



TITLE

DIGITAL SKY MAPS AND CATALOGUES FOR AMATEUR RADIO ASTRONOMY

SPEAKER

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FOR

EUCARA 2018

**Professional astronomers select an observatory
that fits their proposal**

**Amateur observers likely need to match observations
to their instrument**

Sky Map Software

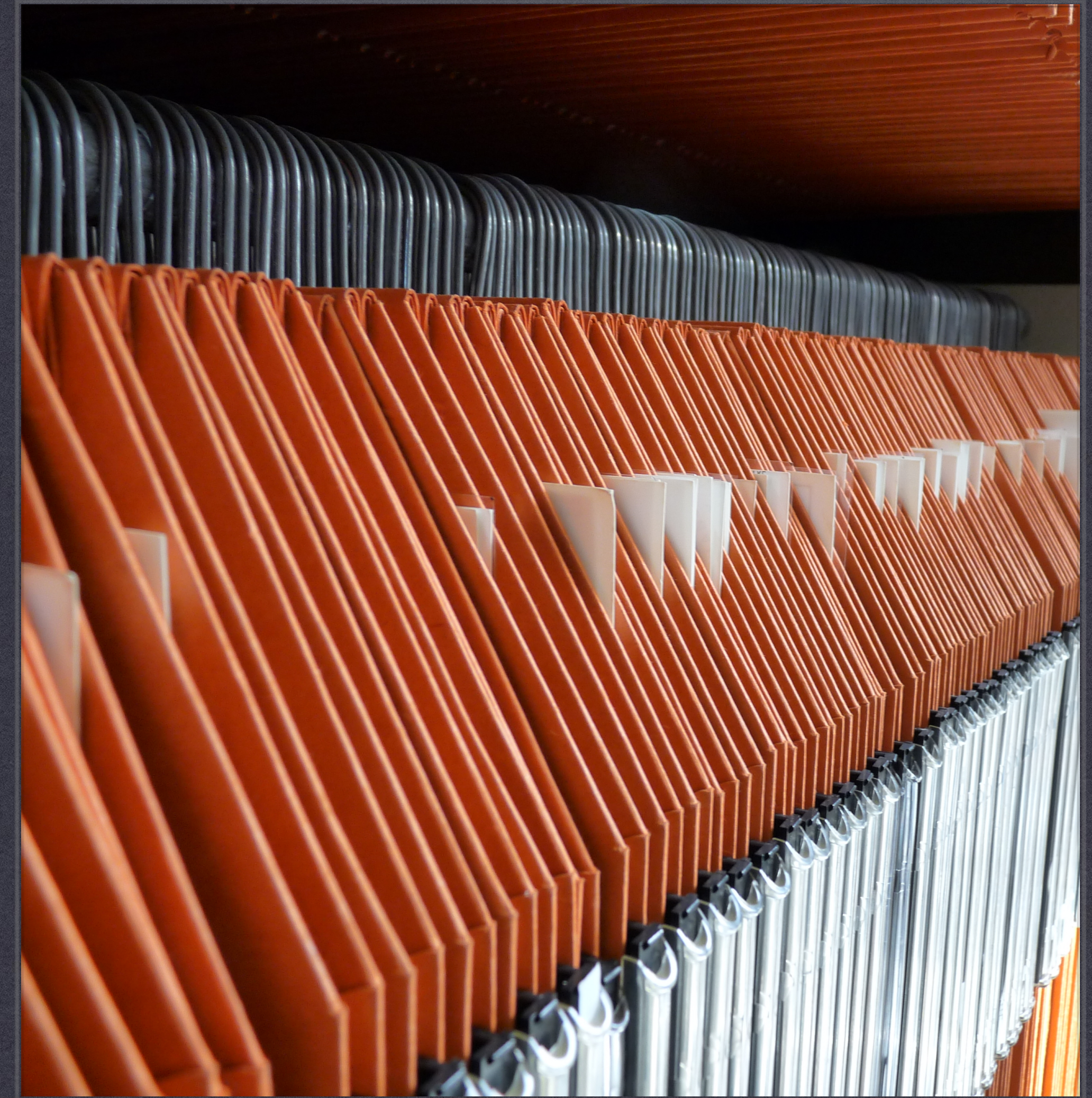
- * Amateur observers in the *optical* enjoy good sky map ecosystem
- * Stellarium
- * KStars
- * Cartes du Ciel
- * But for *radio*...?

The Radio Use Case

- * Which objects of a given class can I detect...
 - * from my location?
 - * given my receiving parameters?
- * What interesting targets are visible above my location right now / this observing session?

