



# SOFIA Legacy Data Preservation

Ed Chambers

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# SOFIA Legacy Projects

- SOFIA Legacy Programs are aimed at generating significant value to the astronomical community by yielding results addressing specific science goals and providing a rich archival data set for future analysis
- 9 Legacy Projects have been observed





Galactic Center (Hankins et al. 2020)


# Legacy Data: Current Status at IRSA

- Science-ready legacy data products are in the SOFIA Science Archive at IRSA
- Legacy projects have links to their archived data products on the main SOFIA page at IRSA

## Stratospheric Observatory for Infrared Astronomy (SOFIA)

  
[SOFIA Archive](#)

  
[Abstract Search](#)

  
[Documentation](#)

**Mission Characteristics**

<b>Description:</b>	SOFIA is a Boeing 747SP aircraft modified to accommodate a 2.5 meter reflecting telescope. Its instruments provide researchers with access to a wavelength coverage from the optical to the submillimeter (0.35 - 655 microns).
<b>Wavelength:</b>	0.35 - 655 $\mu\text{m}$
<b>Area Coverage:</b>	Targeted
<b>Instruments:</b>	2.5-m telescope with <ul style="list-style-type: none"> <li>• FORCAST mid-infrared camera and spectrograph (Herter et al. 2018)</li> <li>• GREAT heterodyne spectrometer (Risacher et al. 2018)</li> <li>• FIFI-LS far-infrared spectrometer (Fischer et al. 2018)</li> <li>• EXES echelle spectrograph (Richter et al. 2018)</li> <li>• FPI+ focal plane imager (Pfuller et al. 2018)</li> <li>• HAWC+ far-infrared camera and polarimeter (Harper et al. 2018)</li> <li>• FLITECAM near-infrared camera and spectrograph (McLean et al. 2006)</li> <li>• HIPO high speed imaging photometer for occultations (Dunham et al. 2004)</li> </ul>
<b>Time Coverage:</b>	25 May 2010 - present
<b>Science Products Generated:</b>	Observation data and calibration files
<b>Acknowledgement:</b>	<a href="#">Information for Authors</a>

**IRSA Services**

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[NASA SOFIA Archive \(Help\)](#)

[HIPO Data](#)

[Abstract Search](#)

Interface to the NASA SOFIA Archive


Occultation data from HIPO

Search abstracts that reference SOFIA products

**SOFIA Legacy Programs:**

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<p><a href="#">Radiative and Mechanical Feedback in Regions of Massive Star Formation</a></p> <p><a href="#">Constraining Recent Star Formation in the Galactic Center</a></p> <p><a href="#">HyGAL: Characterizing the Galactic Interstellar Medium with Hydrides</a></p> <p><a href="#">FIELDMAPS: Filaments Extremely Long and Dark: A Magnetic Polarization Survey</a></p> <p><a href="#">SOFIA Heralds a New Era of Measuring the Magnetic Fields of Galaxies</a></p>	<p>GREAT spectra</p> <p>FORCAST imaging</p> <p>GREAT spectra</p> <p>HAWC+ imaging</p> <p>HAWC+ imaging</p>	<p><a href="#">Data Access</a></p> <p><a href="#">Data Access</a></p> <p><a href="#">Data Access</a></p> <p><a href="#">Data Access</a></p> <p><a href="#">Data Access</a></p>
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Stratospheric Observatory for Infrared Astronomy


SUG #19

2









# Legacy Data: Team Pages

- Legacy teams may reprocess data before publication, resulting in products better suited for their science.
- Some teams make their reprocessed data products available through their own web pages, along with other ancillary data

HOME ABOUT TEAM DATA TOOLS PUBLICATIONS

## CENTAURUS A

↓

Dec (J2000)

RA (J2000)

P (mJy/sqarcsec)

P = 10%

### DETAILS

HAWC+ observations associated with program 07\_0032 (PI: Lopez-Rodriguez, E.). Observations were performed using on-the-fly-map polarization techniques in Band C (89  $\mu\text{m}$ ).

