Karl G. Jansky Very Large Array (VLA)
Atacama Large Millimeter/ submillimeter Array (ALMA)
European Very Long Baseline Interferometer (EVLBI)
Australian Telescope Compact Array (ATCA)
Data Reduction Results

Updated 10-30-19

Plus 9 ft. Dish HI Measurement Results
Dr. Richard Russel

Recently Dr. Russel attended the Very Large Array (VLA) imaging course in Socorro, New Mexico.

This course taught how to take the data sets from multiple large interferometer antenna systems and produce images and science statistics.

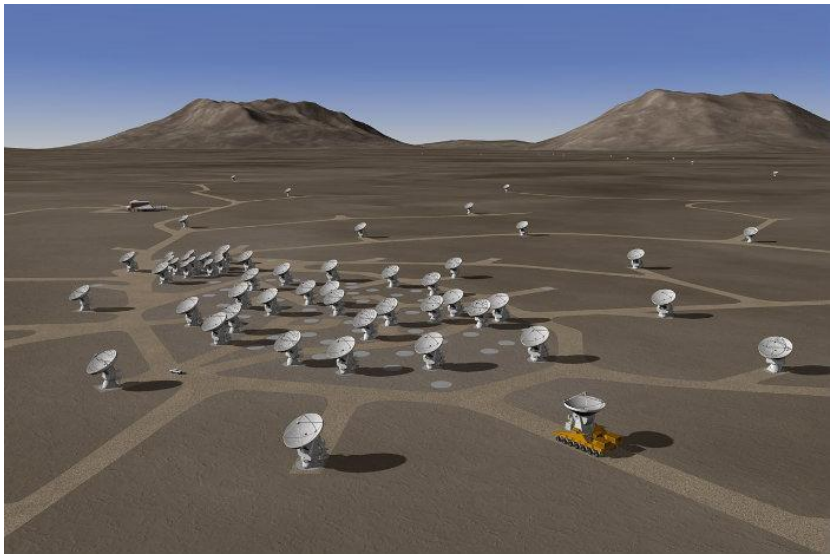
The following is the latest images produced by Dr. Russel from the archives.

Antenna Systems

VLA

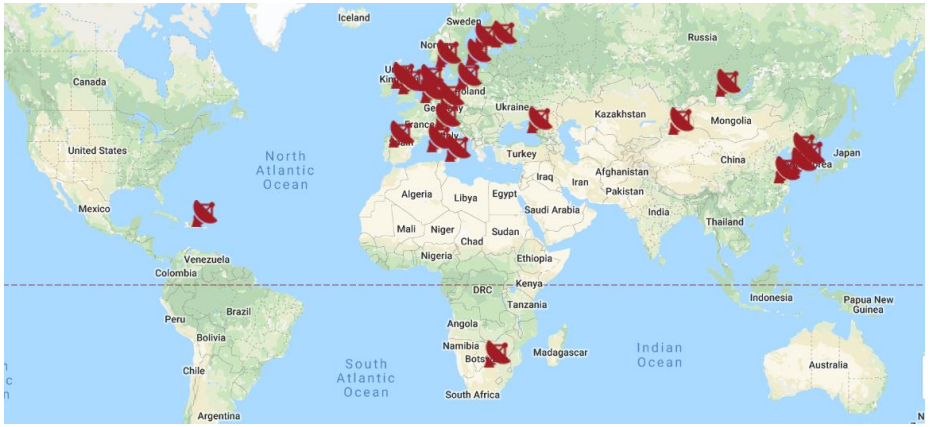
https://www.atlasobscura.com/places/very-large-array

ALMA



http://wikimapia.org/12830127/Atacama-Large-Millimeter-submillimeter-Array-ALMA

European Very Long Baseline Interferometer (EVLBI)



https://www.evlbi.org/telescopes

Australian Telescope Compact Array (ATCA)

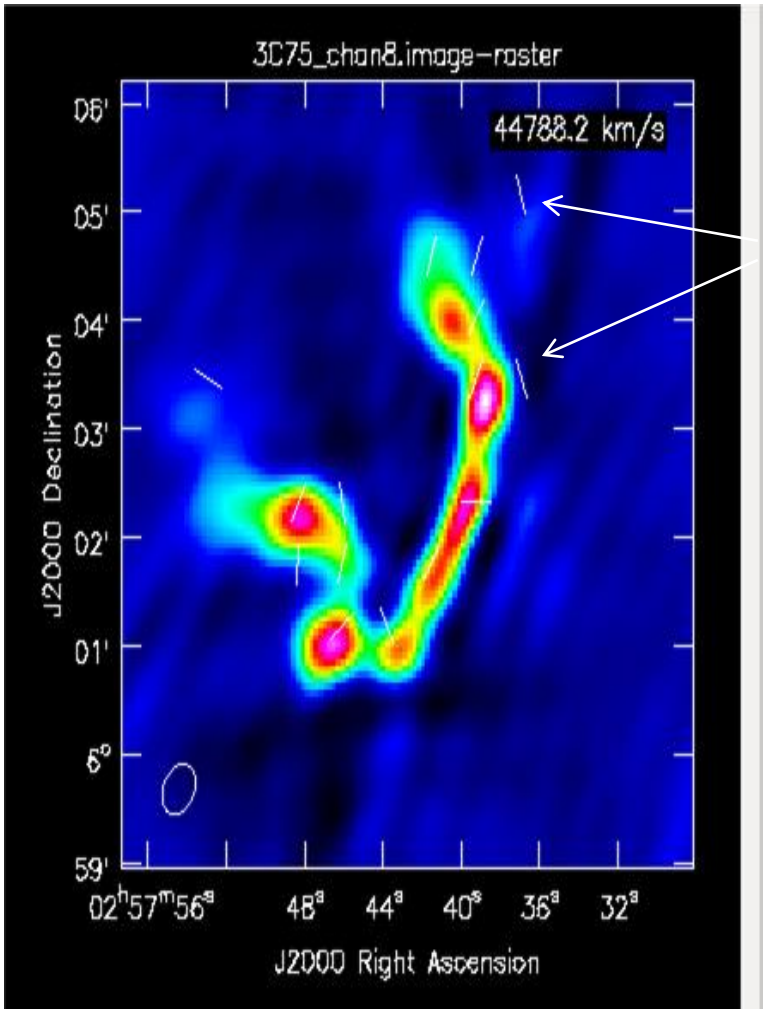
https://www.narrabri.atnf.csiro.au/observing/users_guide/html/chunked/index.html

3C75 Binary Black Hole System (VLA Archive)

VLA OBSERVING LOG **2018-10-04_0541_TDRW0001**

Observing Date:	04-Oct-2018	Project:	TDRW0001 # Subarrays: 1	Observation Type:	Test
Configuration:	D	Observer(PI):	Dr Emmanuel Momjian	Band(s) Used:	C S
Decommissioned:	27	SBID(s):	35624494		
		Source File(s):	TDRW0001_sb35624494_1_1		
		Observer E-mail:	emomjian@nrao.edu		
		Operator(s):	Kenneth Gibson		

Data Reduction Results



Polarization vectors

Background Information Wikipedia

3C75 (a.k.a. 3C 75) is a binary black hole system in the Abell 400 cluster of galaxies. It has four radio jets (two from each accreting black hole). It is travelling at 1200 kilometers per second through the cluster plasma, causing the jets to be swept back. The binary supermassive black holes are themselves contained in the dumbbell shaped galaxy NGC 1128. 3C 75 may be X-ray source 2A 0252+060 (1H 0253+058, XRS 02522+060).[4] Wikipedia

Image in radio (pink) and x-ray (cyan) of 3C 75.

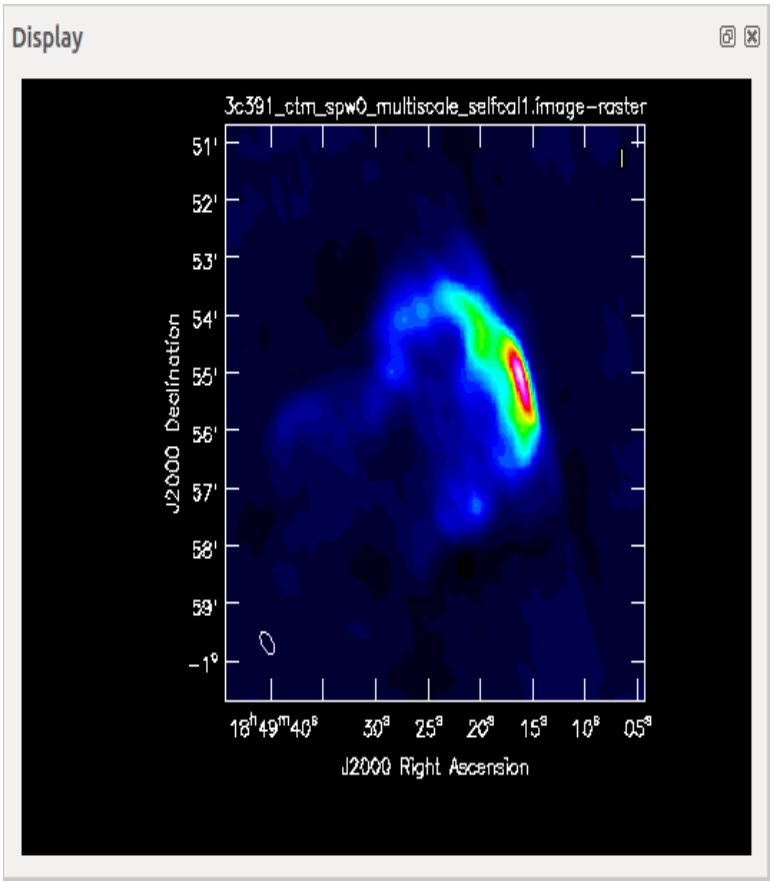
Followed tutorial
https://casaguides.nrao.edu/index.php/Polarization_Calibration_based_on_CASA_pipeline_standard_reduction:_The_radio_galaxy_3C75-CASA4.5.2
and produced this image: Dr. Richard A. Russel 10/16/19 (detail in CASA 3C75 Tutorial.odt)