DATA SOURCES

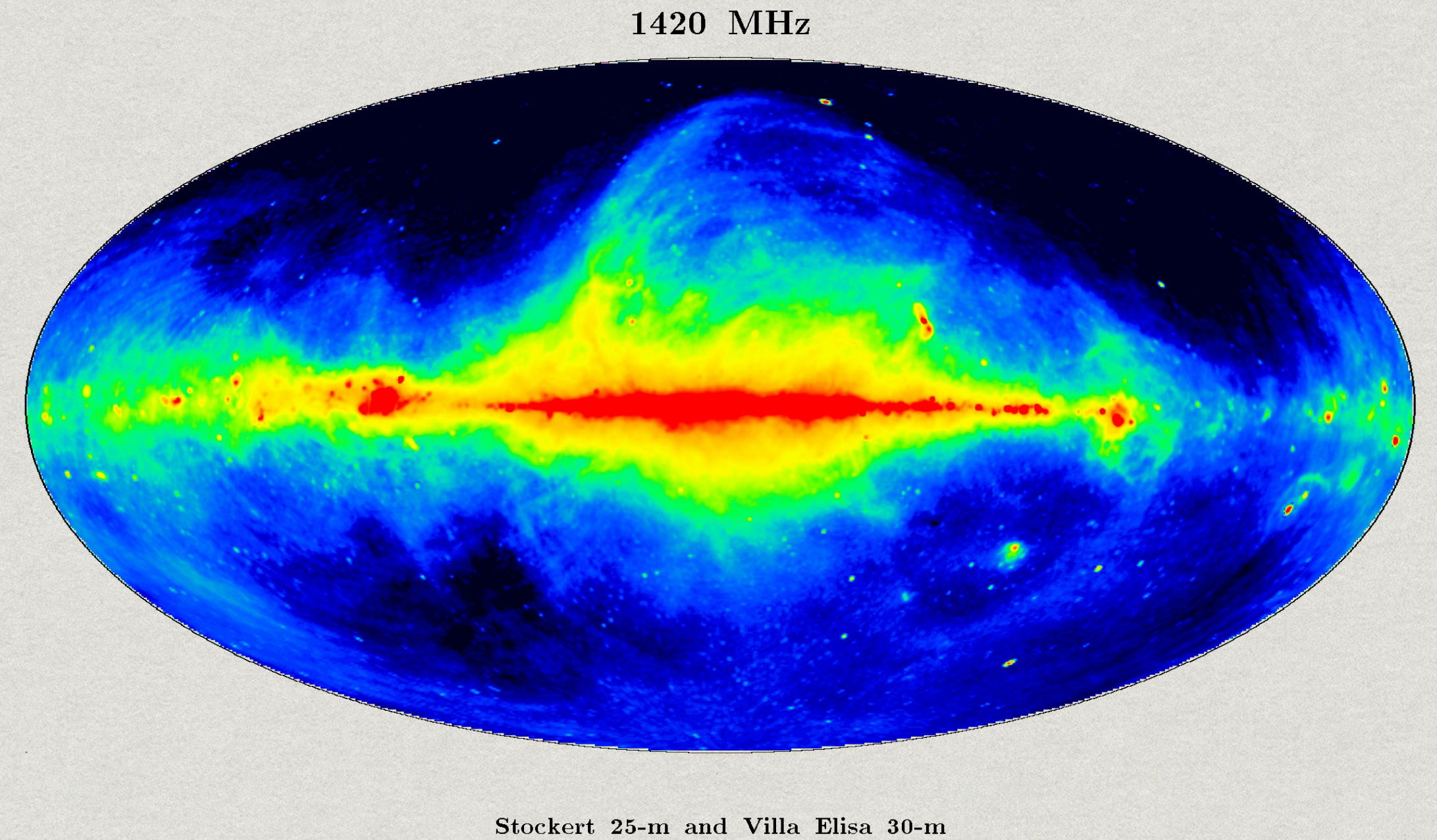
FROM SURVEYS TO SEARCH ENGINES



Surveys and Skymaps

Systematic wide-field searches

- * no focus on specific targets
- * everything within a frequency and intensity range
- * generally only positions, no details



Catalogues

Lists of objects

- * with common properties
- * within a set of constraints („filters“, e.g. brightness)
- * with positions and basic measurements
- * generally distilled from surveys

Search Results

Searching for first_cat sources within 30.0000 arcsec of
07.270 +30 40 37.52 (J2000)

Peak RMS at search position is 0.147 mJy/beam
Catalog detection limit (including CLEAN bias) at source position is 0.98 mJy/beam

Sources found within 30.0000 arcsec

Set	Get	Search	RA (2000)	Dec (2000)	Side	Peak	Int.	RMS	Deconv.	Deconv.	Deconv.	Meas.	Meas.	Meas.	Field No
Opt	FRST	Distance			lobe	Flux	Flux	(mJy/	MajAx	MinAx	PosAng	MajAx	MinAx	PosAng	
chImg	Img	(arcsec)			Prob	(mJy/bm)	(mJy)	beam)	(arcsec)	(arcsec)	(deg)	(arcsec)	(arcsec)	(degrees)	
NED	OPT	FIMG	0.5	10 50 07.261 +30 40 37.05	0.014	6.32	17.90	0.147	10.45	4.49	32.3	11.76	7.02	32.3	10510+30
NED	OPT	FIMG	9.6	10 50 06.982 +30 40 46.36	0.014	2.91	8.64	0.147	13.20	2.78	80.5	14.26	6.07	80.5	10510+
NED	OPT	FIMG	16.7	10 50 06.038 +30 40 42.70	0.014	3.66	7.76	0.147	9.35	1.90	48.5	10.79	5.72	48.5	10510+
NED	OPT	FIMG	17.3	10 50 06.271 +30 40 25.98	0.014	6.79	26.27	0.147	10.38	7.98	57.2	11.70	9.64	57.2	10510+

Description of the table

[catalog description](#) and the [catalog paper](#) for detailed information on the creation of the catalog and its interpretation.