### DATA

- HAWC+ 89  $\mu\text{m}$  (px= 1/4 beam)
- Temperature Map
- Temperature Map (Uncertainties)
- Column Density Map
- Column Density Map (Uncertainties)
- ALMA 12CO(1-0) (moment 0, 8")
- ALMA 12CO(1-0) (moment 1, 8")
- ALMA 12CO(1-0) (moment 2, 8")
- Herschel images (70-500 microns)

### PUBLICATION

- Lopez-Rodriguez 2021 (Nature Astronomy)

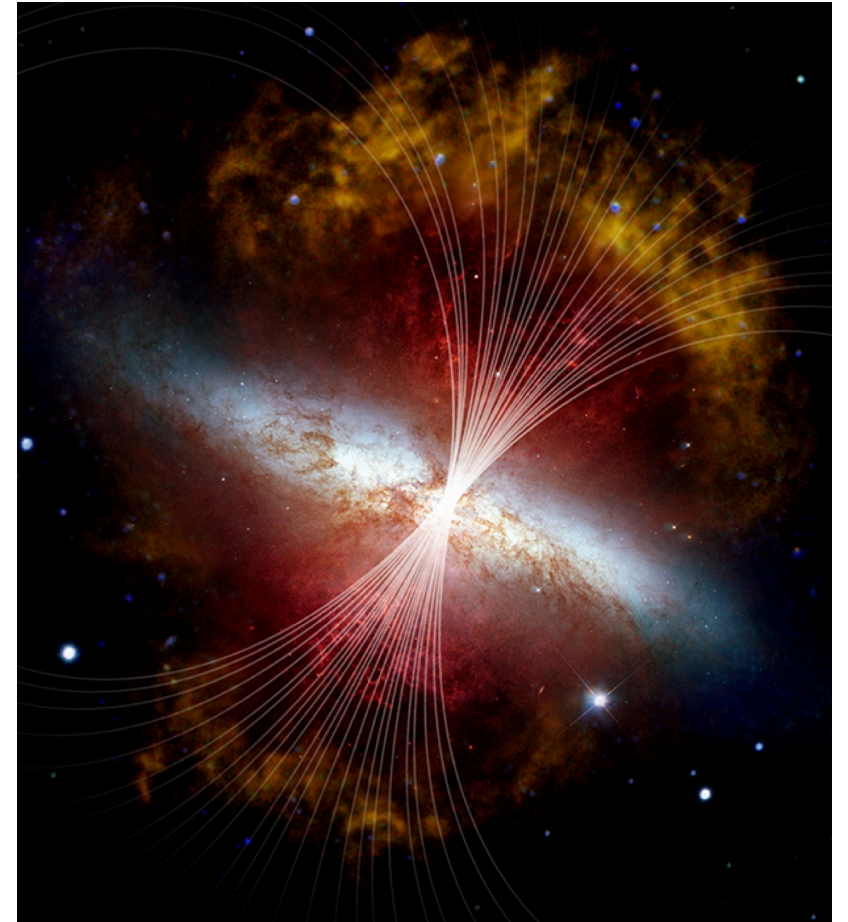
<http://galmagfields.com/singleobjects/centaurusA.html>



# Legacy Data: Long-term Access and Preservation

- How can we access the data long into the future?
- Standard products will be available at IRSA, but what about the custom data products and ancillary data?
- What if the team pages are not permanently available?

Proposed Solution: Create Legacy Project web pages at IRSA, and store and serve the data at IRSA as *Enhanced Contributed Data*. This will ensure “long-term accessibility through both interactive graphical interfaces and standard application program interfaces”




M82 (Lopez-Rodriguez et al. 2021)


# Legacy Project Pages at IRSA

- Would be available on the main SOFIA page at IRSA
- These pages could provide direct access to the archived Legacy data and can also include:
  - Customized SOFIA data products
  - Ancillary data from other facilities
  - Catalogs
  - Documentation
  - Additional text and image files

## Stratospheric Observatory for Infrared Astronomy (SOFIA)

  
[SOFIA Archive](#)

  
[Abstract Search](#)

  
[Documentation](#)

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### IRSA Services

<a href="#">NASA SOFIA Archive (Help)</a>	Interface to the NASA SOFIA Archive
<a href="#">HIPO Data</a>	Occultation data from HIPO
<a href="#">Abstract Search</a>	Search abstracts that reference SOFIA products