3C391 Supernova Remnant (VLA Archive)

EVLA OBSERVING LOG **2010-04-24_0801_TDEM0001**

Observing Date:	24-Apr-2010	Program:	TDEM0001	Observing Mode:	Mixed Modes
Configuration:	D	Observer(s):	James Miller-Jones	Bands Used:	C
Decommissioned:	10	User #:	2398	# Subarrays:	1
VLBI Ref Ant:		Observer's E-mail:	jmiller@nrao.edu, mrupen@aoc.nrao.edu	Initial Source:	J1331+3030
VLBI Ant Pad:		Source File(s):	TDEM0001_sb1218006_1.evla		
		Operator(s):	Sam Gilmore		

Data Reduction Results



Background Information
Astronomy and Astrophysics 78,75-77 (1979)

Observations of the Supernova Remnant 3C391 at 1.4 and 10.7 GHz

W. M. Goss[1], D. J. Skellern[2], A. Watkinson[2], and P. A. Shaver[1]*

[1] Kapteyn Astronomical Institute, University of Groningen, Postbus 800, 9700 AV Groningen, The Netherlands
[2] School of Electrical Engineering, University of Sydney, Australia

Received August 17, 1978

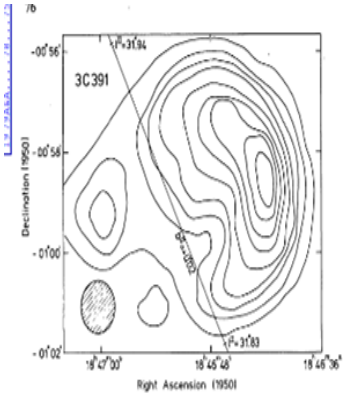


Fig. 1. Map of 3C391 observed with the Fleurs Synthesis Telescope. The HPBW is 54 × 66″ arc (α × δ). The contour levels are 50, 100, 150, 200, 300,..., 700 K (50 K = 0.27 Jy/beam)

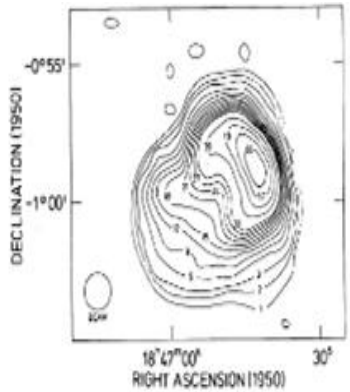


Fig. 2. Map of 3C391 observed at 10.7 GHz with the Effelsberg telescope. The half-power beamwidth is 77″. The contour unit is 0.02°K in antenna temperature or 0.03°K in brightness temperature

Imaged based on VLA Tutorial and VLA Archive Data: Dr. Richard A. Russel 10/16/19 (Detailed file VLA Image Workshop Obs 3c391.odt)

Asymptotic Giant Branch (AGB) Star IRC+10216 (VLA Archive)

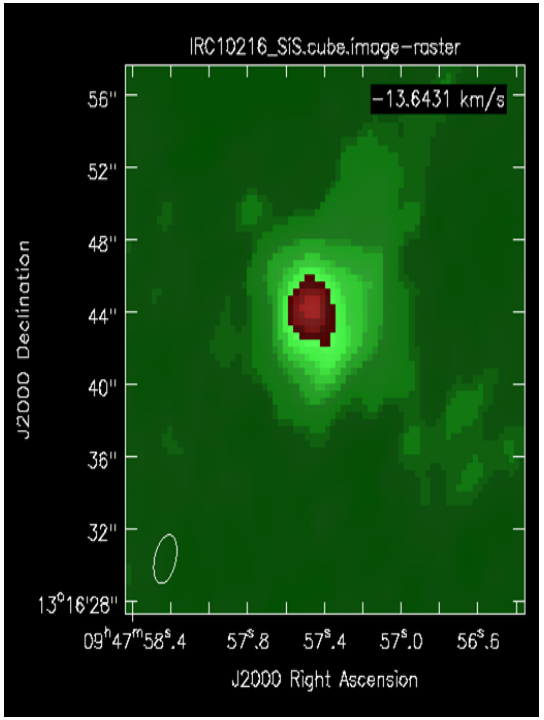
EVLA OBSERVING LOG **2010-04-26_0310_TDEM0003**

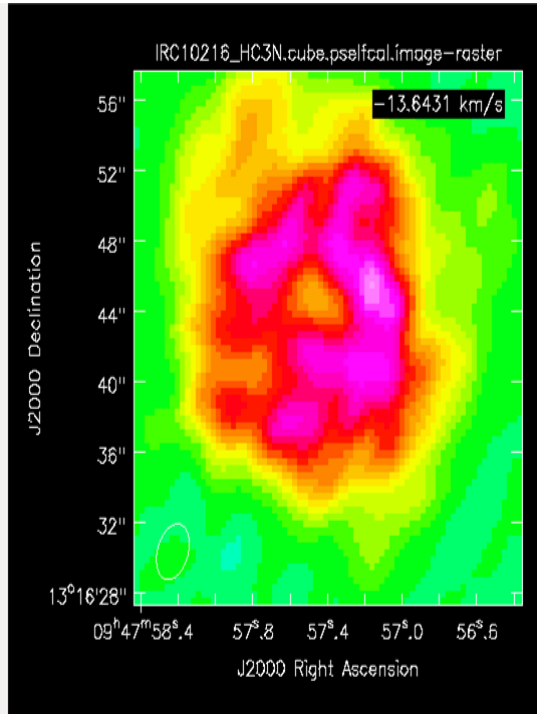
Observing Date:	26-Apr-2010	Program:	TDEM0003	Observing Mode:	Continuum
Configuration:	D	Observer(s):	Mark Claussen	Bands Used:	C, Ka
Decommissioned:	10	User #:	661	# Subarrays:	1
VLBI Ref Ant:		Observer's E-mail:	mdausse@nrao.edu, mrupen@nrao.edu	Initial Source:	J1008+0730
VLBI Ant Pad:		Source File(s):	TDEM0003_sb1345754_1.evla		
		Operator(s):	Matt Gardner		

Background Information Wikipedia

IRC +10216 or CW Leonis is a well-studied carbon star that is embedded in a thick dust envelope. It was first discovered in 1969 by a group of astronomers led by Eric Becklin, based upon infrared observations made with the 62 inches (1.6 m) Caltech Infrared Telescope at Mount Wilson Observatory.

Data Reduction Results





Its energy is emitted mostly at infrared wavelengths. At a wavelength of 5 μm, it was found to have the highest flux of any object outside the Solar System.[12]


CW Leonis in ultraviolet showing the bowshock

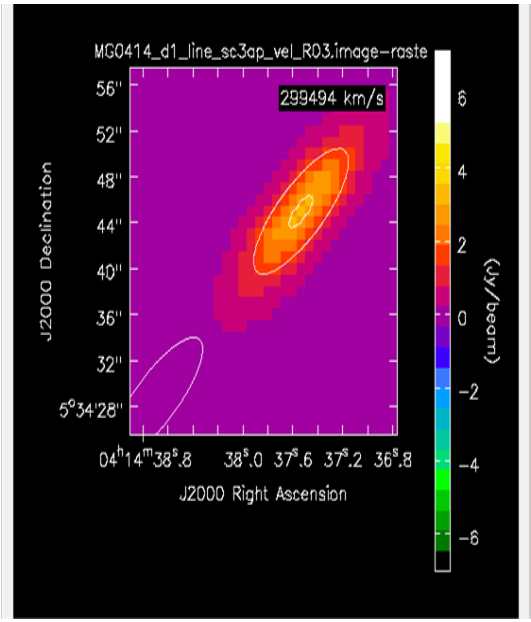
Imaged based on VLA Tutorial and VLA Archive Data: Dr. Richard A. Russel 10/16/19 (Detailed file VLA ImageIRC+10216.odt.odt)

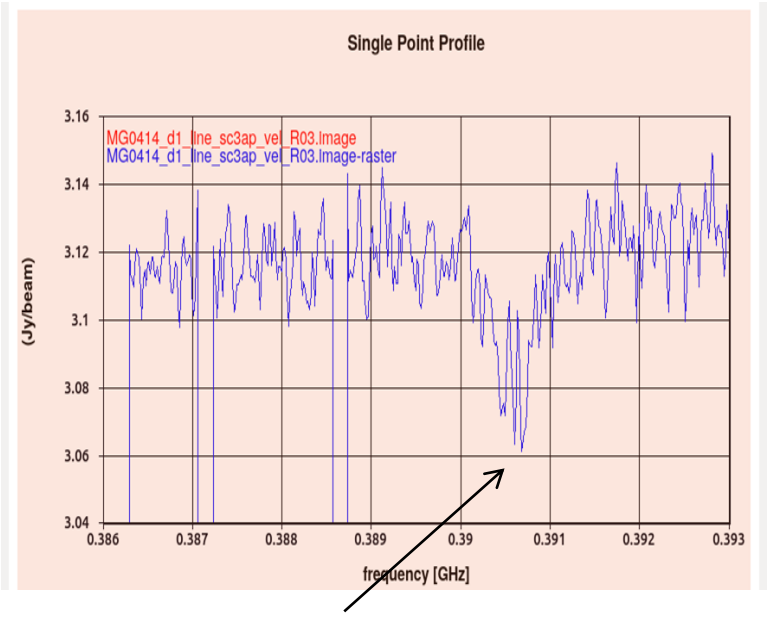
MG0414+0534 Gravitational Lens
HI Absorption Line (VLA Archive)