Summary of the search result table:

Column	Description
NED	Search NASA/IPAC Extragalactic Database at this position
OPT	Extract 3x3 arcmin optical image
FIMG	change the region size to 5 arcmin

Well-known Surveys in Radio Astronomy

- * **FIRST:** VLA's „Faint Images of the Radio Sky at Twenty cm“, northern sky > 1 mJy
„the radio sky's POSS“

- * **NVSS:** VLA Sky Survey, northern sky above -40°

- * **HIPASS:** HI Parkes All Sky Survey, southern sky

21cm sky maps done at many sites

- * Jodrell Bank

- * Stockert

- * Villa Elisa

- * Effelsberg

- * Parkes

Well-known Catalogues in Radio Astronomy

Cambridge Catalogues of Radio Sources

- * Most famous: 3C

- * original 3C from 1959, at 159 MHz

- * [3CR](#) (1962) and [3CRR](#) (1983) updating the original

- * Other surveys at different frequency bands used similar designations, from 1C to 10C.

Practical Problems

- * In practice, you'll find catalogues...
- * that are outdated
- * that cover only tiny fractions of the sky
- * that use weird selection criteria
- * Ambiguous listings
- * different catalogues focusing on different properties

Messier 82

From Wikipedia, the free encyclopedia

Coordinates:  09^h 55^m 52.2^s, +69° 40′ 47″

Messier 82 (also known as **NGC 3034**, **Cigar Galaxy** or **M82**) is a **starburst galaxy** approximately 12 million **light-years** away in the **constellation Ursa Major**. A member of the **M81 Group**, it is about five times **more luminous** than the whole **Milky Way** and has a center one hundred times more luminous than our galaxy's center.^[6] The starburst activity is thought to have been triggered by interaction with neighboring galaxy **M81**. As the closest starburst galaxy to Earth, M82 is the prototypical example of this galaxy type.^[6] **SN 2014J**, a **type Ia supernova**, was discovered in the galaxy on 21 January 2014.^{[7][8][9]} In 2014, in studying M82, scientists discovered the brightest pulsar yet known, designated **M82 X-2**.^{[10][11][12]}

Contents [hide]

- Discovery
- Structure
 - Starburst region
 - Unknown object
- Starbursts
- 2014 supernova
- See also
- References
- External links

Messier 82



A mosaic image taken by the **Hubble Telescope** of Messier 82, combining exposures taken with four colored filters that capture starlight from visible and infrared wavelengths as well as the light from the glowing hydrogen filaments.

Observation data (J2000 epoch)

Constellation	Ursa Major
Right ascension	09 ^h 55 ^m 52.2 ^s ^[1]
Declination	+69° 40′ 47″ ^[1]
Redshift	203 ± 4 km/s ^[1]
Distance	11.4–12.4 Mly (3.5–3.8 Mpc) ^[2]
Apparent magnitude (V)	8.41 ^{[3][4]}

Characteristics

Type	l0 ^[1]
Size	~37,000ly in diameter ^[5]
Apparent size (V)	11′.2 × 4′.3 ^[1]
Notes	Notable for its starburst activity

Other designations

NGC 3034, UGC 5322, Arp 337, Cigar Galaxy, PGC 28655, 3C 231^[1]

