(Astro)Physics 343 Lecture # 2:
Lab #1 & Radiative Processes

Lab and office hour schedules

Section	Time	Students
A	Mon 5:00	M. Crews, S. Karanam, C. Matthews
B	Tue 12:00	A. Golugula, G. Kanarek, B. Shappee
C	Tue 1:40	A. Merced, C. Ng, T. Stelling
D	Tue 3:20	B. Baghal, G. Jain, A. Tomczak
E	Tue 5:00	S. Patel, A. Suszko, B. Urbanowicz

Office hours (every week): Mon 2:30–3:30 & 6:30–7:30 (Baker); Fri 2:00–3:00 (Fadely)

“On call” hours (analysis week): regular lab times (week of 2/11: A & C = Baker; B, D, & E = Fadely)

Computer accounts

I have set up individual accounts for you on the *obsastro* PC network, which includes the computer we will use to run the telescope ("blanco" in room 403b).

Accounts (and passwords) carried over from last semester:

Kanarek, Karanam, Matthews, Merced, Ng, Patel

New accounts:

baselb, yngmogul, golugula, gothum, ben.shappee, voldie, arthur72, tomczak, burbanow

Computing protocol for labs

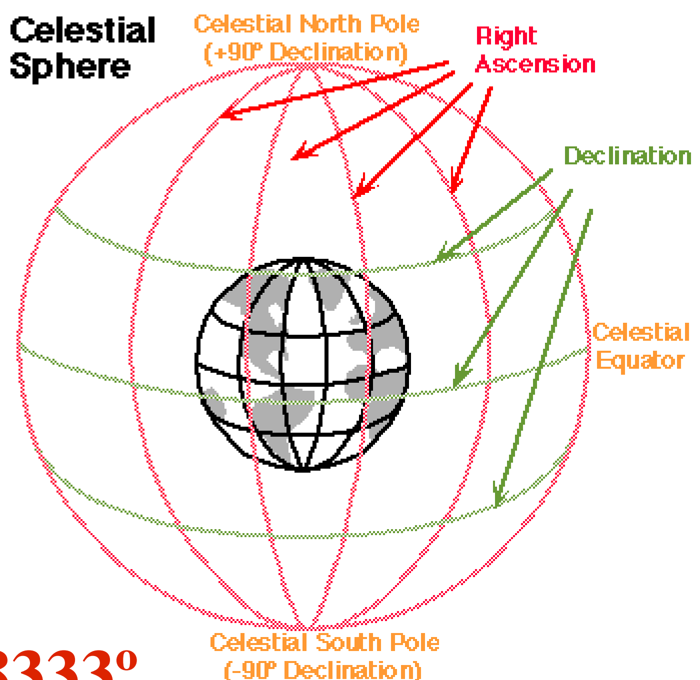
The directory on blanco in which the telescope control software is installed is c:\srt . This directory contains a reference file srt.cat that should not be modified except by the instructor! (This includes important calibration information.)

Your should use c:\srt to store command files and output data files during your lab session, but to avoid swamping that directory, make sure to copy them to a subdirectory (identified with your name or initials) when you are done for the day.

Your analysis will be done on your own computer at home.

Celestial coordinates: units of R.A.

Right ascension ("R.A.", α) & declination ("Dec.", δ) = celestial latitude and longitude that describe a source's position.



Example # 1:

A source has R.A. 14:11:45.2.

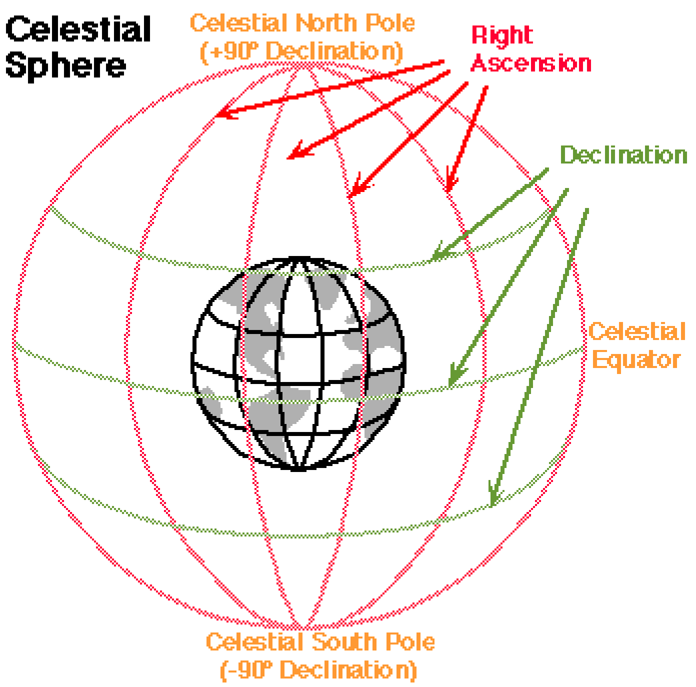
What is this in units of degrees?

Answer:

$$15 \times (14 + 11/60 + 45.2/3600) = 212.938333^{o}.$$

(Note that R.A. 23:59:59 corresponds to 359.995833°.)

Celestial coordinates: source separations



Example # 2:

Source A lies at 02:33:24.5 +15:32:29.

Source B lies at 02:33:32.9 +15:24:06.

How far apart are they on the sky?

Answer:

$\Delta\delta$ is easy: $(24 \times 60 + 6) - (32 \times 60 + 29) = -503'' = -8.383'$

$\Delta\alpha$ is harder: $15 \times (32.9 - 24.5) \times \cos(15.4715) = 121'' = 2.024'$

For small angles, separation $\simeq [(\Delta\delta)^2 + (\Delta\alpha)^2]^{1/2} = 8.6'$

Celestial coordinates: directions

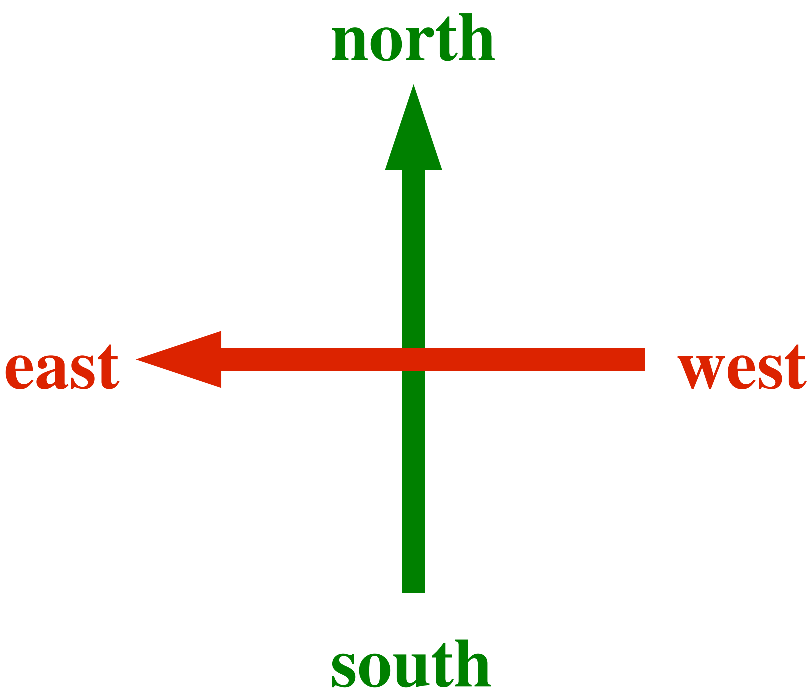
Consider again: source A lies at 02:33:24.5 +15:32:29,