### SOFIA Legacy Programs:

<a href="#">Radiative and Mechanical Feedback in Regions of Massive Star Formation</a>	GREAT spectra	<a href="#">Data Access</a>
<a href="#">Constraining Recent Star Formation in the Galactic Center</a>	FORCAST imaging	<a href="#">Data Access</a>
<a href="#">HyGAL: Characterizing the Galactic Interstellar Medium with Hydrides</a>	GREAT spectra	<a href="#">Data Access</a>
<a href="#">FIELDMAPS: Filaments Extremely Long and Dark: A Magnetic Polarization Survey</a>	HAWC+ imaging	<a href="#">Data Access</a>
<a href="#">SOFIA Heralds a New Era of Measuring the Magnetic Fields of Galaxies</a>	HAWC+ imaging	<a href="#">Data Access</a>

# Enhanced Contributed Data

- High-level data products contributed by researchers
- Searchable based on coordinates, using the IRSA Atlas tool
- Can include SOFIA data and ancillary data products (e.g., data from other telescopes, temperature maps)
- IRSA has instructions on how to contribute data, and can work with researchers to ensure proper data format and coordinate information
- Products are discoverable using the Data Discovery tool on the main IRSA page (search results will include the standard products in the SOFIA archive as well as the contributed data)
- Note: these products do not appear in the standard SOFIA archive!

The screenshot shows the NASA/IPAC Infrared Science Archive (IRSA) website. The header includes the IRSA logo and the text "NASA/IPAC INFRARED SCIENCE ARCHIVE". Navigation links for "IRSA", "DATA SETS", "SEARCH", "TOOLS", and "HELP" are visible, along with a "Login" link. The main content area features a "Search for Source" section with a text input field for "Name or Coordinates", a "Search" button, and a "Radius" dropdown set to "30" with "arcsec" as the unit. Below this is a "Search Catalog:" dropdown set to "WISE" with another "Search" button. A "ZTF Public Data Release 10" section displays an image of a galaxy and text stating: "The tenth public data release from the Zwicky Transient Facility contains approximately 36 million images, 600 billion source detections extracted from these images, and over 4 billion light curves." A grid of icons represents various data products and tools: "Catalogs", "IRSA Viewer", "Finder Chart", "VO/API", "Spitzer", "WISE", "SOFIA", "IRTF", "2MASS", "Herschel", "Planck", and a "MORE" button. At the bottom, a navigation bar contains buttons for "Contribute Data" (circled in red), "Documentation", "Video Tutorials", and "Help Desk".



# Sample Legacy Page at IRSA

Spitzer Legacy/Exploration Science Programs - Galactic Data Sets	
<a href="#">C2D: From Molecular Cores to Planet-Forming Disks</a>	Images, spectra, catalogs, ancillary
<a href="#">CSI2264: The Coordinated Synoptic Investigation of NGC 2264</a>	Light curves, catalogs
<a href="#">A Spitzer Legacy Survey of the Cygnus-X Complex</a>	Images, catalogs
<a href="#">FEPS: The Formation and Evolution of Planetary Systems</a>	Images, spectra, catalog, ancillary
<a href="#">GLIMPSE: Galactic Legacy Infrared Midplane Survey Extraordinaire</a>	Images, catalogs
<a href="#">MIPSGAL: A 24 and 70 Micron Survey of the Inner Galactic Disk with MIPS</a>	Images
<a href="#">SASS: Spitzer Archive of Stellar Spectra</a>	Spectra, catalog
<a href="#">Taurus 2: Finishing the Spitzer Map of the Taurus Molecular Clouds</a>	Images, catalog
<a href="#">YSOVAR: Young Stellar Object Variability</a>	Light curves, catalogs

<https://irsa.ipac.caltech.edu/Missions/spitzer.html>

**Spitzer Formation and Evolution of Planetary Systems (FEPS) Overview**

[FEPS Overview](#)

[FEPS Primary Data Access](#)

[FEPS Summaries](#)

[IRSA Catalog Search Tool: FEPS](#)

### Overview

The Formation and Evolution of Planetary Systems (FEPS) Spitzer Legacy program was designed to characterize the evolution of circumstellar gas and dust around solartype stars between ages of 3 Myr and 3 Gyr. To achieve these goals, FEPS obtained spectrophotometric observations with the Spitzer Space Telescope for a sample of 328 stars. The observing strategy was to measure the spectral energy distribution (SED) between wavelengths of 3.6 and 70 micron with IRAC and MIPS photometry, and between 8 and 35 micron with low-resolution IRS spectra. In addition, the FEPS program obtained MIPS 160 micron photometry for 80 stars to search for colder dust, and high-resolution IRS spectra for 33 sources to probe for circumstellar gas. If you use FEPS data, please cite [Carpenter et al. \(2008\)](#).