Introducing the Virtual Observatory

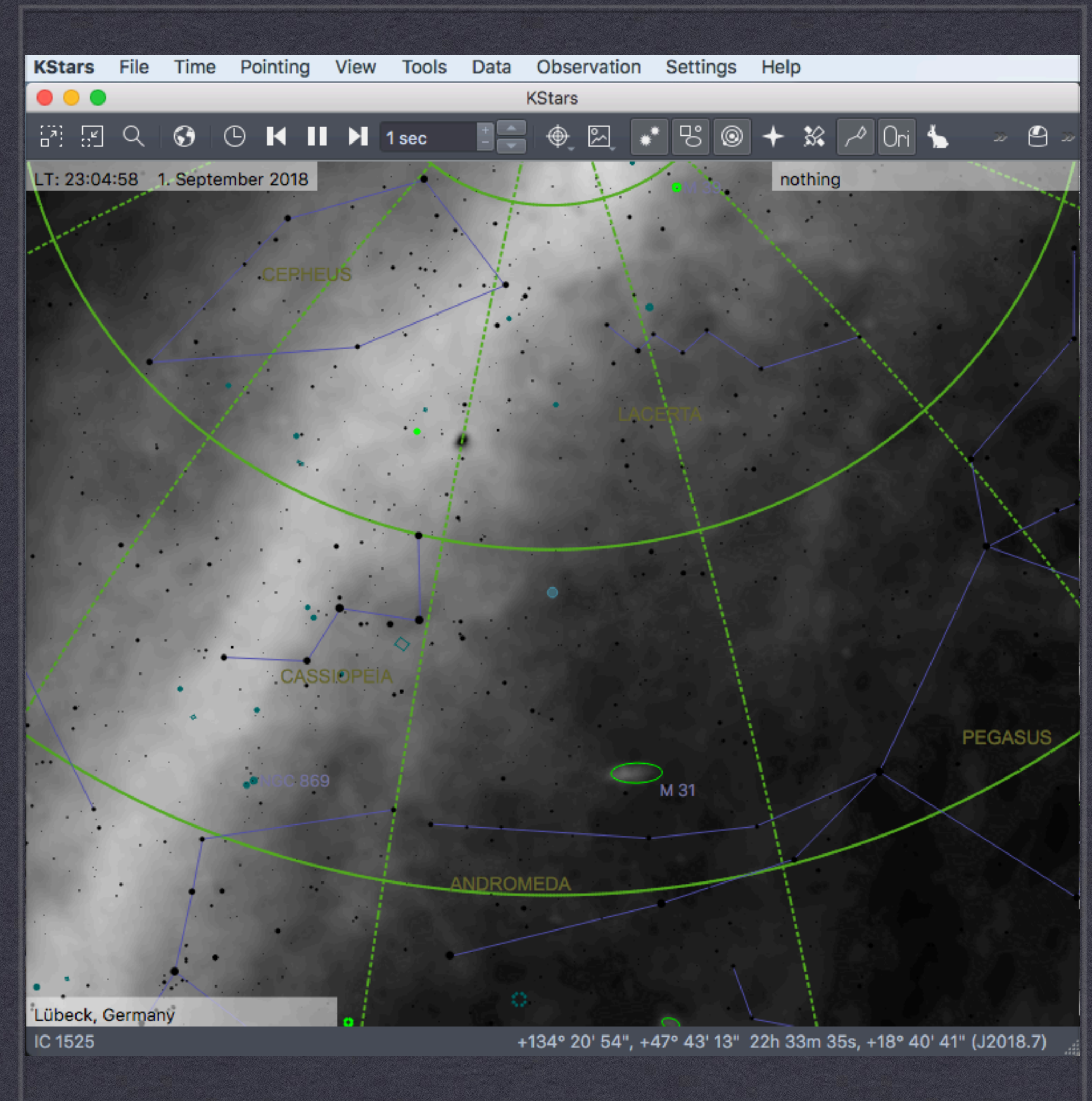
- * Digital research infrastructure combining datasets from many observatories worldwide
- * Standards for interoperability
- * Important for Skymaps: **HiPS** (Hierarchical Progressive Surveys¹) — think Google Maps' dynamic resolution

Introducing Search Engines and Metacatalogues


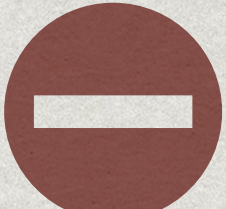
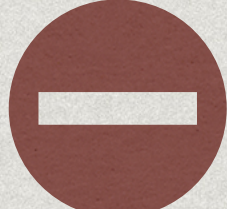
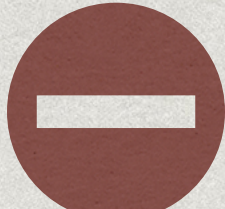
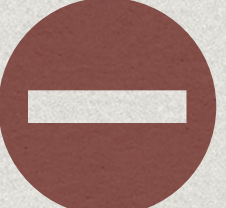

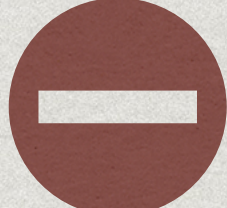

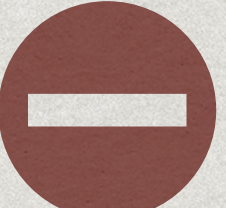



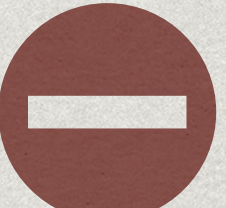
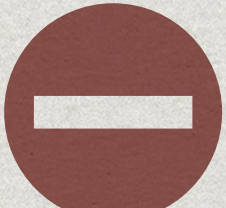
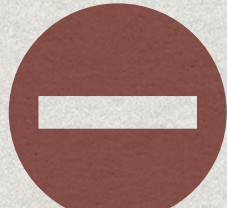
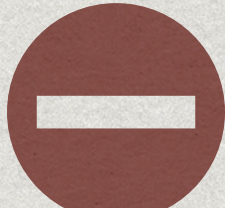
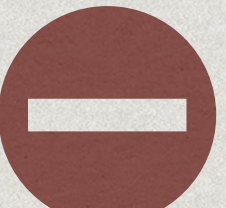