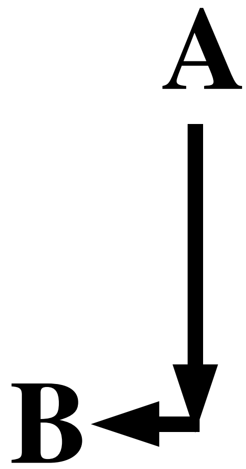
source B lies at 02:33:32.9 +15:24:06.

How do they *look* on the sky?

$\Delta\delta = -8.383'$

$\Delta\alpha = 2.024'$





Celestial coordinates: precession

When can a source's right ascension and declination change?

(1) It's a solar system object (Sun, moon, planet, asteroid, etc.).

(2) It's a nearby star with a high "proper motion" (e.g., α Cen).

(3) We wait long enough that the earth's rotation axis wobbles a little (i.e., it precesses).

To deal with (3), every right ascension and declination must be specified with an epoch ("B1950" and "J2000" are common).

Celestial timekeeping

Astronomers use two principal time conventions:

(1) UT = Universal Time

This is a solar time that corresponds (apart from daylight savings) to the local time in Greenwich, England.

At a given moment, UT is the same everywhere.

(2) LST = Local Sidereal Time

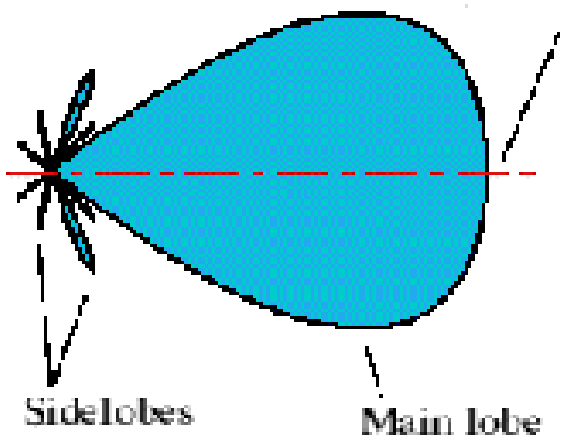
This is the R.A. that is directly overhead right now.

At a given moment, LST is different at different longitudes.

Lab # 1: measuring the telescope's beam

A radio telescope can only see a limited range in solid angle (relative to its own axis) at any given time.

The normalized beam pattern describes a telescope's response to a given sky direction (defined to be 1 on-axis).



The main lobe has a width proportional to λ/D for λ the wavelength and D the diameter of the telescope. We will measure the width of the main lobe for the SRT by scanning across the sun.

The SRT's receiver

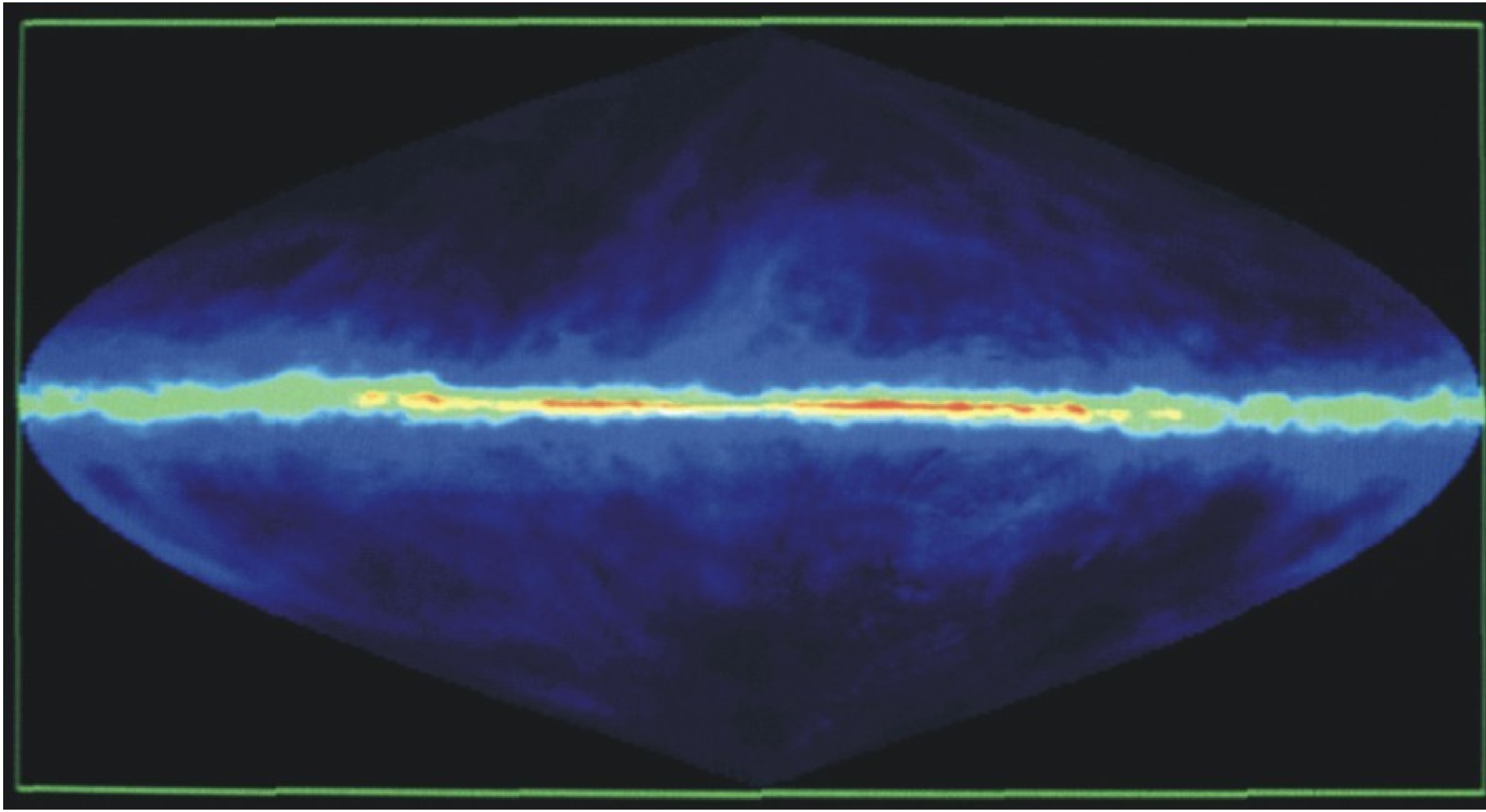
The telescope on the roof of Serin is equipped with the digital receiver rather than the analog receiver (digital systems use digital signals, i.e., 1s and 0s, while analog systems use signals that are continuous in time and amplitude).