VLA OBSERVING LOG **2016-09-14_0620_TSUB0001**

Observing Date:	14-Sep-2016				
Configuration:	B=>A				
Decommissioned:	11				
Project:	TSUB0001	# Subarrays:	1	Observation Type:	Test
Observer(PI):	Frazer Owen			Band(s) Used:	X P
SB ID(s):	32720781				
Source File(s):	TSUB0001_sb32720781_1				
Observer E-mail:	fowen@nrao.edu				
Operator(s):	Blythe Guvenen				

Data Reduction Results





Hydrogen Absorption Feature

Background Information
NRAO.edu

Goal was to reduce the spectral-line data in the low-frequency P-band of the VLA (230–470 MHz).

The goal is to make an image cube containing HI 21cm absorption against the strong radio continuum of gravitationally lensed radio galaxy MG0414+0534.

As a result of the high redshift of z=2.6365, the HI absorption signal in MG0414+0534 is redshifted to an observed frequency of 390.597 MHz.

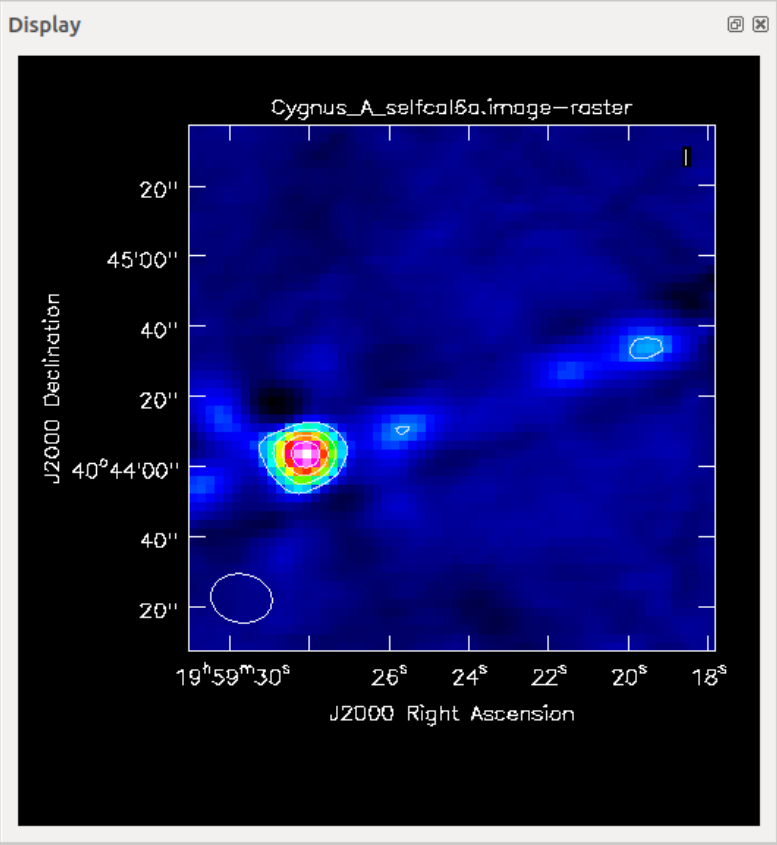
The HI absorption in MG0414+0534 was previously imaged with the VLA by Moore, Carilli & Menten 1999 (ApJ, 510, 87), (at end of this file) before the upgrade to the WIDAR system.

VLA tutorial reduced by Dr. Richard Russel 10/18/19 – full script of reduction in file:VLA Image MG0414+0534.odt https://casaguides.nrao.edu/index.php/MG0414%2B0534_P-band_Spectral_Line_Tutorial_-_CASA_5.5.0

Cygnus A
(VLA Archive)

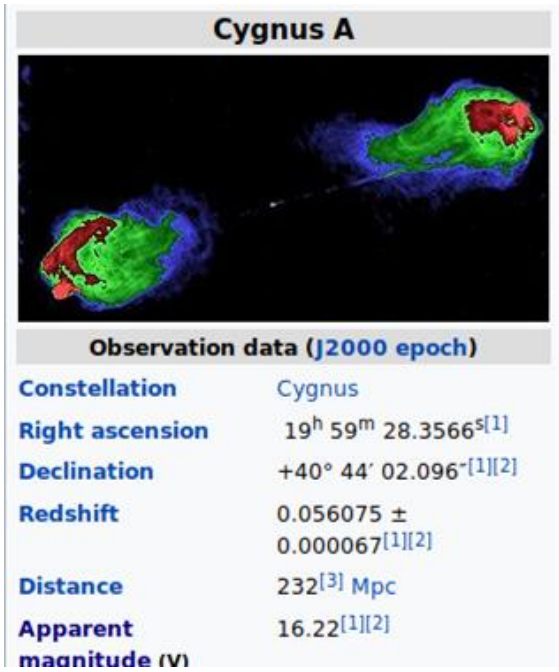
```
================================================================================
   Observer: Dr. Frank Schinzel     Project: uid://evla/pdb/1695465
Observation: EVLA
Computing scan and subscan properties...
Data records: 2045736       Total elapsed time = 508 seconds
   Observed from   17-Oct-2019/22:34:08.0   to   17-Oct-2019/22:42:36.0 (UTC)
```

Data Reduction Results



Background Information
Wikipedia

Cygnus A (3C 405) is a radio galaxy, and one of the strongest radio sources in the sky. It was discovered by Grote Reber in 1939. In 1951, Cygnus A, along with Cassiopeia A, and Puppis A were the first "radio stars" identified with an optical source. Of these, Cygnus A became the first radio galaxy; the other two being nebulae inside the Milky Way.[4] In 1953 Roger Jennison and M K Das Gupta showed it to be a double source.[5] Like all radio galaxies, it contains an active galactic nucleus. The supermassive black hole at the core has a mass of (2.5±0.7)×109 M☉.[3]

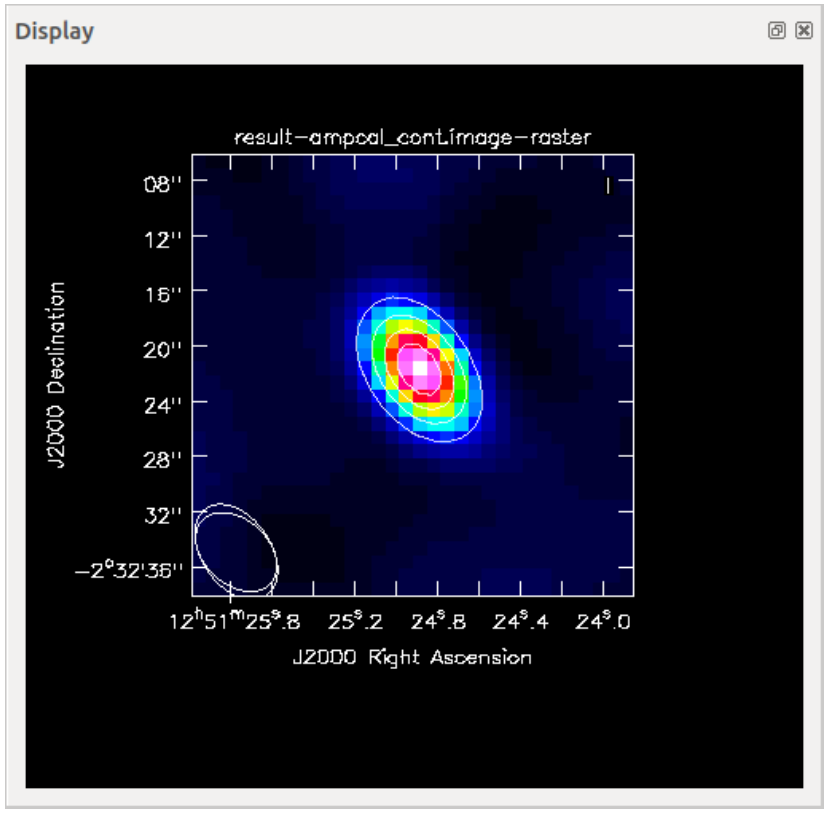


First attempt of a raw data set from archive: Note – no log, or antpos – therefore had to do self calibration to get image. Image reduced by Dr. Richard Russel 10-20-19

Saturn’s moon of Titan (ALMA Archive)

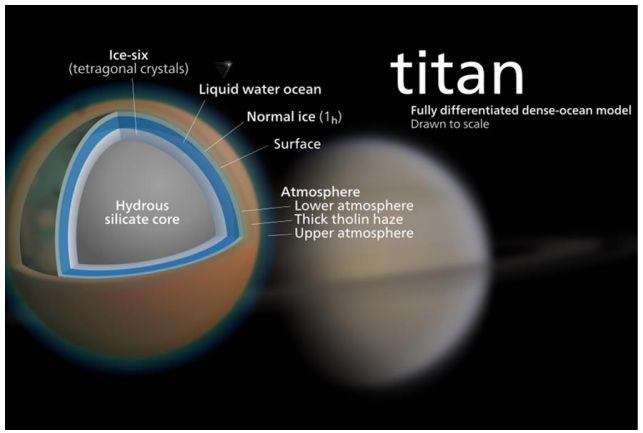
```
Computing scan and subscan properties...
Data records: 326400       Total elapsed time = 90574.4 seconds
   Observed from   16-Apr-2011/02:59:18.2    to   17-Apr-2011/04:08:52.6 (UTC)
```

Data Reduction Results



Background Information Wikipedia

Titan is the largest moon of Saturn and the second-largest natural satellite in the Solar System. It is the only moon known to have a dense atmosphere, and the only known body in space, other than Earth, where clear evidence of stable bodies of surface liquid has been found.