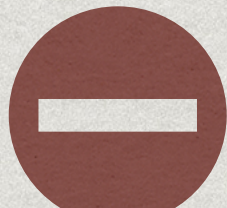

- * Cross-catalogue search enabled through VO standards
- * VizieR searches over 17000 catalogues
 - * <http://vizier.u-strasbg.fr>
 - * Cross-matching to reduce ambiguity, check most current data
- * NASA's HEASARC is a huge metacatalogue with search capabilities
 - * <https://heasarc.gsfc.nasa.gov/docs/archive.html>

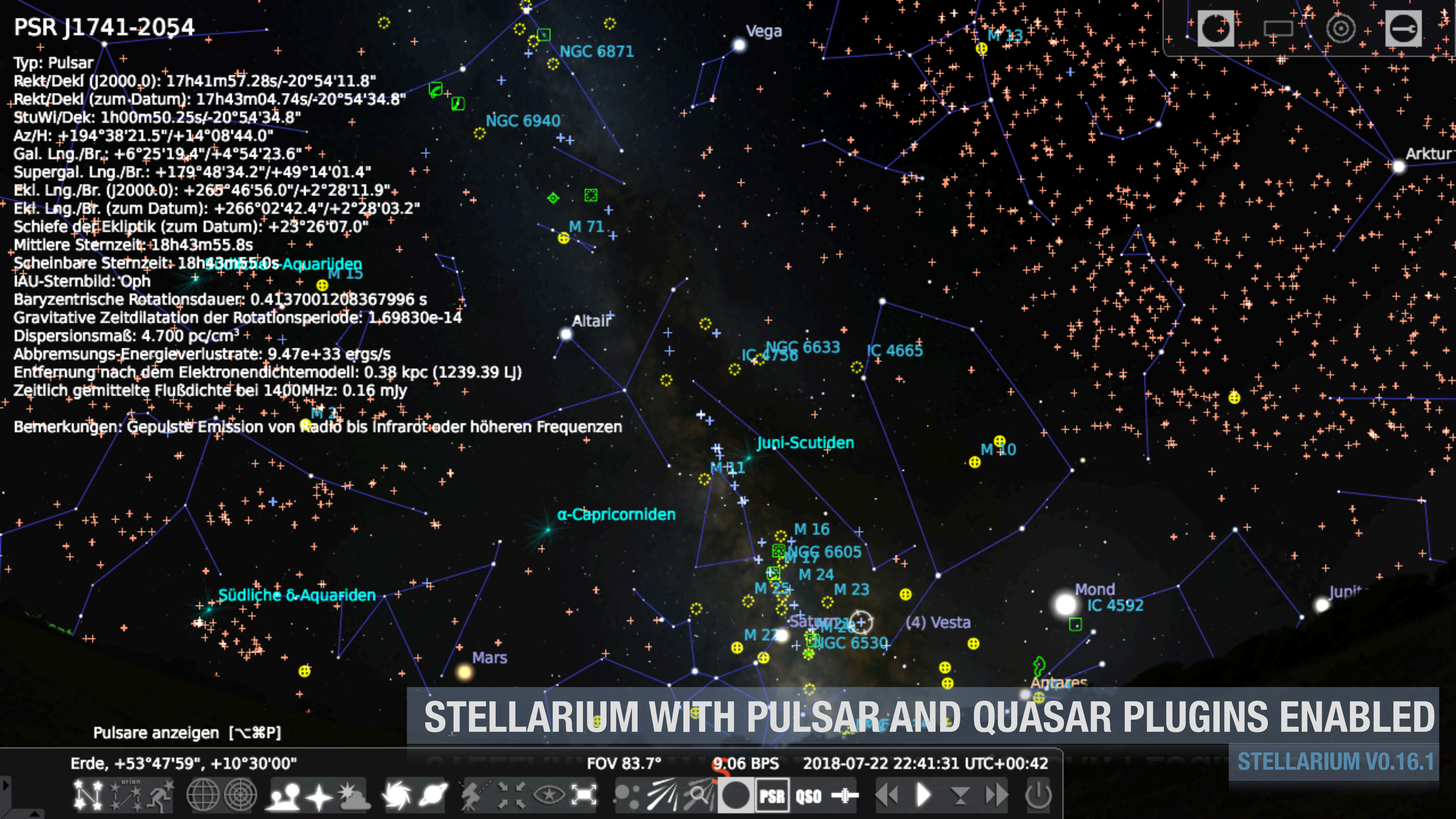
SOFTWARE

INTEGRATING AND VISUALIZING
SKY MAPS AND CATALOGUES



Radio-related features in well-known optical tools

	Stellarium	KStars	Cartes du Ciel	SkytechX
Radio catalogues available	 Pulsars, Quasars			
Radio sky background available		 HiPS, but no dynamic		 HiPS, but no dynamic
Custom catalogue import		 just 'radio' as type	 catgen	
Flux search / filtering				
Antenna footprint		 circular only		 circular only



