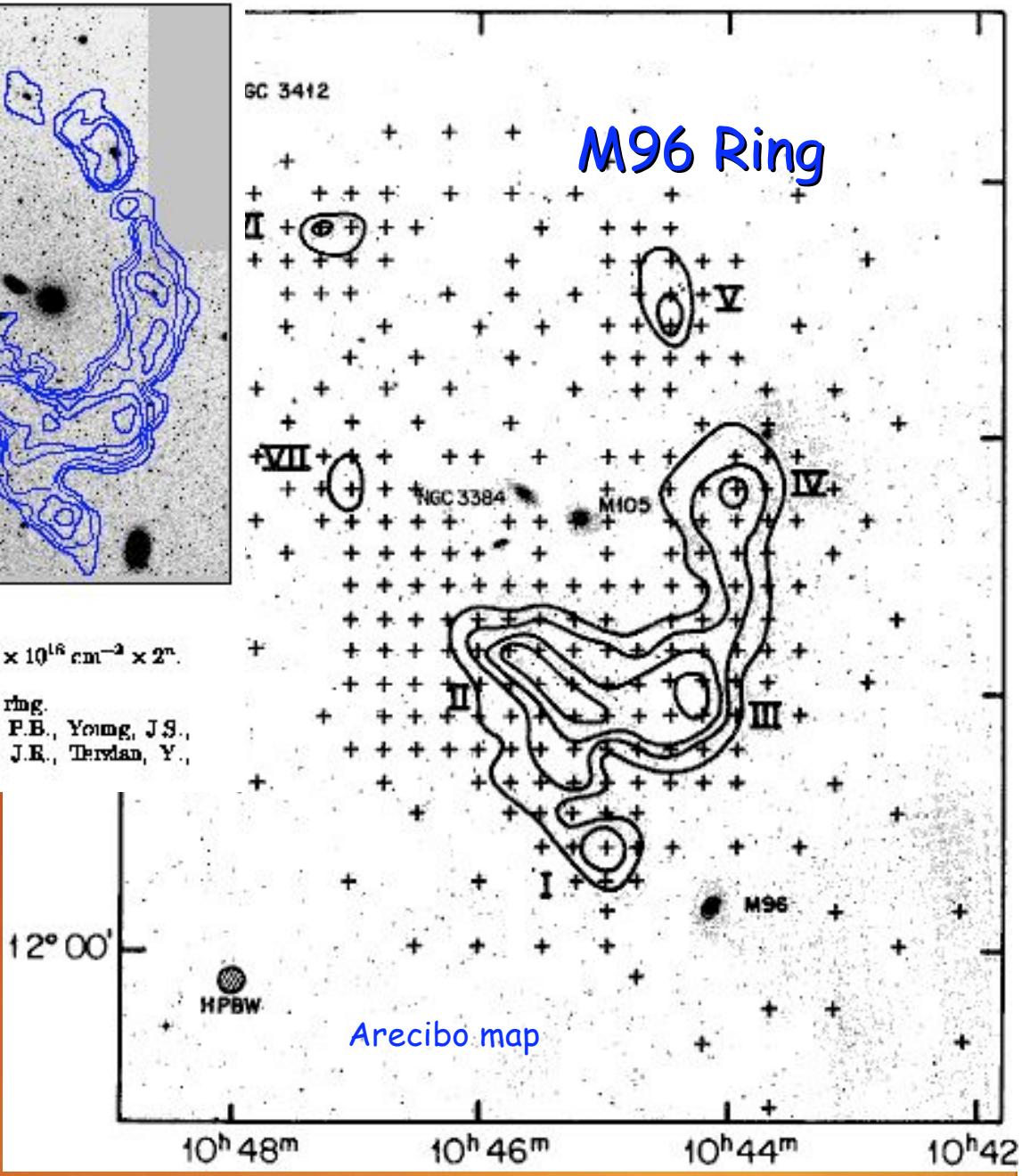


Figure 1. **The Leo Ring System.**
H I: Arecibo single dish map, 3.3′ resolution, contours=2×10^{18} cm$^{-2} \times 2^n$.
Optical: DSS, FOV=70′ × 100′.
Notes: Labeled galaxies have redshifts similar to the H I ring.
Reference: Schneider, S.E., Skrutskie, M.F., Hacking, P.B., Young, J.S., Dickman, R.L., Claussen, M.J., Salpeter, E.E., Houck, J.R., Terzian, Y., Lewis, B.M., & Shure, M. A. 1989, AJ, 97, 666.