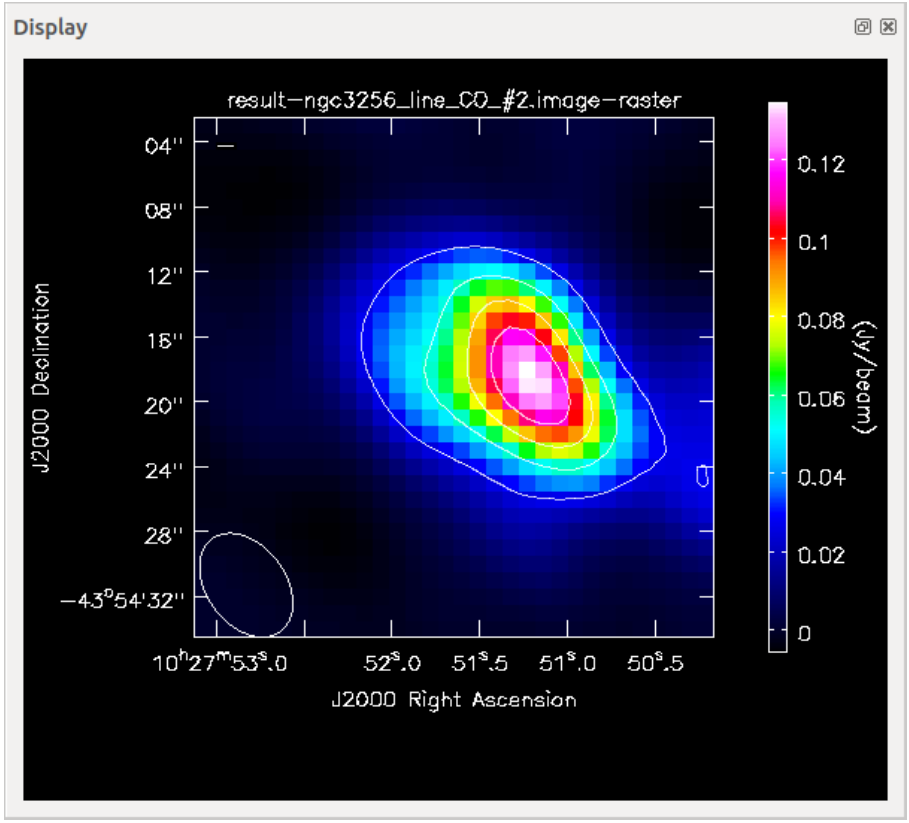


Data reduction conducted by Dr. Richard Russel on 10-22-19 using the ALMA Tutorial located at: https://casaguides.nrao.edu/index.php/NGC3256_Band3_Imaging_for_CASA_4.2

NGC 3256
(ALMA Archive)

```
Computing scan and subscan properties...
Data records: 326400       Total elapsed time = 90574.4 seconds
   Observed from   16-Apr-2011/02:59:18.2   to   17-Apr-2011/04:08:52.6 (UTC)
```

Data Reduction Results



Background Information
Wikipedia

NGC 3256 is a peculiar galaxy formed from the collision of two separate galaxies in the constellation of Vela. NGC 3256 is located about 100 million light years away and belongs to the Hydra-Centaurus supercluster complex.

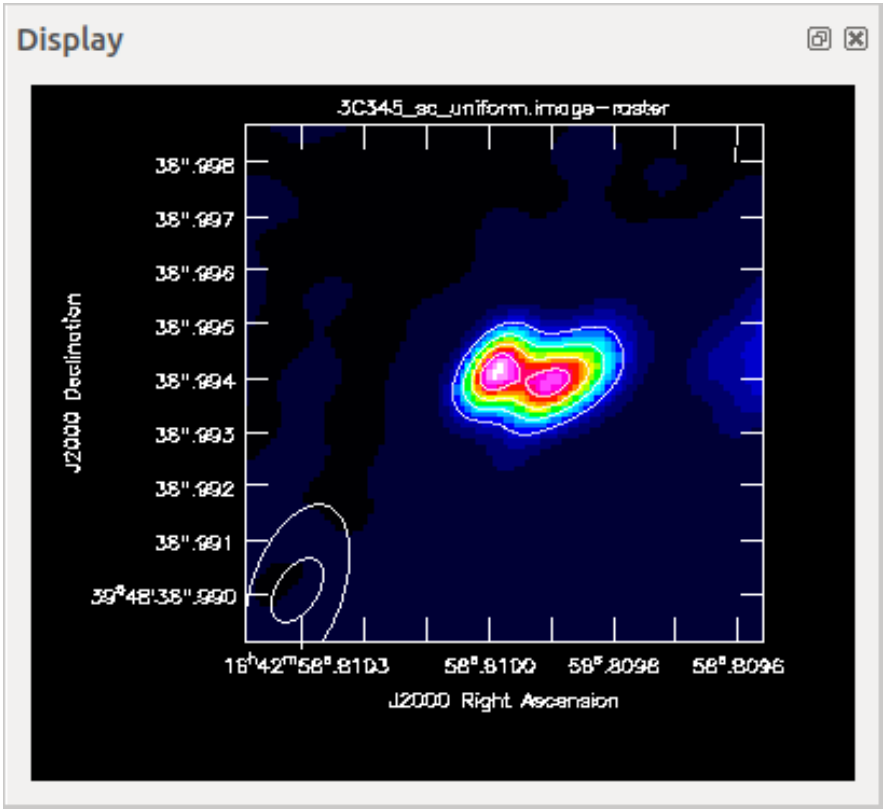
NGC 3256 Hubble Image

Data reduction conducted by Dr. Richard Russel on 10-22-19 using the ALMA Tutorial located at:
https://casaguides.nrao.edu/index.php/NGC3256_Band3_Imaging_for_CASA_4.2

3C345
Binary Supermassive Blackhole Quasar
using the European Very Long Baseline Interferometer (EVLBI Archive)

```
    Observer: N14C3      Project: N14C3
Observation: EVN
Computing scan and subscan properties...
Data records: 1846080        Total elapsed time = 10800 seconds
    Observed from   22-Oct-2014/12:00:00.0   to   22-Oct-2014/15:00:00.0 (UTC)
```

Data Reduction Results



Conducted VLBI Imaging Tutorial at:

http://www.jb.man.ac.uk/DARA/unit4/Workshops/EVN_continuum.html

Data reduction conducted on VLBI archive data by Dr. Richard Russel on 10-25-19

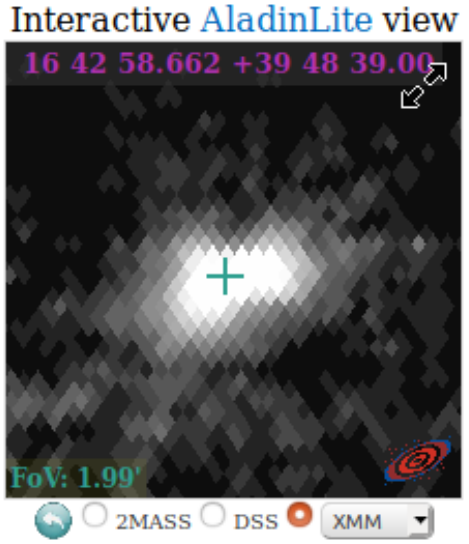
A supermassive binary black hole in the quasar 3C345.

LOBANOV A.P. and ROLAND J.

Abstract (from CDS):

Radio loud active galactic nuclei present a remarkable variety of signs indicating the presence of periodical processes possibly originating in binary systems of supermassive black holes, in which orbital motion and precession are ultimately responsible for the observed broad-band emission variations, as well as for the morphological and kinematic properties of the radio emission on parsec scales. This scenario, applied to the quasar 3C345, explains the observed variations of radio and optical emission from the quasar, and reproduces the structural variations observed in the parsec-scale jet of this object. The binary system in 3C345 is described by two equal-mass black holes with masses of ≃7.1x108M⊙ separated by ≃0.33pc and orbiting with a period ∼480yr. The orbital motion induces a precession of the accretion disk around the primary black hole, with a period of ≃2570yr. The jet plasma is described by a magnetized, relativistic electron-positron beam propagating inside a wider and slower electron-proton jet. The combination of Alfven wave perturbations of the beam, the orbital motion of the binary system and the precession of the accretion disk reproduces the variability of the optical flux and evolution of the radio structure in 3C345. The timescale of quasi-periodic flaring activity in 3C345 is consistent with typical disk instability timescales. The present model cannot rule out a small-mass orbiter crossing the accretion disk and causing quasi-periodic flares.