Output is one long row per time dump, containing: time stamp, azimuth, elevation, azimuth offset, elevation offset, frequency, channel spacing, 1, # of spectra bins, and finally contents of those bins (typically 64).

The SRT's command language

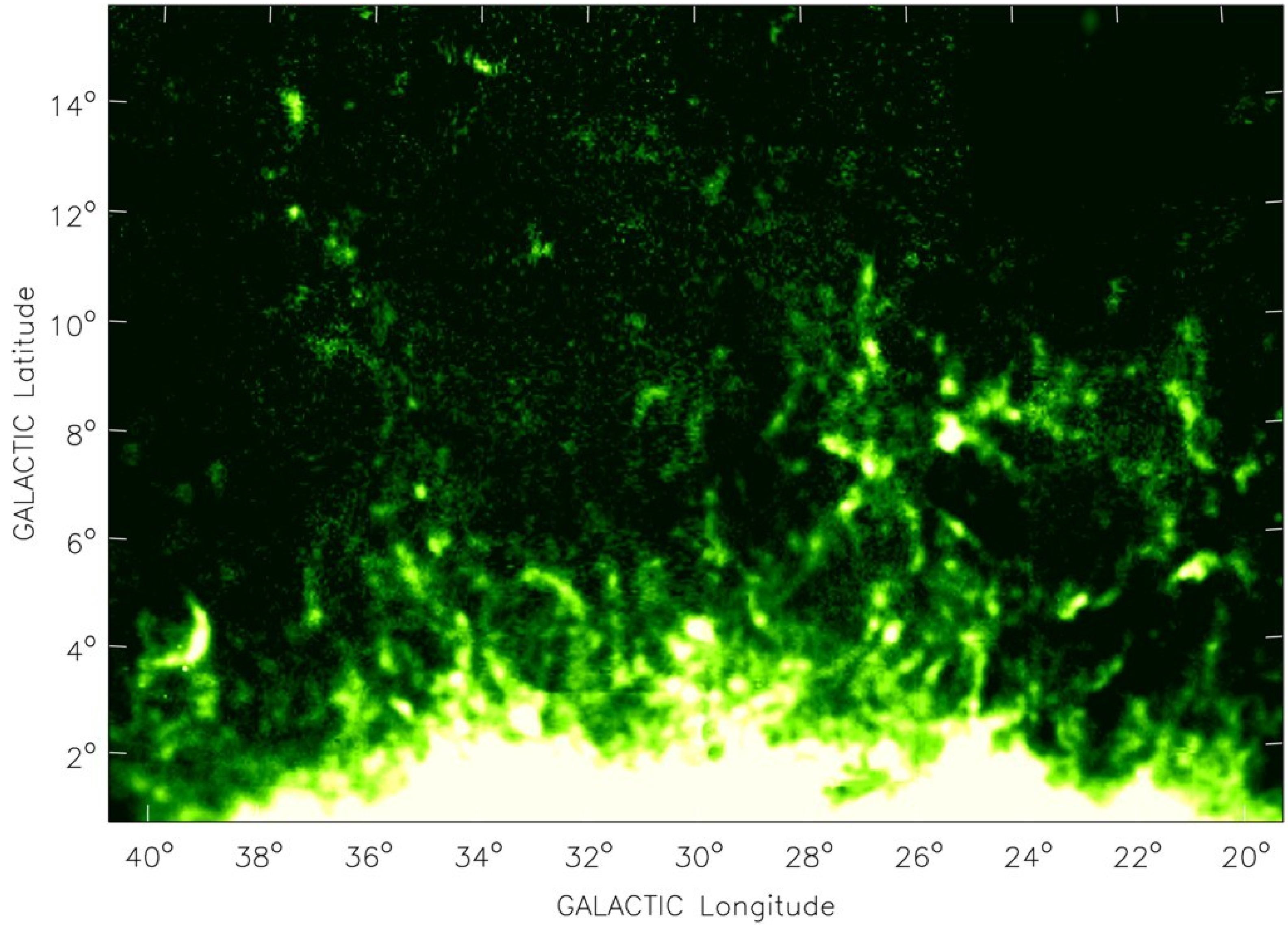
Our observing scripts can be prepared as *.cmd (text) command files, copied to "blanco", and executed within the SRT control software environment. Results will be recorded into *.rad files. Note that all commands except an instruction to wait must be preceded by a ': '.!

Quiz



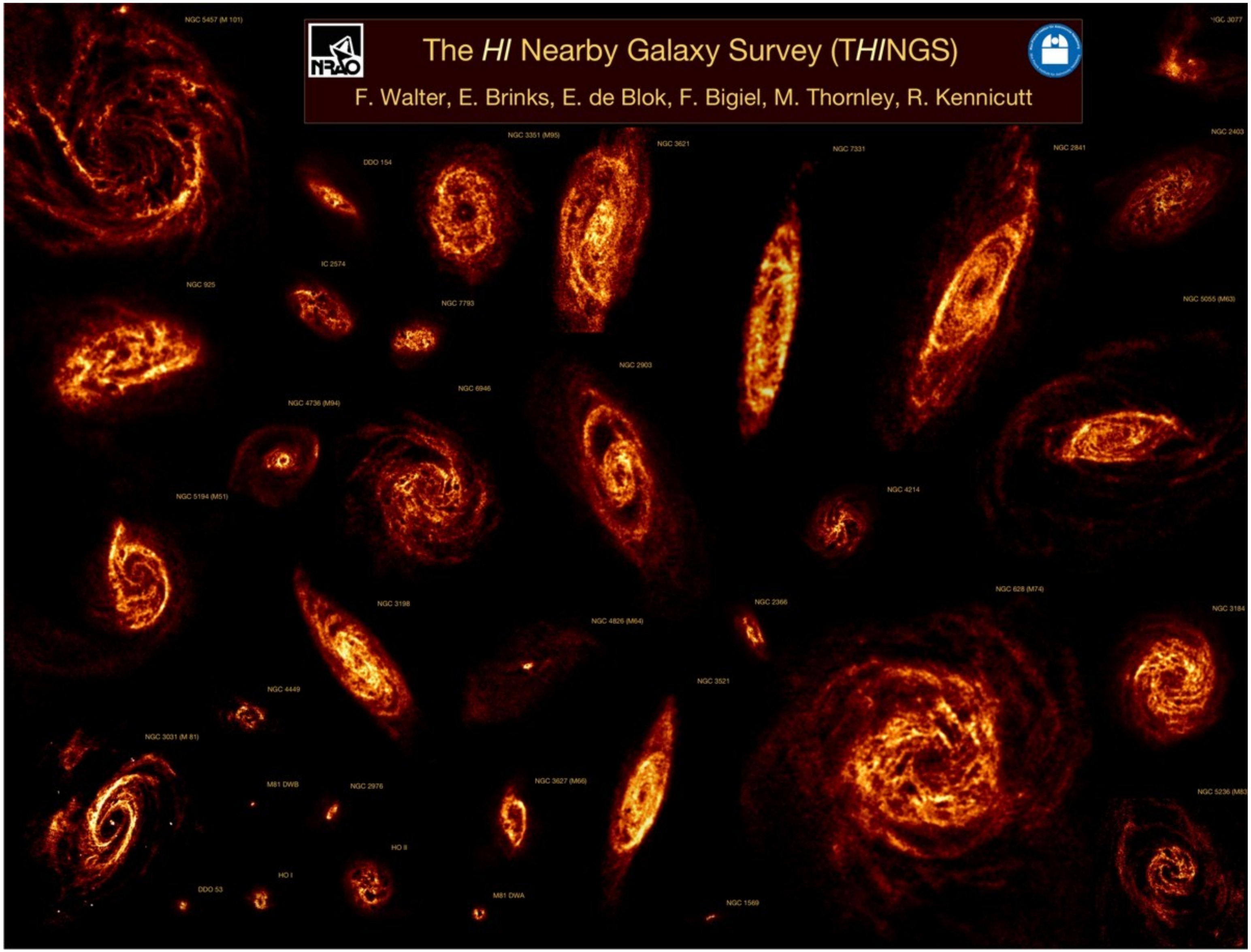
HI in the Milky Way, plotted in (*l*,*b*) coordinates