Schneider et al 1989 VLA map and Hibbard's HI Rogues Gallery

Schneider, Helou, Salpeter & Terzian 1983

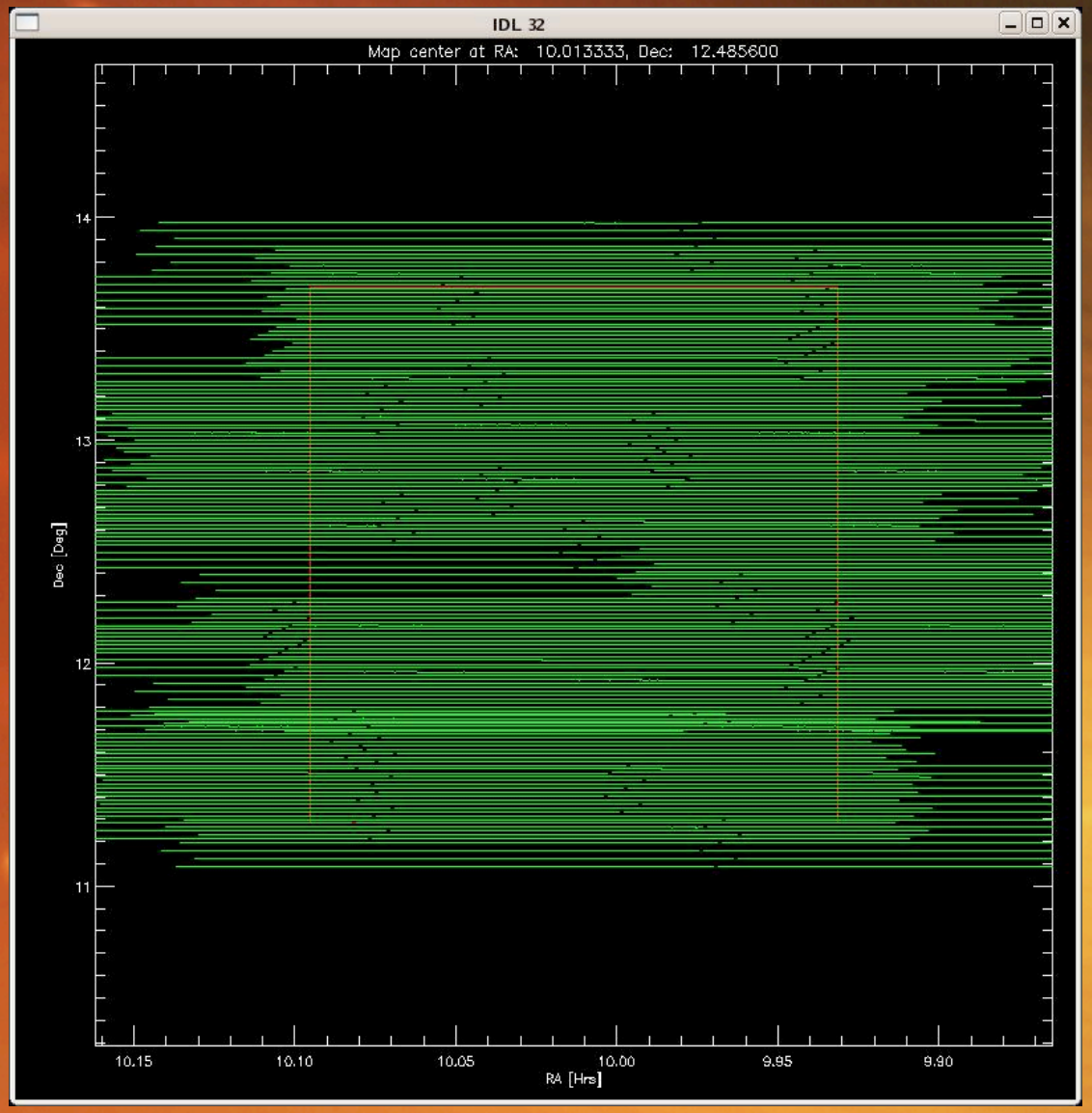


ALFALFA Coverage of Ring

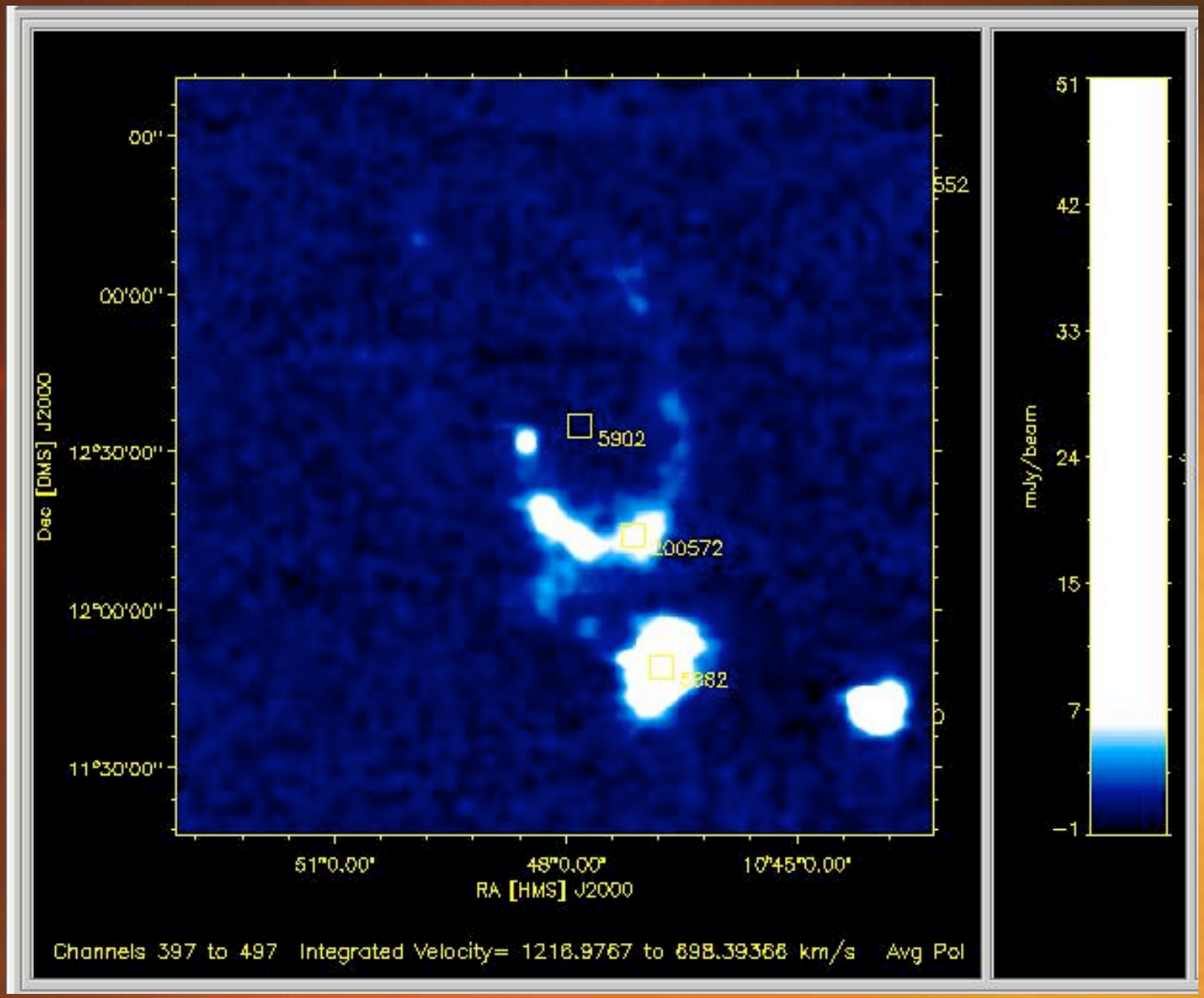
Grid Center:

RA $10^h48^m08^s$

Dec 12°29'08"

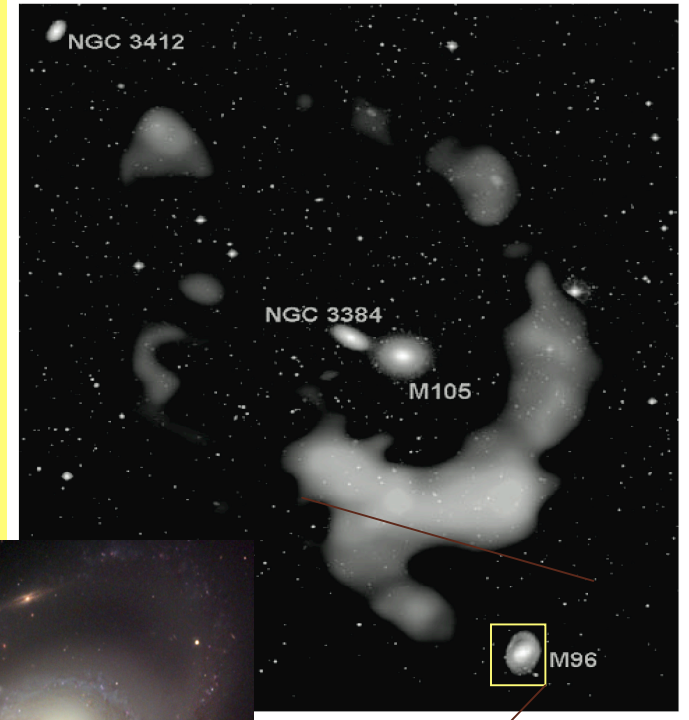


The Leo Ring in ALFALFA

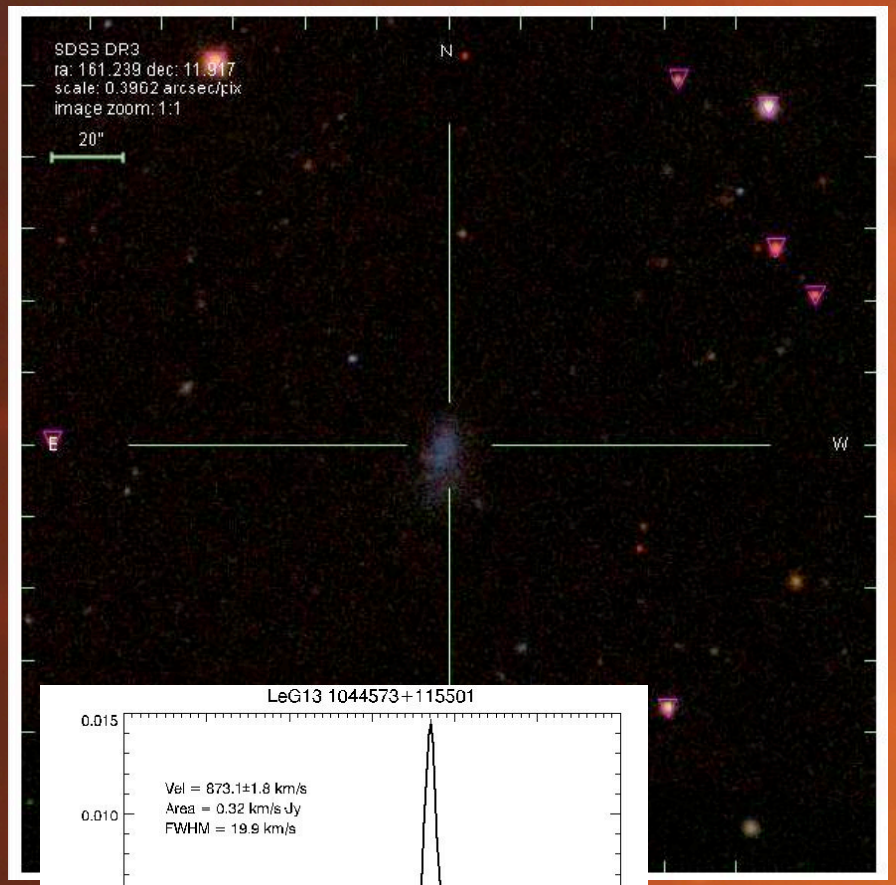


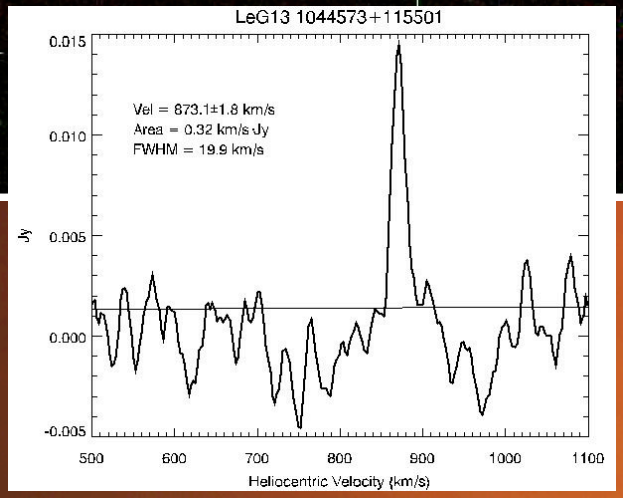
What's Next?

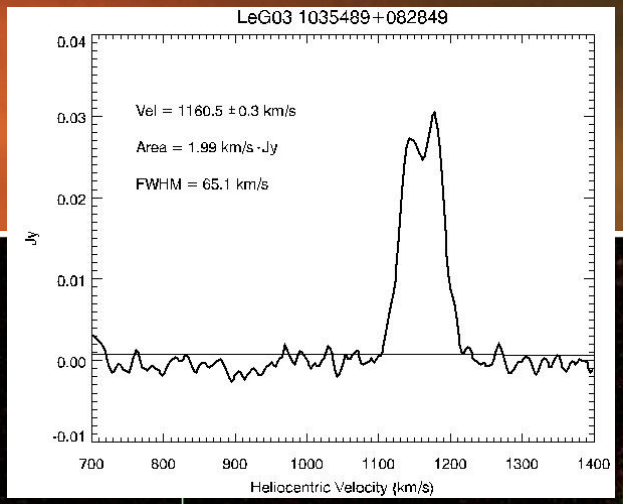
- Continue making source catalogs for the Leo region (that's 60 ALFALFA grids - not an easy job!)
- Determine group status and statistics among the several galaxy groups in the Leo region
- Follow up on objects with no obvious optical counterparts (what are they?)
- Determine the HIMF for this unique environment
- And as always … take more data!