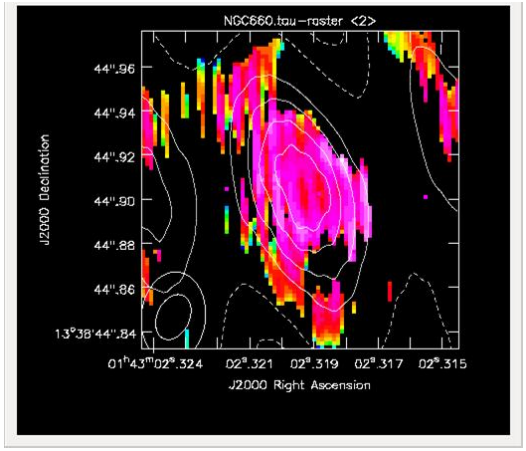
http://simbad.u-strasbg.fr/simbad/sim-ref?bibcode=2005A%26A...431..831L



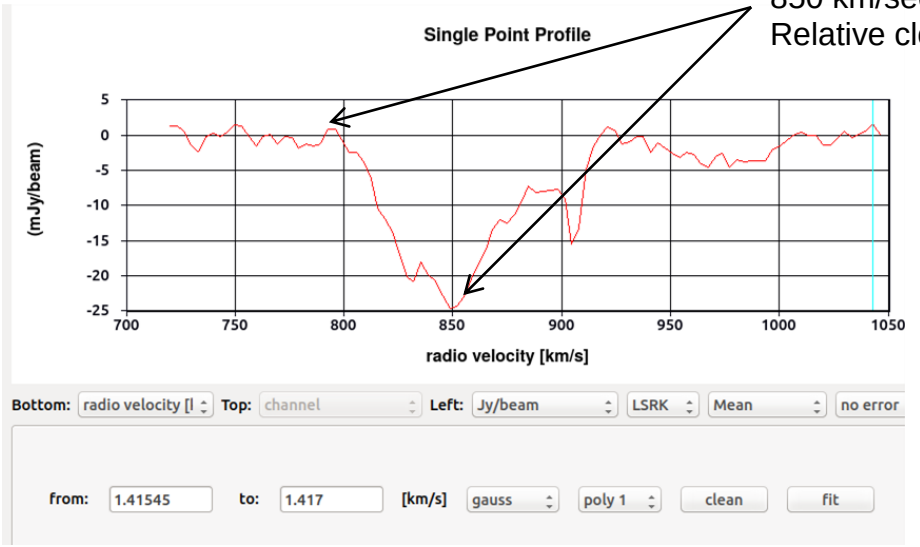
NGC-660 Galaxy
Velocity of Jet Measured using Spectral Line Technique
using the European Very Long Baseline Interferometer (EVLBI Archive)

```
   Observer: EA054      Project:
Observation: EVN
Computing scan and subscan properties...
Data records: 49159        Total elapsed time = 41950 seconds
   Observed from   30-Oct-2013/15:50:40.0   to   31-Oct-2013/03:29:50.0 (UTC)

   ObservationID = 0         ArrayID = 0
  Date        Timerange (UTC)          Scan  FldId FieldName              nRows
  30-Oct-2013/15:50:40.0 - 19:16:00.0     1      0 NGC660                   16
              19:38:42.0 - 23:04:58.0     2      0 NGC660                   15
              23:26:26.0 - 02:52:38.0     3      0 NGC660                   12
  31-Oct-2013/03:12:36.0 - 03:29:50.0     4      0 NGC660
          (nRows = Total number of rows per scan)
Fields: 1
  ID   Code Name                RA               Decl           Epoch   SrcId
  0          NGC660             01:43:02.291000 +13.38.44.30000 J2000   0
```



850 km/sec
Relative closing rate of jet



Background Information
Wikipedia

NGC 660 is a peculiar and unique polar-ring galaxy located approximately 45 million light years from Earth in the Pisces constellation.[3] It is the only such galaxy having, as its host, a "late-type lenticular galaxy".[4] It was probably formed when two galaxies collided a billion years ago.[5] However, it may have first started as a disk galaxy that captured matter from a passing galaxy. This material could have, over time, become "strung out" to form a rotating ring.

Late in 2012, this polar-ring galaxy produced an enormous outburst having a magnitude of approximately ten times brighter than a supernova explosion. The cause is not certain, but this event may have resulted from a tremendous jet being emanating from galaxy's central black h

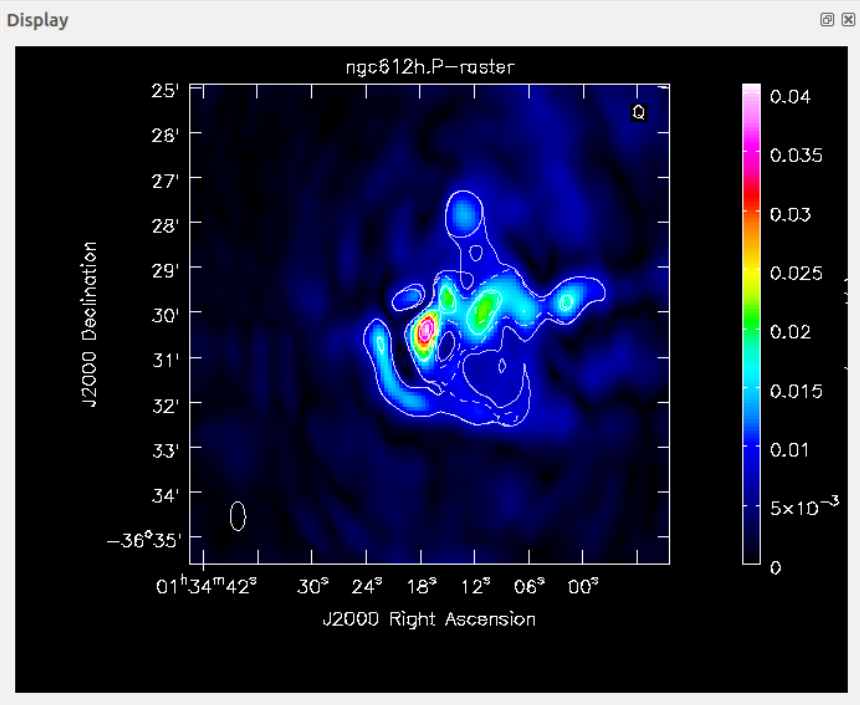
NGC 660 showing Polar-Galaxy Structure

Reduced from tutorial at website: http://www.jb.man.ac.uk/DARA/unit4/Workshops/Spectral_line.html
By Dr. Richard Russel 10-26-19

NGC-612 using the Australian Telescope Compact Array (ATCA Archive)

```
================================================================================
           MeasurementSet Name:  /home/dses/Imaging/NGC612_ATCA/ngc612.ms.0
================================================================================
   Observer: obs     Project: C2728
Observation: ATCA
Computing scan and subscan properties...
Data records: 60465       Total elapsed time = 43730 seconds
   Observed from   25-Oct-2012/07:07:39.9   to   25-Oct-2012/19:16:29.9 (UTC)
```

Data Reduction Results

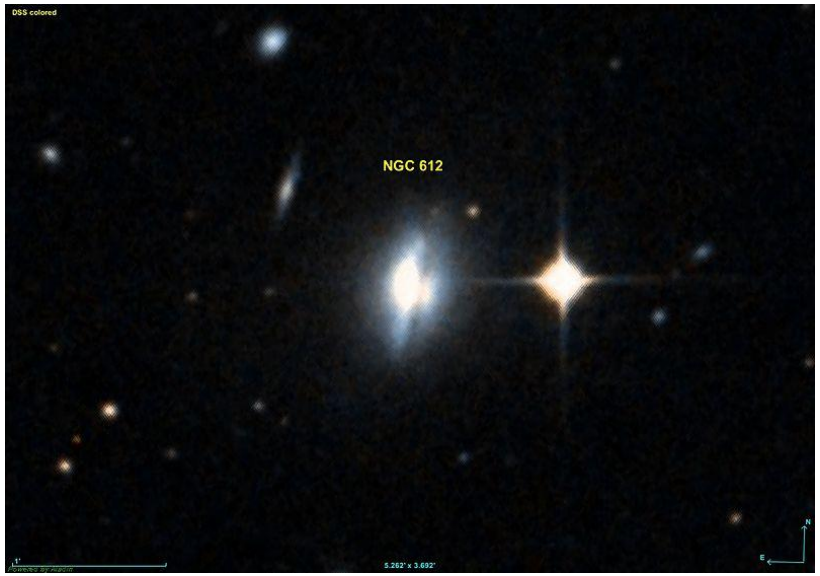


Total polarized flux density: 1.942 Jy

Pol. Angles in western lobe: -57.5 and 23.7 degrees

Background Information Wikipedia

NGC 612 is a lenticular galaxy in the constellation of Sculptor located approximately 388 million light-years from Earth. It is a type II Seyfert galaxy and thus has an active galactic nucleus.[1][3] NGC 612 has been identified as an extremely rare example of a non-elliptical radio galaxy, hosting one of the nearest powerful FR-II radio sources.[4]Coordinates: 01h33m57.74s, −36° 29′ 35.7″[5]