J. M. Dickey & F. J. Lockman

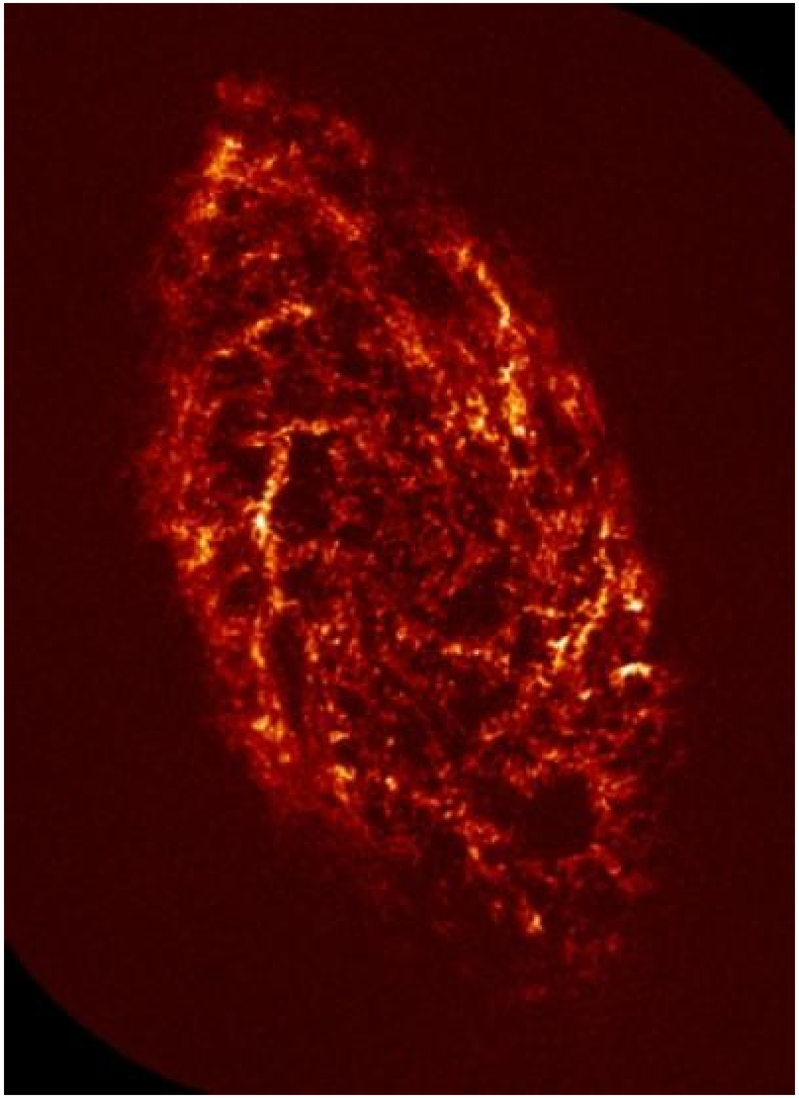


HI in the Milky Way halo (z ~ 2 kpc); field's total M_{HI} ~ 10^6 $M_\odot$