PSR J1741-2054

Typ: Pulsar
Rekt/Dekl (J2000.0): 17h41m57.28s/-20°54'11.8"
Rekt/Dekl (zum Datum): 17h43m04.74s/-20°54'34.8"
StuWi/Dek: 1h00m50.25s/-20°54'34.8"
Az/H: +194°38'21.5"/+14°08'44.0"
Gal. Lng./Br.: +6°25'19.4"/+4°54'23.6"
Supergal. Lng./Br.: +179°48'34.2"/+49°14'01.4"
Ekl. Lng./Br. (J2000.0): +265°46'56.0"/+2°28'11.9"
Ekl. Lng./Br. (zum Datum): +266°02'42.4"/+2°28'03.2"
Schiefe der Ekliptik (zum Datum): +23°26'07.0"
Mittlere Sternzeit: 18h43m55.8s
Scheinbare Sternzeit: 18h43m55.8s
IAU-Sternbild: Oph
Baryzentrische Rotationsdauer: 0.4137001208367996 s
Gravitative Zeitdilatation der Rotationsperiode: 1.69830e-14
Dispersionsmaß: 4.700 pc/cm³
Abbremsungs-Energieverlustrate: 9.47e+33 ergs/s
Entfernung nach dem Elektronendichtemodell: 0.38 kpc (1239.39 LJ)
Zeitlich gemittelte Flußdichte bei 1400MHz: 0.16 mJy
Bemerkungen: Gepulste Emission von Radio bis Infrarot oder höheren Frequenzen

STELLARIUM WITH PULSAR AND QUASAR PLUGINS ENABLED

STELLARIUM V0.16.1

Pulsare anzeigen [~%P]

Erde, +53°47'59", +10°30'00"