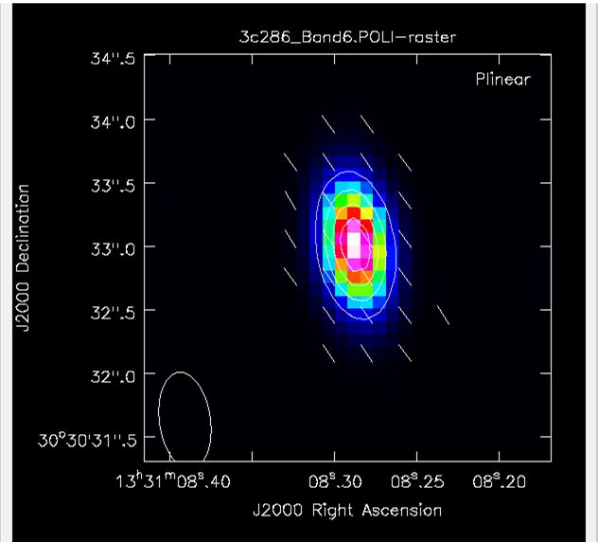
ATCA Tutorial located at: https://casaguides.nrao.edu/index.php/CASA_Guides:ATCA_Advanced_Continuum_Polarization_Tutorial_NGC612-CASA4.7

Reduced by Dr. Richard Russel 10-28-19

3C286 Quasar Full Polarization (ALMA Archive)

```
================================================================================
   Observer: knakanishi     Project: uid://A002/X845868/X11
Observation: ALMA
Data records: 10125065       Total elapsed time = 3858.05 seconds
   Observed from   01-Jul-2014/21:18:10.9   to   01-Jul-2014/22:22:29.0 (UTC)
```

Data Reduction Results



Measured Statistics

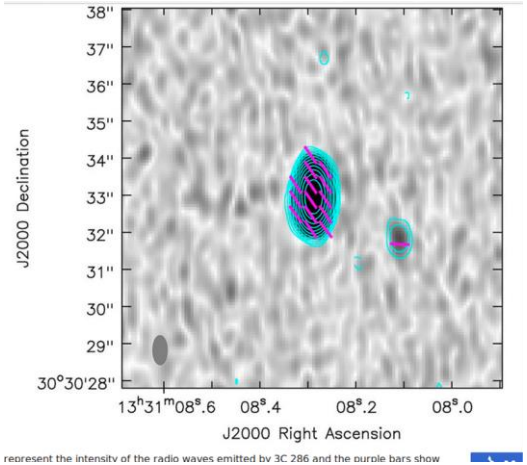
3C286	Flux	Err
I(Jy)	0.369024458019	0.000533920312708
Q(Jy)	0.0120461752389	4.28833878305e-05
U(Jy)	0.0590976963663	0.00010008727778
Pol int (mjy)	60.3129178011	0.0984439608693
P(%)	0.163438808704	0.000356487589209
X (deg)	39.2394747207	0.0221021634448

Image and statistics reduced by Dr. Richard A. Russel 10-29-19, using ALMA tutorial located at: https://casaguides.nrao.edu/index.php/3C286_Polarization

Background Information Wikipedia

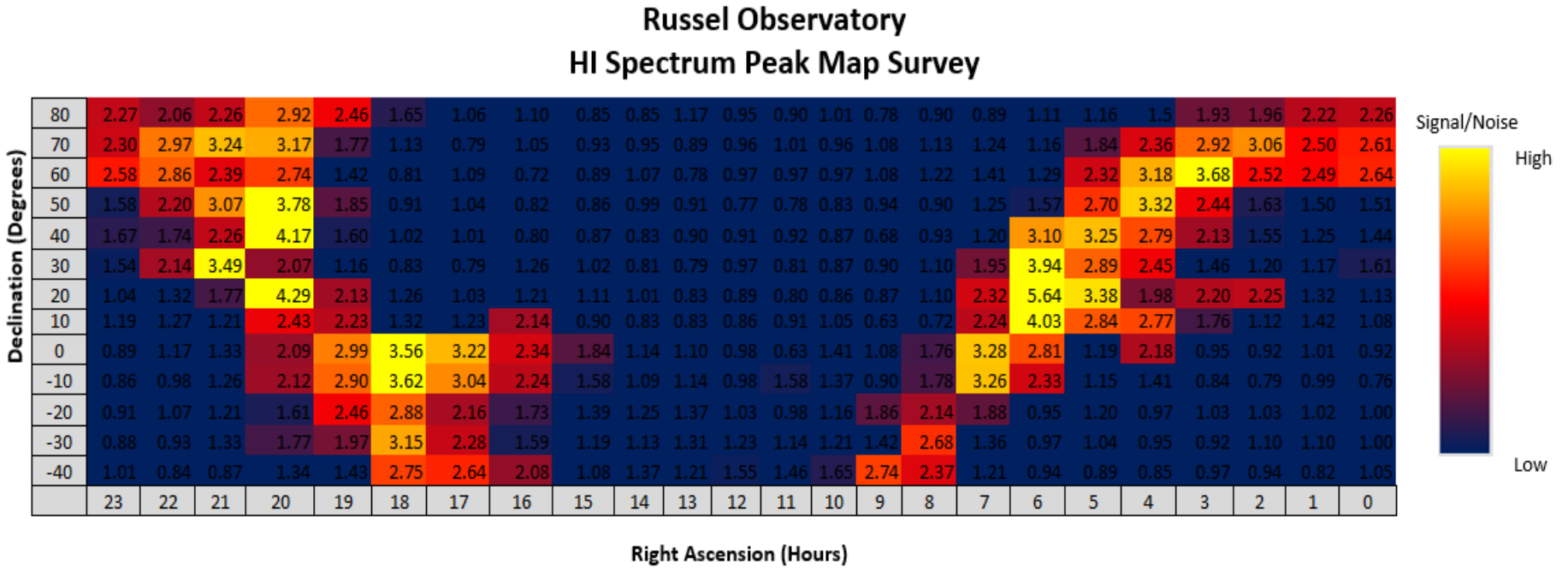
3C 286, also known by its position as 1328+307 (B1950 coordinates) is a quasar[3] at redshift 0.8493 with a radial velocity of 164,137 km/s.[4] It is part of the Third Cambridge Catalogue of Radio Sources.

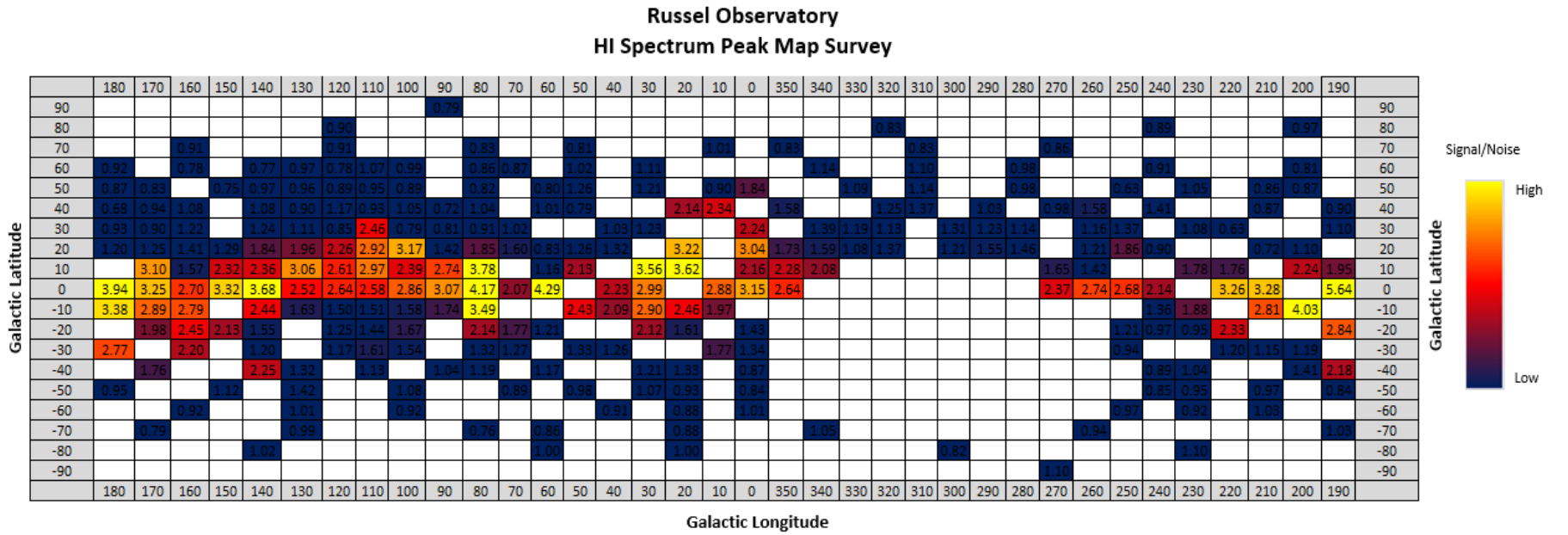
3C 286 is one of four primary calibrators used by the Very Large Array (along with 3C 48, 3C 138, and 3C 147). Visibilities of all other sources are calibrated using observed visibilities of one of these four calibrators.[5]



Using the data for publication: The following statement should be included in the acknowledgment of papers using the datasets listed above: "This paper makes use of the following ALMA data: ADS/JAO.ALMA#2011.0.00017.SV. ALMA is a partnership of ESO (representing its member states), NSF (USA) and NINS (Japan), together with NRC (Canada) and NSC and ASIAA (Taiwan), and KASI (Republic of Korea), in cooperation with the Republic of Chile. The Joint ALMA Observatory is operated by ESO, AUI/NRAO and NAOJ."