Y. Pidopryhora, F. J. Lockman, & J. Shields

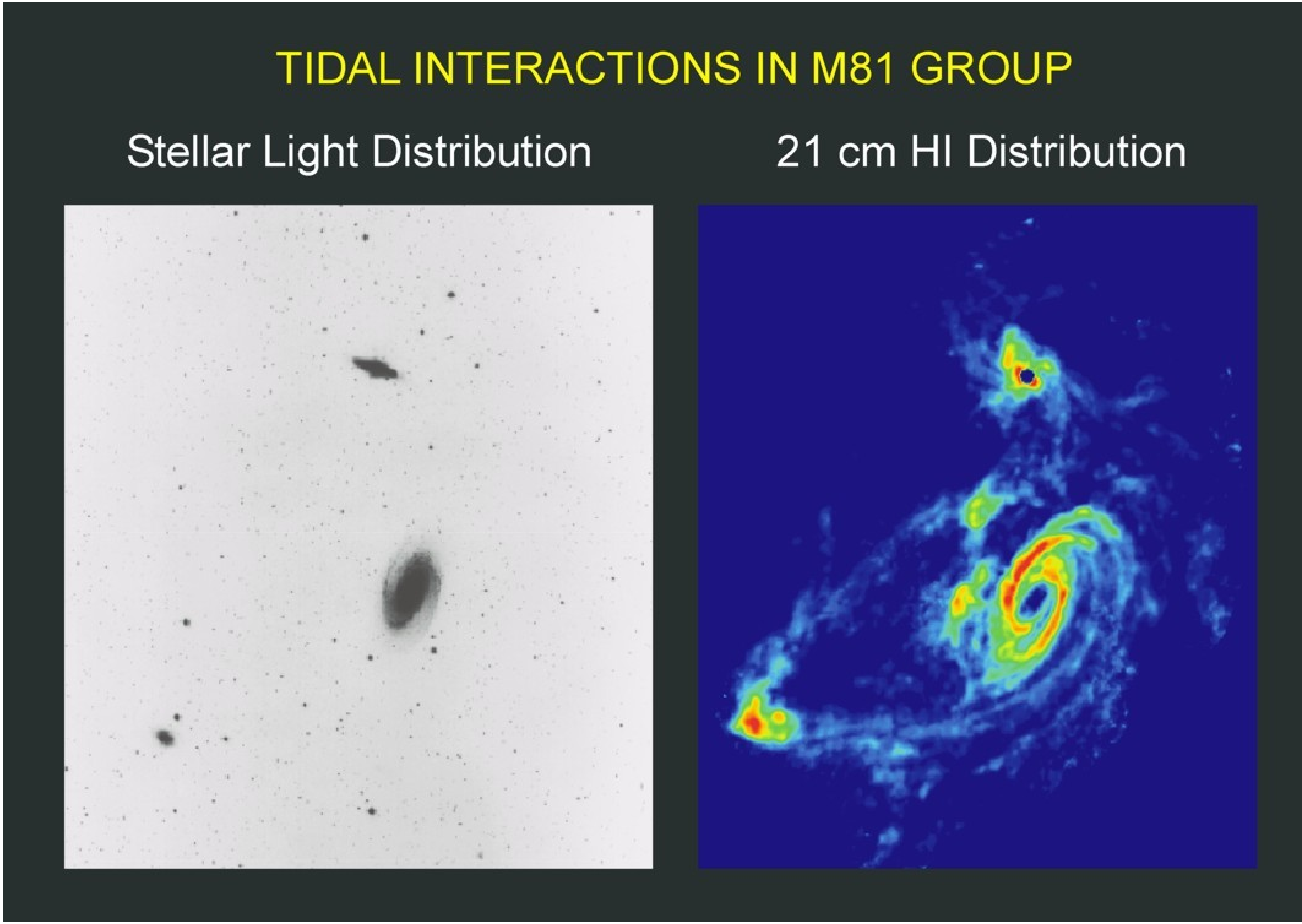


HI in nearby, normal galaxies



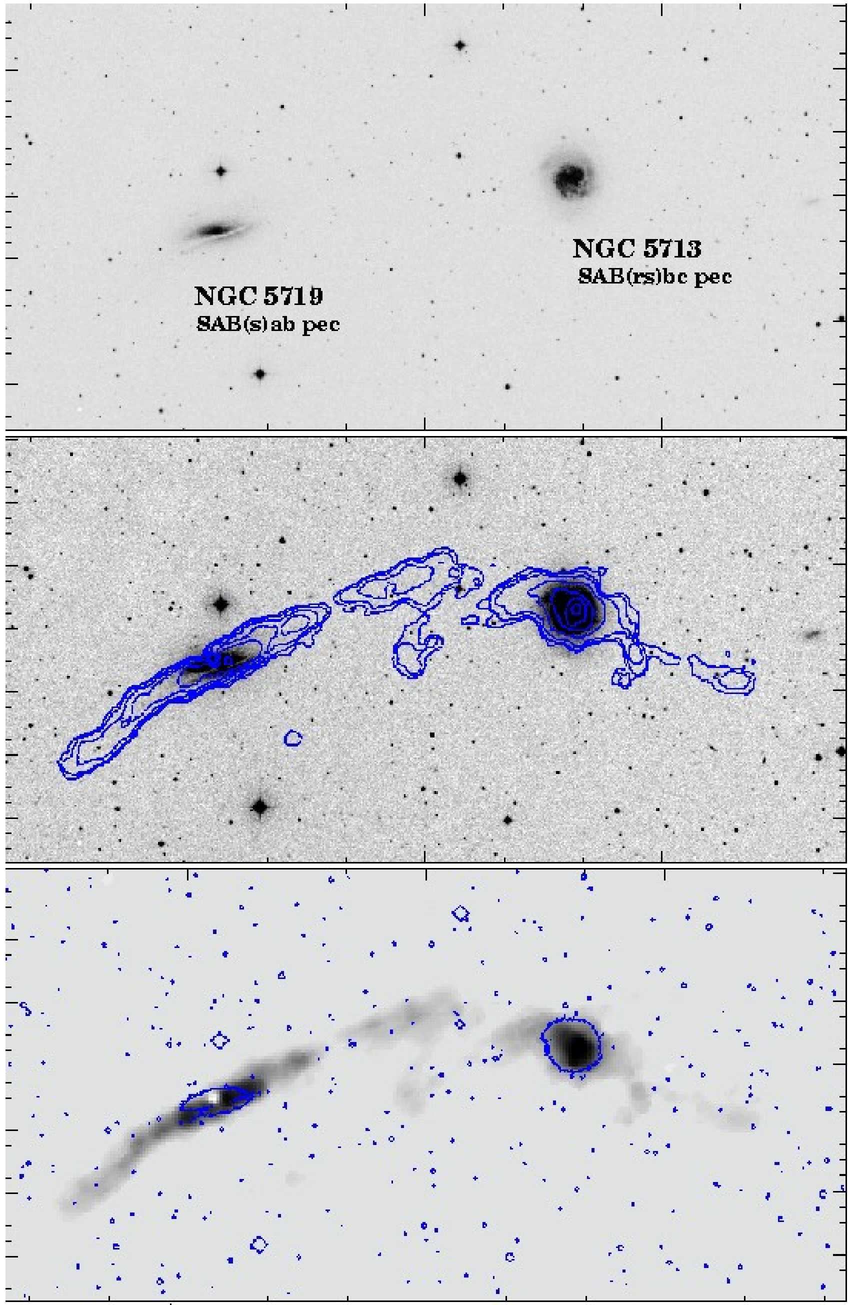
HI in M33 (very nearby spiral)