FOV 83.7°

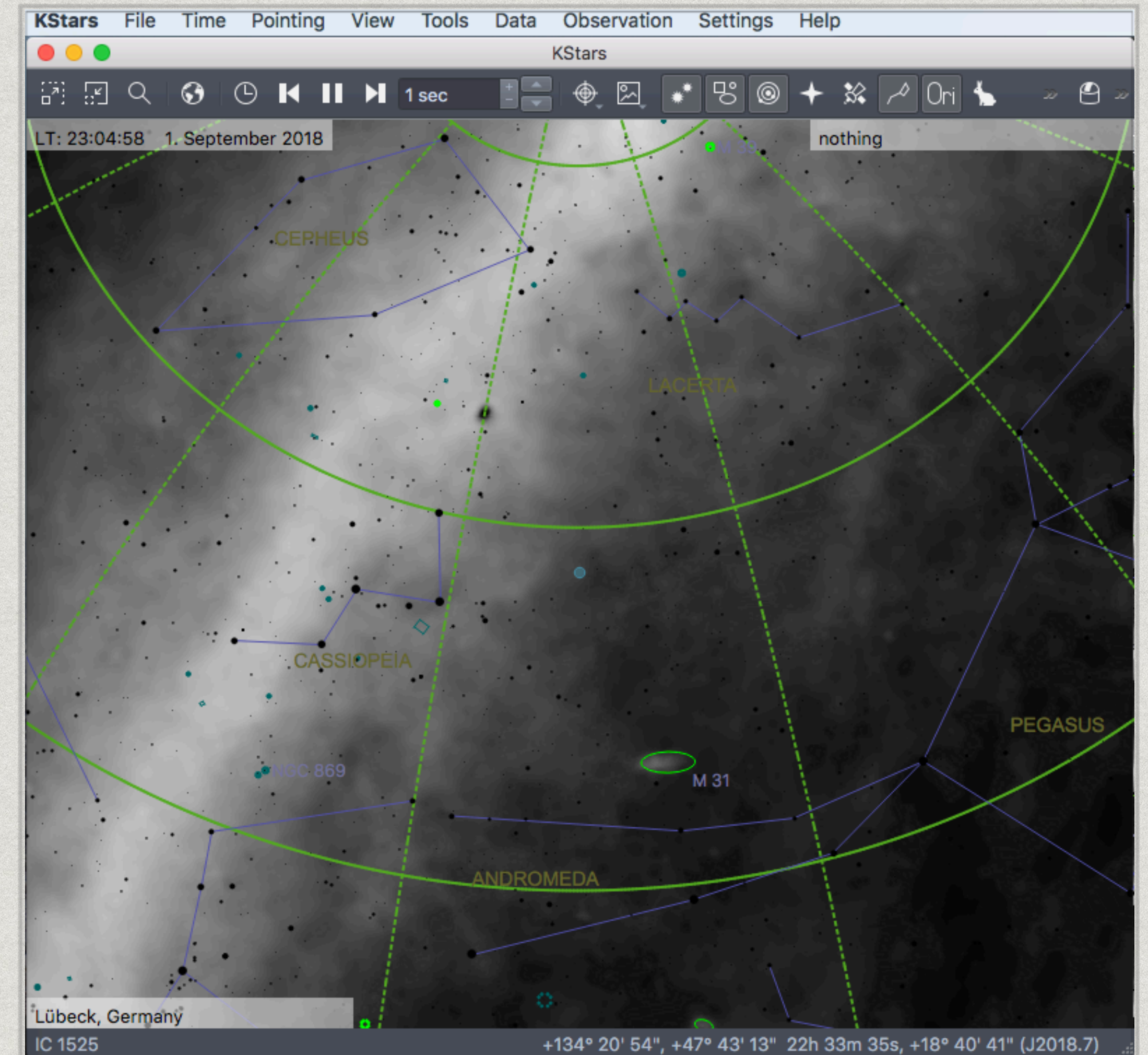
9.06 BPS

2018-07-22 22:41:31 UTC+00:42



KStars

- * Rather powerful for optical amateur use
- * For radio:
 - * Point sources and catalogue import works (but no radio catalogues by default)
 - * Supports HiPS skymap backgrounds, HI surveys available
 - * can calculate and display antenna „footprint“
 - * no flux search

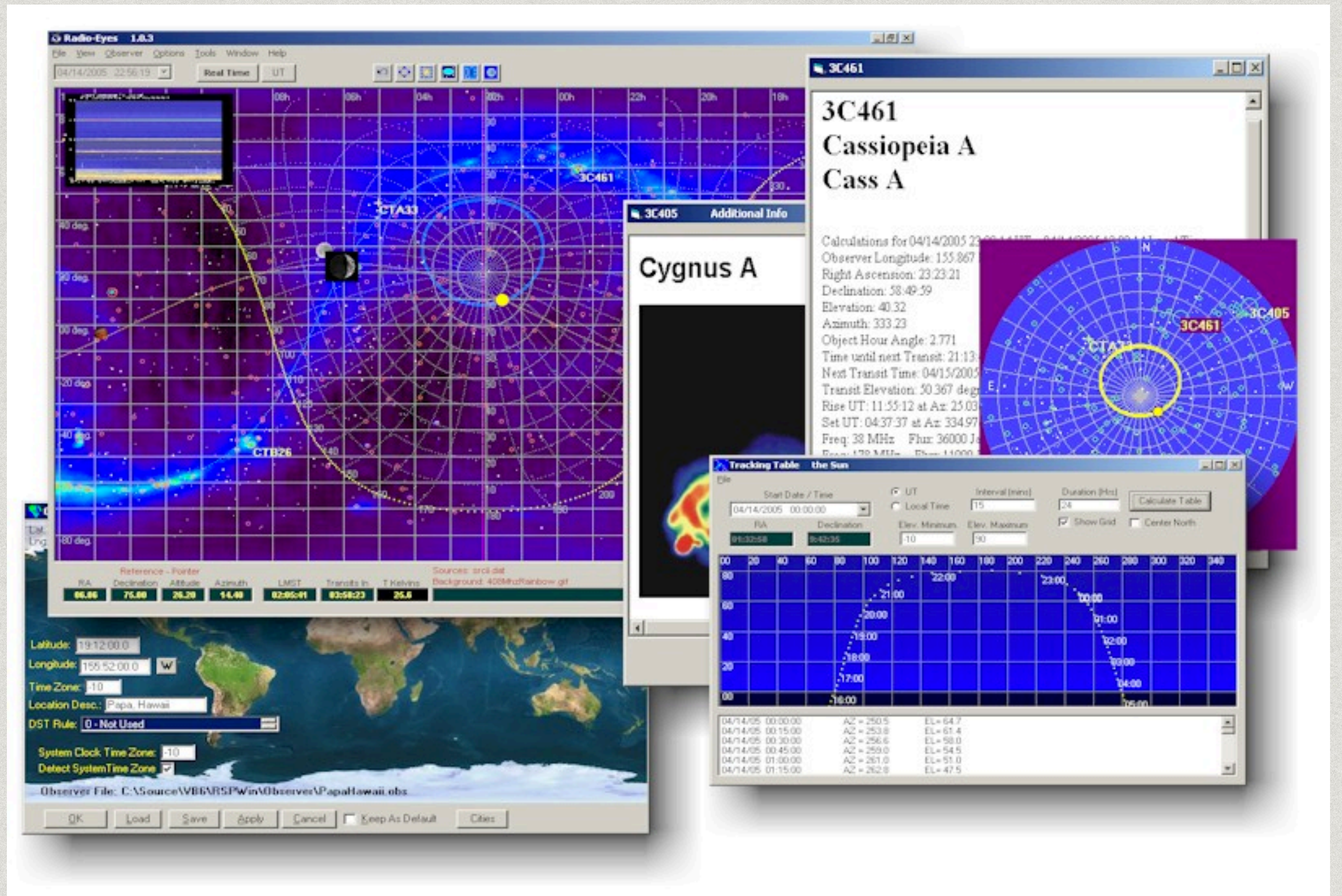


Cartes du Ciel

- * Seemingly no support for skymaps, neither HiPS nor images
- * Catgen can import catalogues
 - * but search is limited
 - * no preconfigured radio catalogues
- * no flux filtering

Best compromise: Radio Eyes

- * Windows only
- * Commercial
- * ticks all the boxes
- * Lacks VO compatibility
- * Supports custom catalogues
- * basic interferometry support
- * http://www.radiosky.com/radioeyes/help/features_list.htm



Aladin

- * Professional interactive sky atlas
- * Not very polished, steep learning curve, small mem hack¹ required, but powerful
- * Java, cross-platform
- * Integrates most VO compatible resources
 - * Skymaps, Catalogues, Data cubes
- * No horizon!