[Jump to documentation.](#)

### Data Set Characteristics

Data Product	Description	Data Access
Images	Spitzer/IRAC 3.6, 4.5, 5.8, 8 micron Spitzer/MIPS 24, 70, 160 micron	<ul style="list-style-type: none"> <li>• <a href="#">Image and Spectrum Server (Atlas)</a></li> <li>• <a href="#">Browseable Directories</a></li> <li>• <a href="#">Program Interface</a></li> </ul>
Spectra	Spitzer/IRS	<ul style="list-style-type: none"> <li>• <a href="#">Image and Spectrum Server (Atlas)</a></li> <li>• <a href="#">Browseable Directories</a></li> <li>• <a href="#">Program Interface</a></li> </ul>
Catalog	FEPS Photometry Catalog	<ul style="list-style-type: none"> <li>• <a href="#">Catalog Search Tool</a></li> <li>• <a href="#">Program Interface</a></li> <li>• <a href="#">Download</a></li> </ul>
Models	Model Spectra	<a href="#">Browseable Directories with previews</a>

### FEPS Documentation

Documentation	Catalogs
<a href="#">Documentation</a>	<a href="#">FEPS Photometry Catalog Descriptions</a>

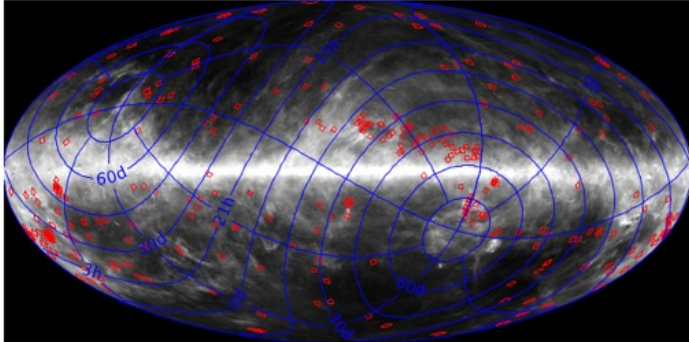
<https://irsa.ipac.caltech.edu/data/SPITZER/FEPS/overview.html>



# Sample Legacy Data Search

**Formation and Evolution of Planetary Systems (FEPS) Data Access**

[FEPS Overview](#) | 
 [FEPS Primary Data Access](#) | 
 [FEPS Summaries](#) | 
 [IRSA Catalog Search Tool: FEPS](#)



You can get a close-up map of a region by clicking on any area in red on the above IRAS image, or by typing a coordinate below.

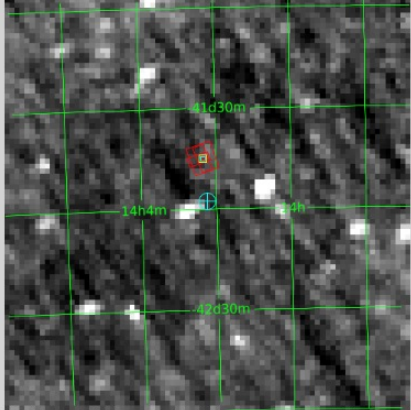
**Single Object** (Name or Coords)   
 **Table Upload** (Multi Object)  No file chosen

Size (deg): [maximum 12.5]   Images must cover coordinate  
 Source Search Radius: [maximum 6.25 deg]    Search Whole Region

**Coordinate Examples:** 47.5512025 14.5998733 eq | 3h 10m 12.29s +14d 35m 59.5s Equ J2000 | 166.10133 -36.38465 ga | 1E\_0307.4+1424  
**Default:** Equatorial J2000

<https://irsa.ipac.caltech.edu/data/SPITZER/FEPS/index.html>

Collection: FEPS Object: 210.563088 -41.957911 eq J2000



Your position is marked by the cyan crosshairs. The background image is described in Background. Click on image to re-center, or fine tune your Coordinates or Search Area below. See tables below for keys to color overlays.