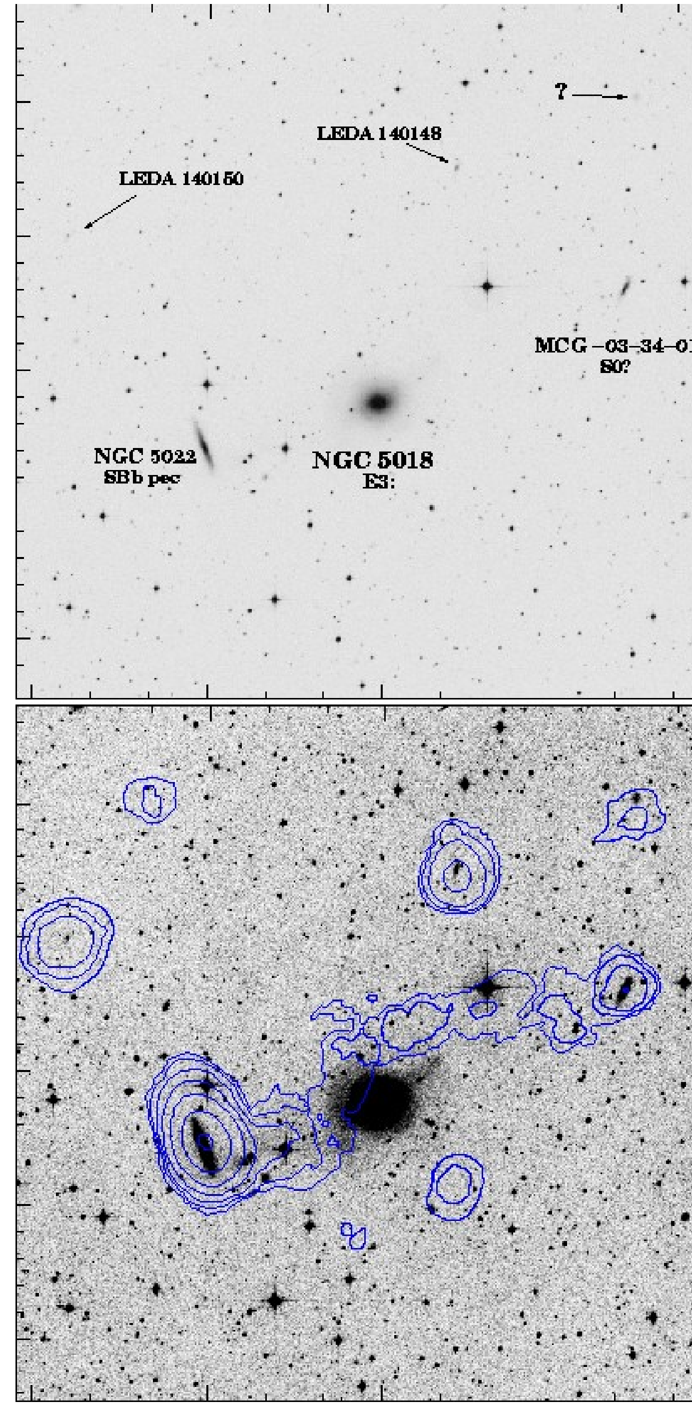
D. Thilker, R. Braun, & R. Walterbos



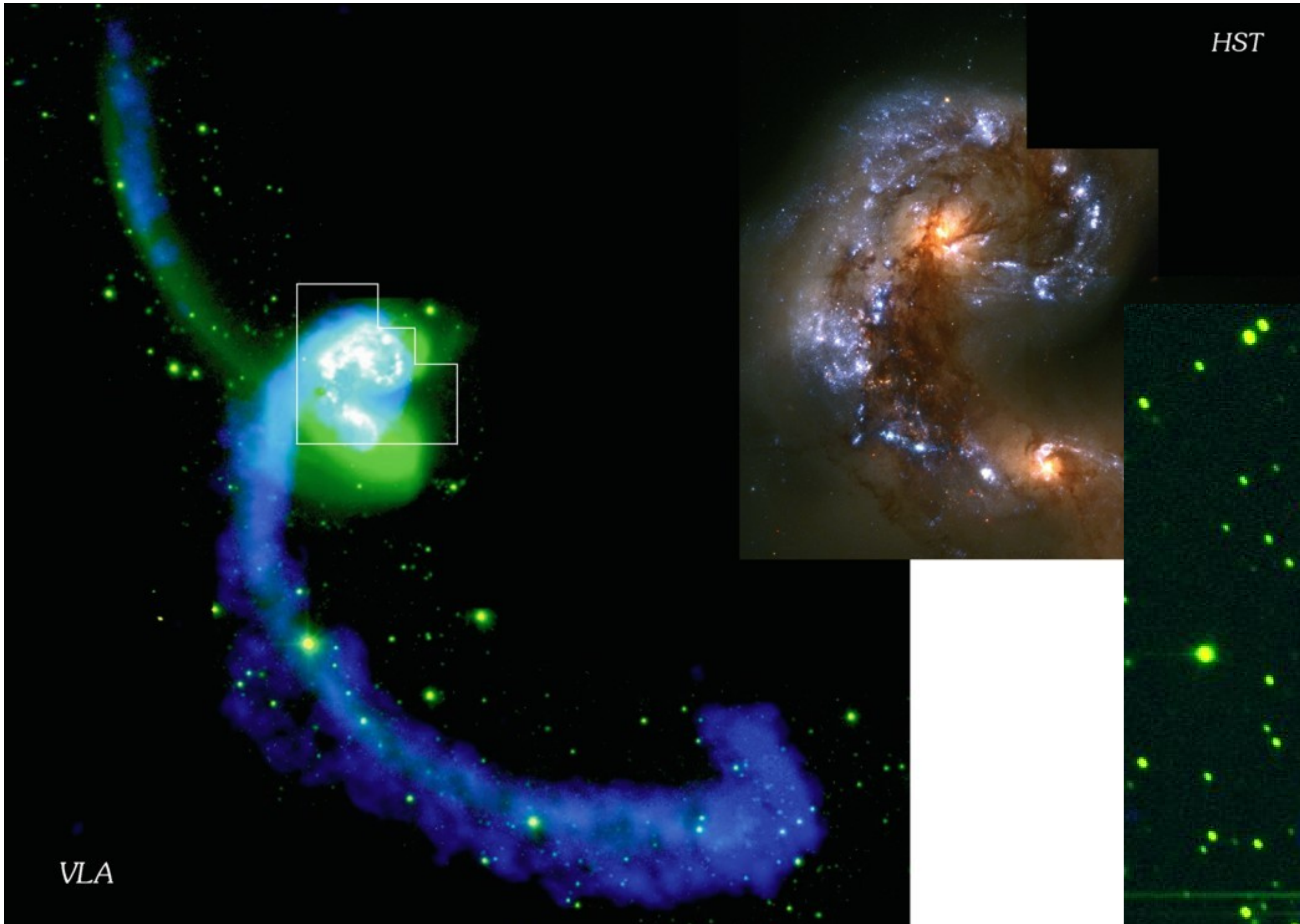
HI in common envelope for the M81 galaxy group