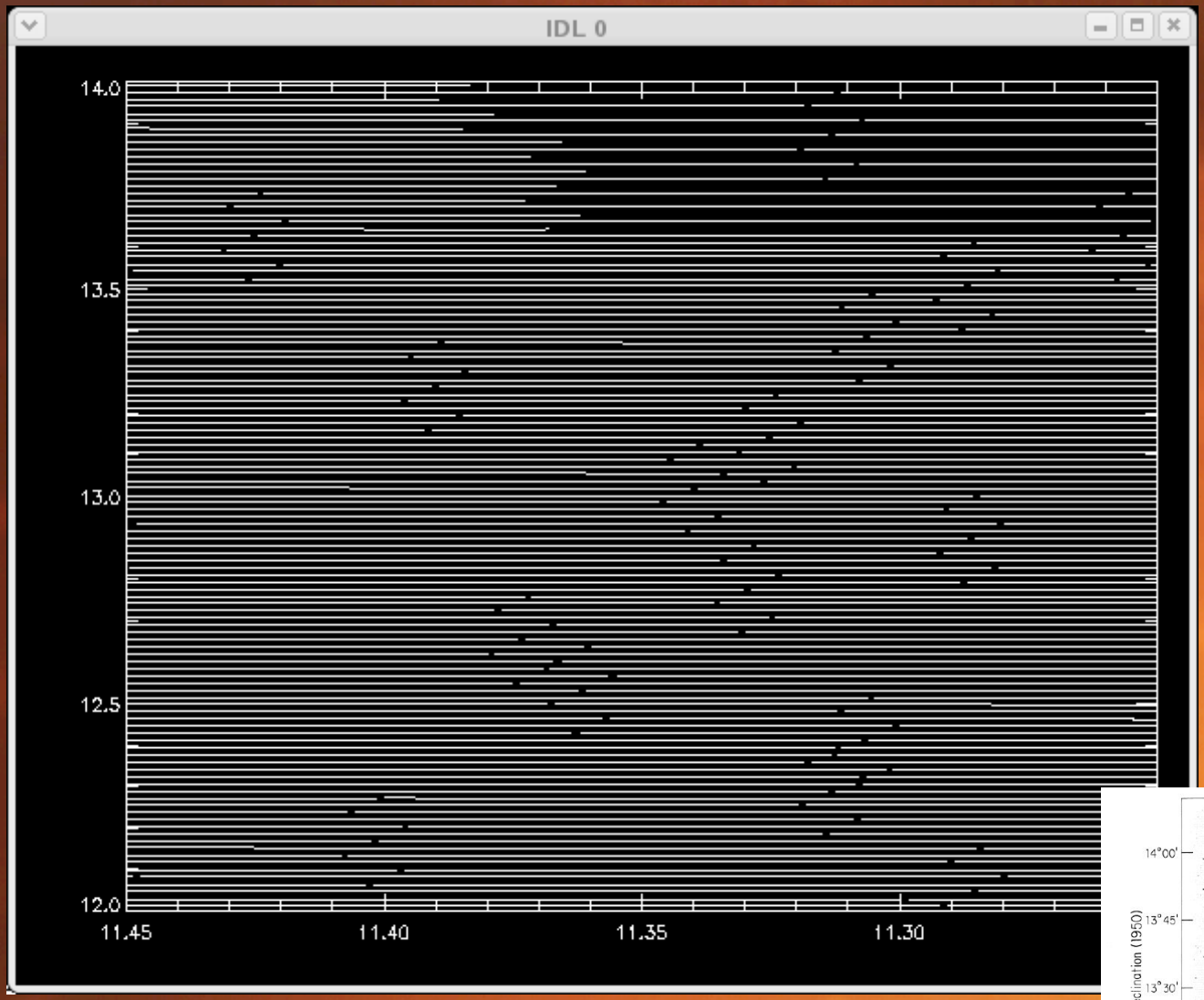

NGC 3412
NGC 3384
M105
M96

Optically-Selected Sample









Leo Triplet

RA=11:15-11:27

Dec=12:0-14:0

Cz=1125-452

step of 26 km/s

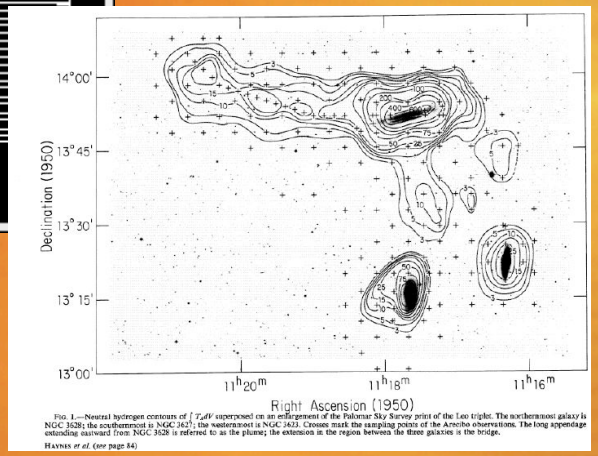


FIG. 1.—Neutral hydrogen contours of [T_{21H} superposed on an enlargement of the Palomar Sky Survey print of the Leo triplet. The northernmost galaxy is NGC 3628; the southernmost is NGC 3627; the easternmost is NGC 3623. Crosses mark the sampling points of the Arecibo observations. The long appendage extending eastward from NGC 3628 is referred to as the plume; the extension in the region between the three galaxies is the bridge.

HAYNES *et al.* (*see* page 84)