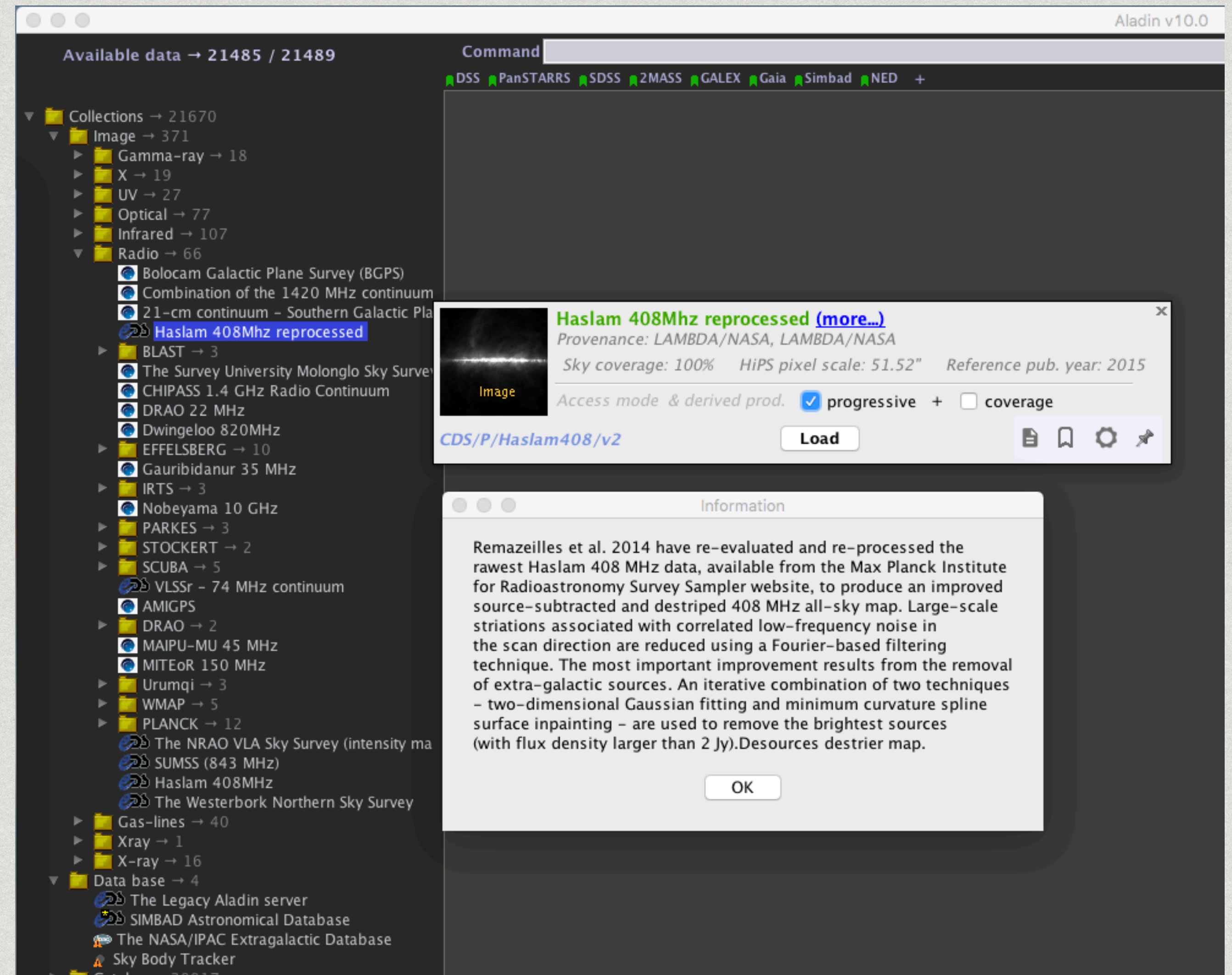


<https://aladin.u-strasbg.fr>

[1] <http://aladin.u-strasbg.fr/java/FAQ.htx#ToC20>

Aladin Dataset Browser

- * Large tree aggregates all data collections compatible with Virtual Observatory standards
- * Details for most of the important collections right in Aladin through „more...” link
- * Watch out for „Sky coverage”
 - * green collections contain results in the current sky view



ALADIN LIVE DEMO:

HUNTING OBSERVABLE PULSARS AT STOCKERT

THANK YOU!