M. S. Yun, P. T. P. Ho, & K. Y. Lo

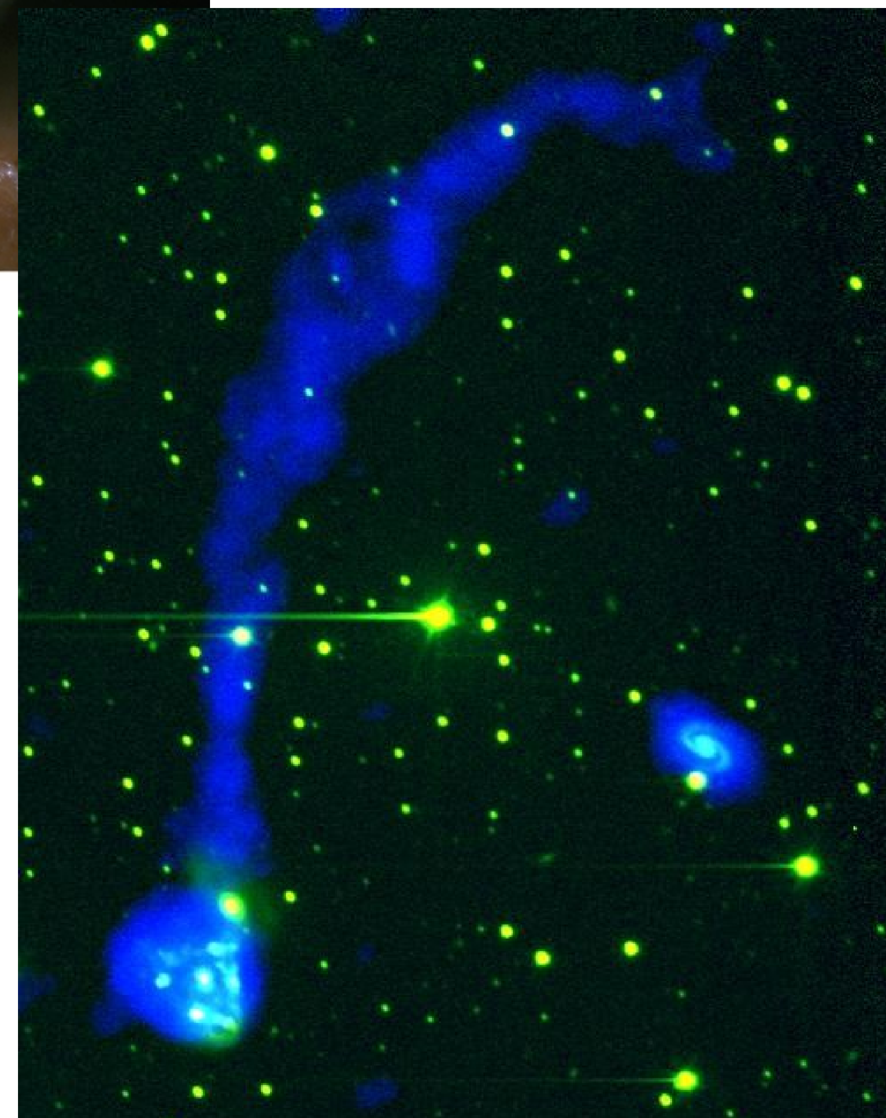




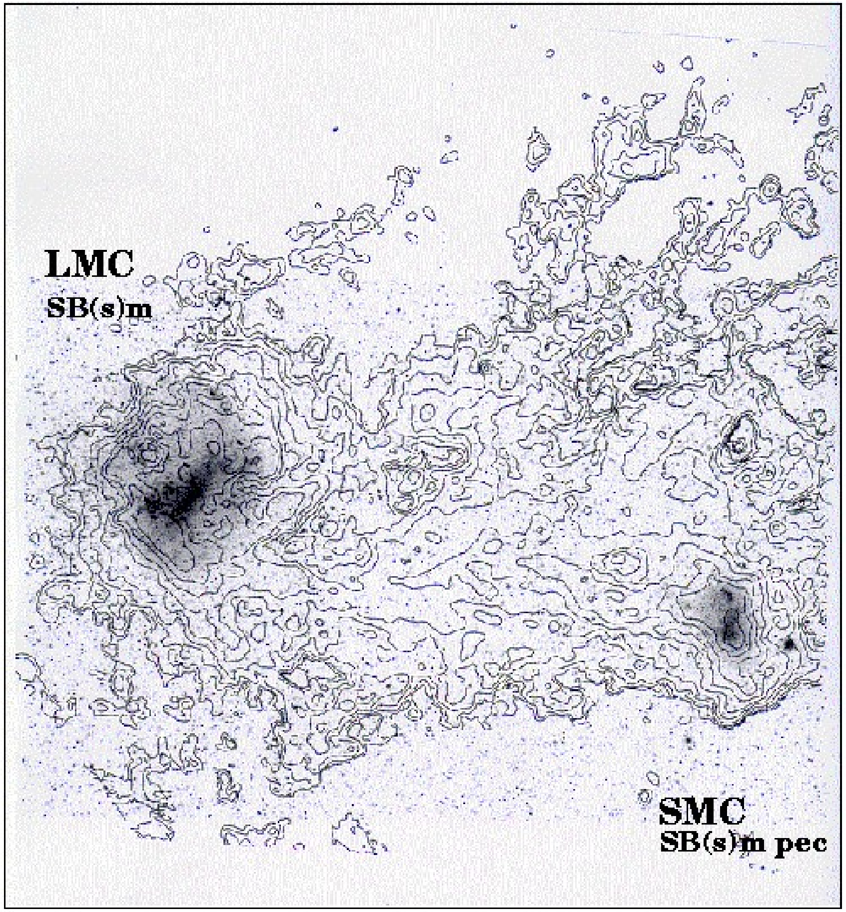
HI in current or past interacting systems