HI Drift Scan using 9-ft Dish at Russel Observatory
September 2019



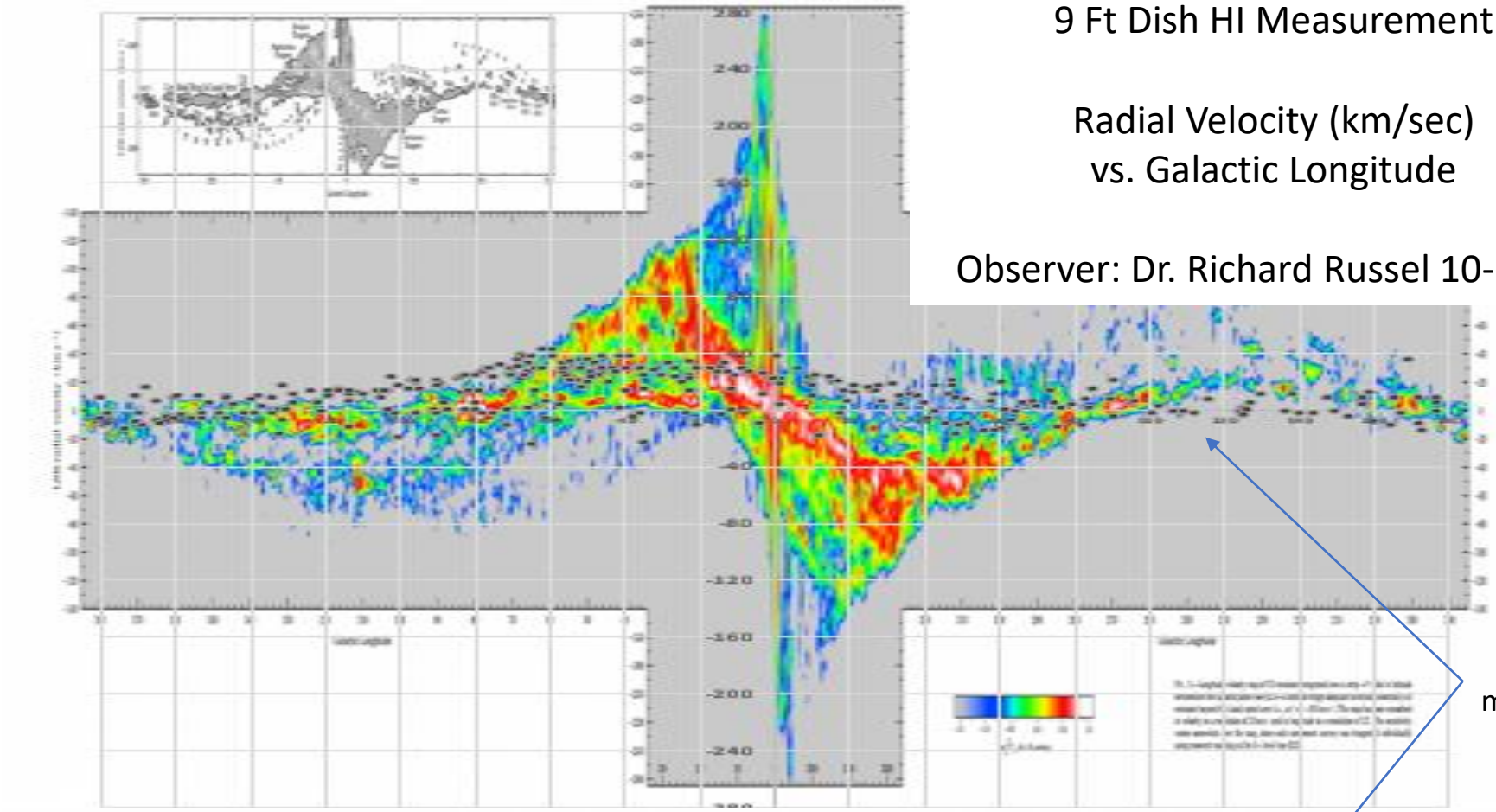


Dr. Richard Russel Observer and Analyst (DrRichRussel@Netscape.net)

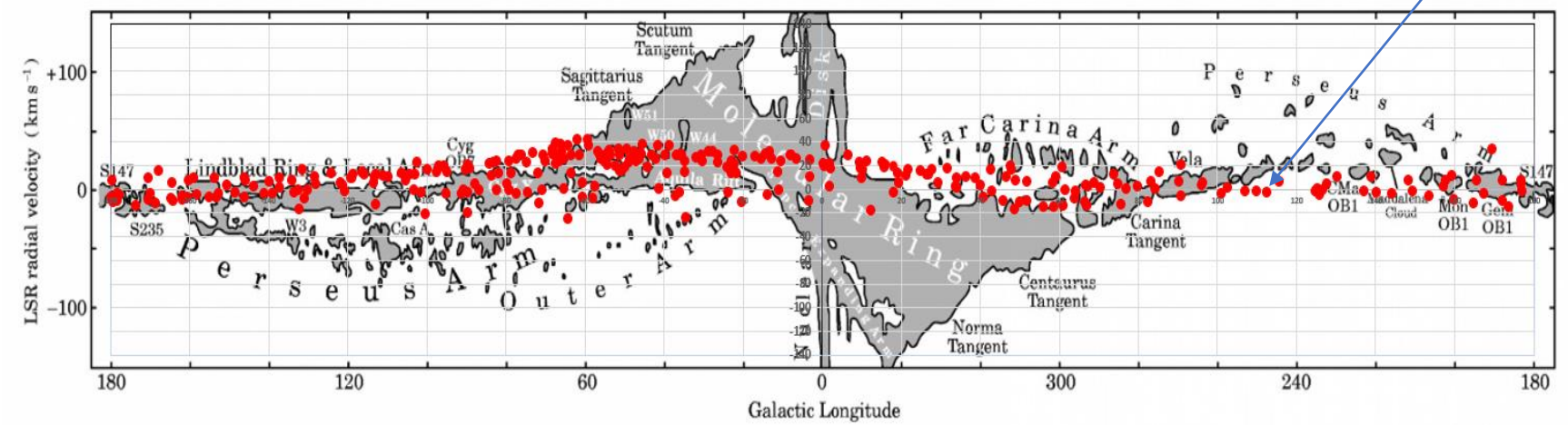
9 Ft Dish HI Measurement

Radial Velocity (km/sec)
vs. Galactic Longitude

Observer: Dr. Richard Russel 10-23-19



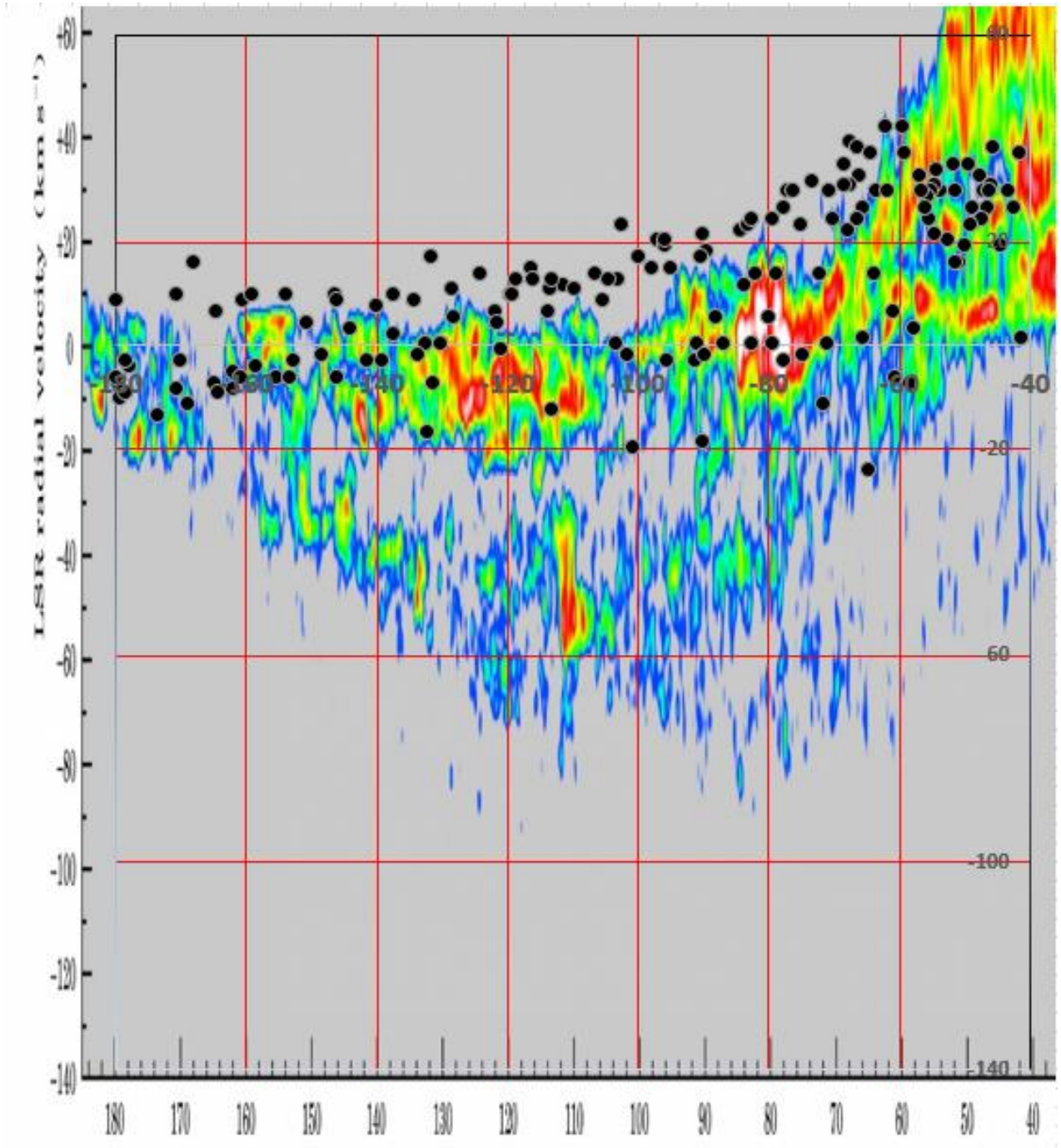
9ft dish HI measurements



Background images obtained at:

https://www.britannica.com/place/Milky-Way-Galaxy/The-structure-and-dynamics-of-the-Milky-Way-Galaxy

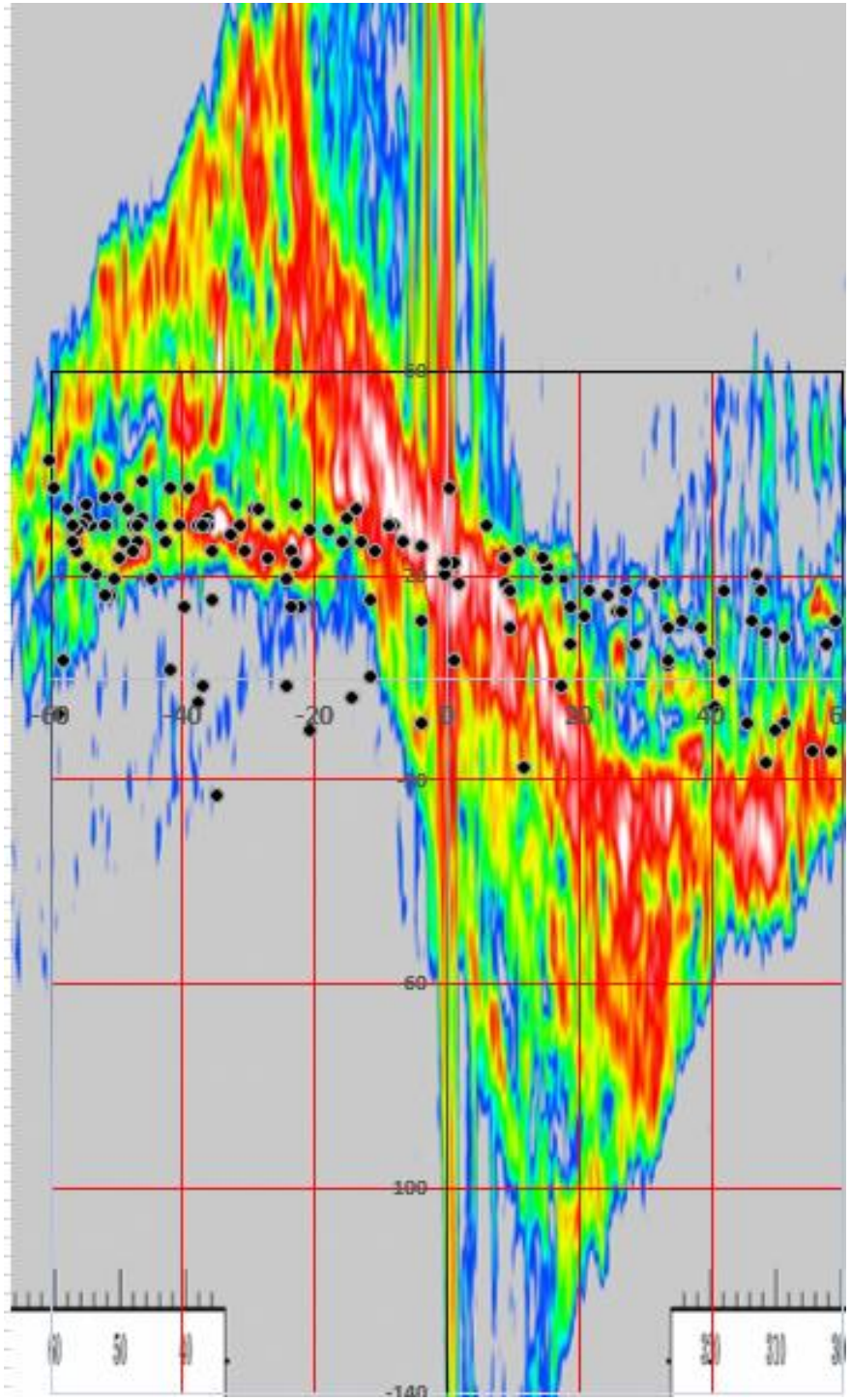
Perseus Arm (Left)



Russel Observatory 9 ft dish data (black dots) overlaid on the following image

https://www.britannica.com/place/Milky-Way-Galaxy/The-structure-and-dynamics-of-the-Milky-Way-Galaxy

Molecular Ring



Russel Observatory 9 ft dish data (black dots) overlaid on the following image

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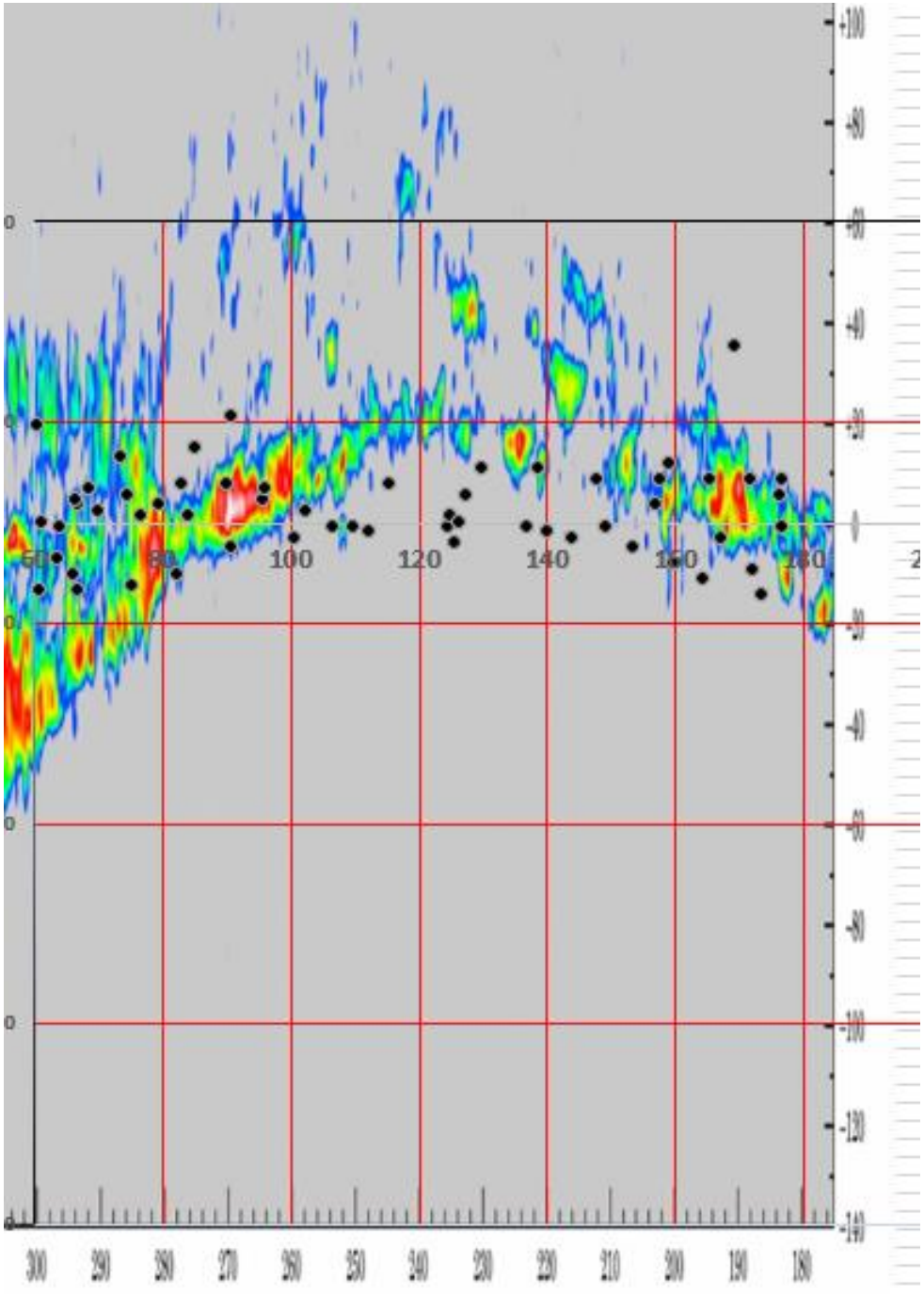
Perseus Arm (Right)



Russel Observatory 9 ft dish data (black dots) overlaid on the following image

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