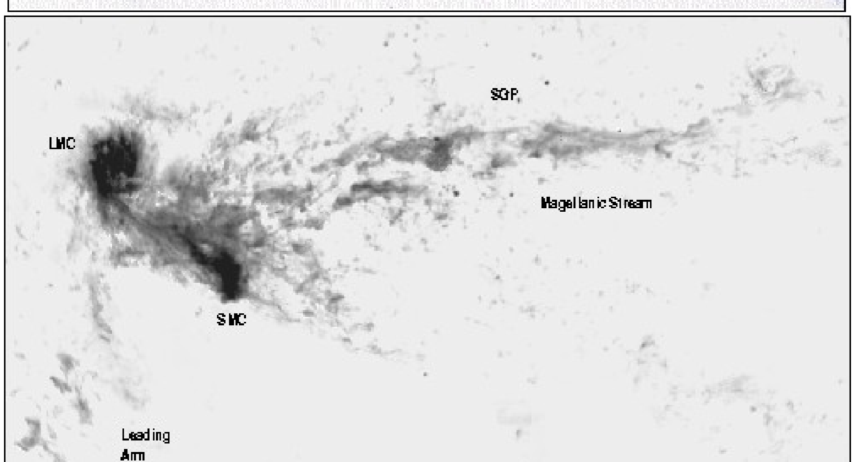


J. E. Hibbard et al.



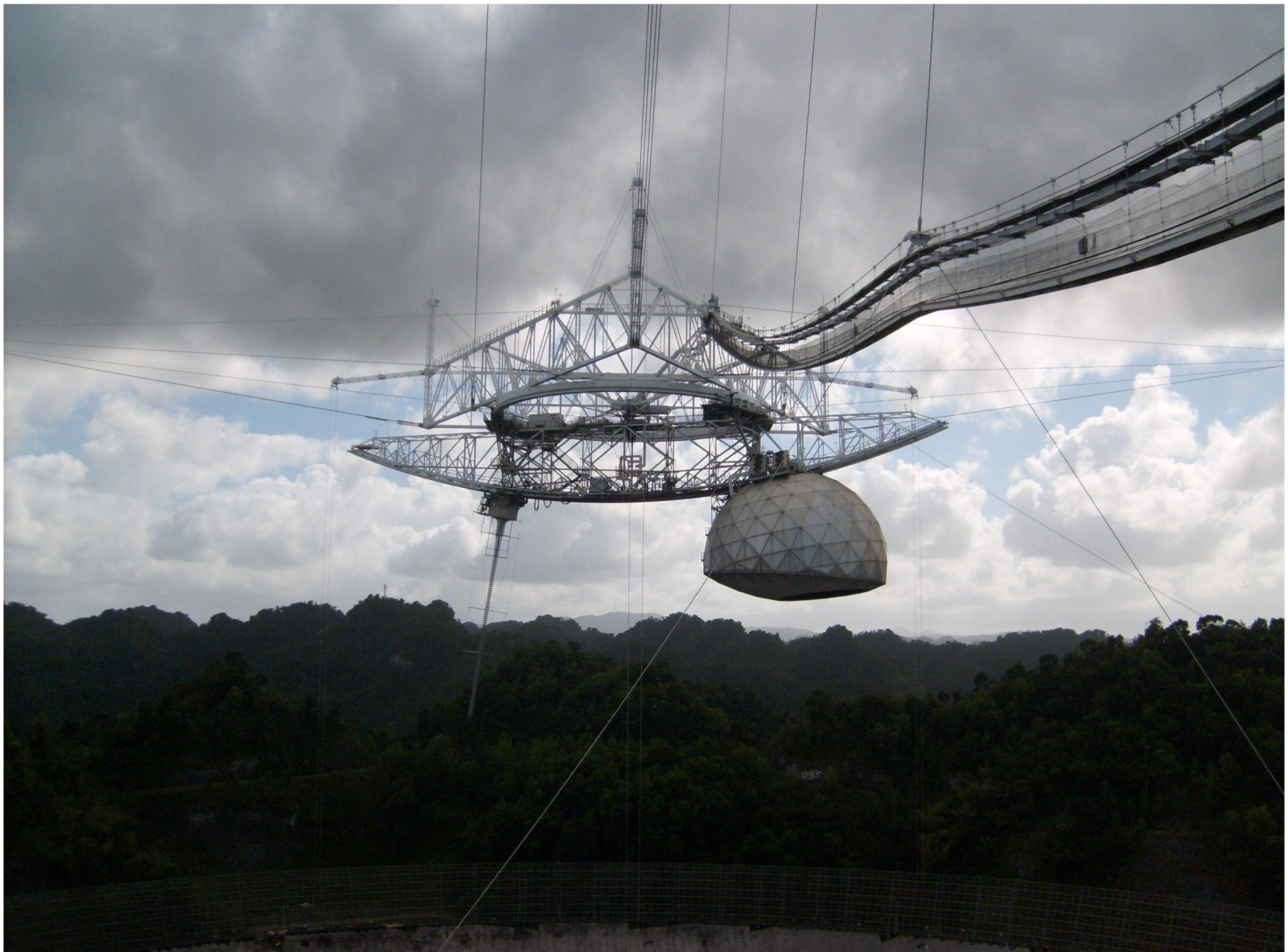
gas+stellar tails imply tidal (gravity)
gas-only tails imply ram-pressure stripping





Magellanic Stream is being ripped out of Large & Small Magellanic Clouds by hot gas in halo of Milky Way.

Arecibo radio telescope: receivers



Arecibo radio telescope: 305m dish

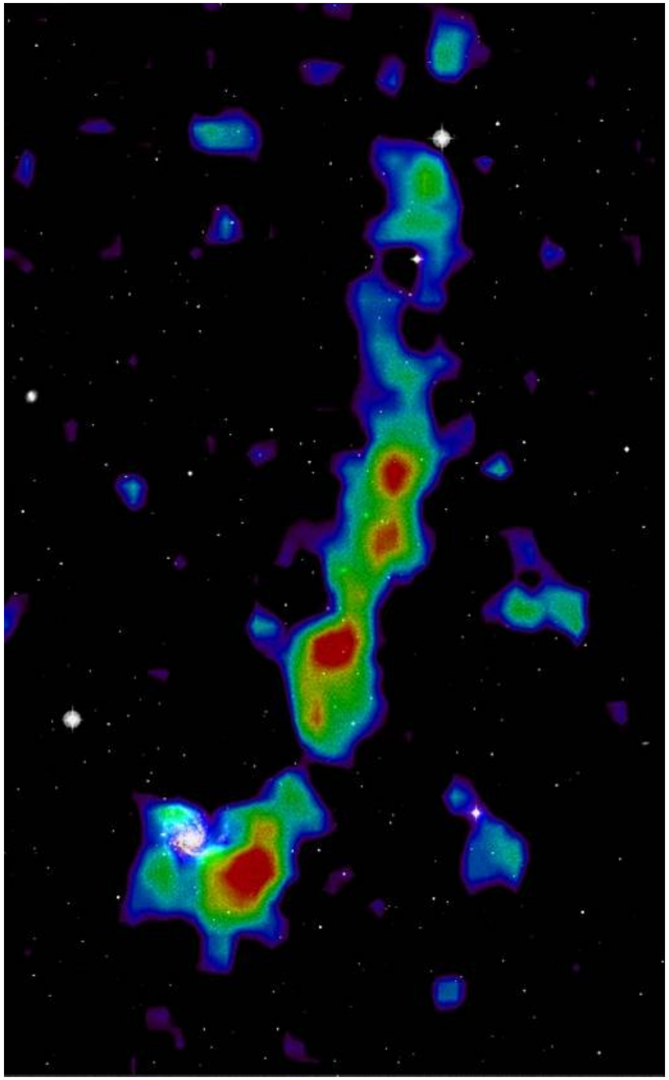
Edge of dish (40,000 aluminum panels) + 1 of 3 support towers each with six cables.

Arecibo radio telescope: access

Edge of dish + second support tower + human access catwalk.

ALFA and ALFALFA

ALFA = Arecibo L-band Feed Array: allows telescope to observe seven times more rapidly than before.



ALFALFA

= Arecibo Legacy Fast ALFA survey (= Arecibo Legacy Fast Arecibo L-band Feed Array survey!?): blind extragalactic HI survey being done in drift-scan mode (will detect 25,000 galaxies with *z* < 0.06)

Why visit Arecibo: future outlook

Every ten years, U.S. astronomers collectively write a “wish list” for all the telescopes and projects they would like to see funded over the <u>next</u> ten years (this is known as the “Decadal Review” and is used to lobby Congress for more funding).

Goal of last week's workshop: develop an exciting strategy for the next decade of HI science that can be successfully sold to other astronomers during the upcoming Decadal Review.