Coordinates/Object:   
 Image Search Size (deg): [maximum 12.5 deg]   Images must cover coordinate  
 Source Search Radius: [maximum 6.25 deg]    Match with image search size

14h 02m 15.14s -41d 57m 28.5s Equ J2000 | 
 Image Header Table: (6 images in total)  | 
 Background Image: (factor of 1.0 larger than search size)

[Bulk Download Script](#) of all results using WGET

**Tables of Sources in Requested Area**

These are small contributed catalogs, e.g. spectra or some photometry. Large photometry catalogs are available via the IRSA [Catalog Search](#) (Look under the relevant mission or Contributed Dataset link.)

Table	Count	Data Type	Column Key
<a href="#">FEPS_photometry_V5.tbl</a> (small yellow symbols)	1	catalog	<a href="#">Column Key</a>
<a href="#">FEPS_spectra_V5.tbl</a> (small cyan symbols)	1	spectra	<a href="#">Column Key</a>

**All Images in Requested Area** (columns are sortable) [Column Key](#)

Entire Image	Distance (arcmin)	RA (degree)	Dec (degree)	Telescope	Instrument	Band	Wavelength (microns)	Type of Data	FITS
	12.6279	210.6136794	-41.750846	Spitzer	MIPS	MIPS160	160	science	images/mips/mips160/MML_40.fits
	12.6368	210.5861104	-41.747996	Spitzer	IRAC	IRAC4	8	science	images/irac/irac8.0/MML_40.fits
	12.6382	210.5861901	-41.7479781	Spitzer	IRAC	IRAC1	3.6	science	images/irac/irac3.6/MML_40.fits
	12.6404	210.5862385	-41.7479436	Spitzer	IRAC	IRAC2	4.5	science	images/irac/irac4.5/MML_40.fits
	12.688	210.5881496	-41.747268	Spitzer	MIPS	MIPS70	70	science	images/mips/mips70/MML_40.fits
	12.6904	210.5885808	-41.7470836	Spitzer	MIPS	MIPS24	24	science	images/mips/mips24/MML_40.fits

Search results

# Sample Ancillary Data Links

**Index of /data/SPITZER/FEPS/models**

Name	Last modified	Size	Description
<a href="#">1E_0307.4+1424.dat</a>	2010-06-08 13:17	194K	
<a href="#">1E_0324.1-2012.dat</a>	2010-06-08 13:17	194K	
<a href="#">1RXS_J025216.9+361658.dat</a>	2010-06-08 13:17	194K	
<a href="#">1RXS_J025751.8+115759.dat</a>	2010-06-08 13:17	194K	
<a href="#">1RXS_J030759.1+302032.dat</a>	2010-06-08 13:17	194K	
<a href="#">1RXS_J031644.0+192259.dat</a>	2010-06-08 13:17	194K	
<a href="#">1RXS_J031907.4+393418.dat</a>	2010-06-08 13:17	194K	
<a href="#">1RXS_J034423.3+281224.dat</a>	2010-06-08 13:17	194K	
<a href="#">1RXS_J035028.0+163121.dat</a>	2010-06-08 13:17	194K	
<a href="#">1RXS_J043243.2-152003.dat</a>	2010-06-08 13:17	194K	
<a href="#">1RXS_J051111.1+281353.dat</a>	2010-06-08 13:17	194K	
<a href="#">1RXS_J053650.0+133756.dat</a>	2010-06-08 13:17	194K	
<a href="#">2RE_J0255+474.dat</a>	2010-06-08 13:17	194K	
<a href="#">AO_Men.dat</a>	2010-06-08 13:17	194K	
<a href="#">AP_93.dat</a>	2010-06-08 13:17	194K	
<a href="#">B102.dat</a>	2010-06-08 13:17	194K	

<https://irsa.ipac.caltech.edu/data/SPITZER/FEPS/models/>

**Formation and Evolution of Planetary Systems (FEPS) Summary Pages**

FEPS Overview | FEPS Primary Data Access | FEPS Summaries | IRSA Catalog Search Tool: FEPS

Below is a list of FEPS objects, their coordinates and links to each star's data summary page:


FEPS Object Name	RA (J2000)	DEC (J2000)	Summary Page
HD_224873	0.348599	39.610592	<a href="#">Summary</a>
HD_105	1.468973	-41.753040	<a href="#">Summary</a>
HD_377	2.107247	6.616805	<a href="#">Summary</a>
HD_691	2.843348	30.449568	<a href="#">Summary</a>
HD_984	3.542728	-7.199159	<a href="#">Summary</a>
QT_And	10.322187	34.421326	<a href="#">Summary</a>
HD_6434	16.167306	-39.488163	<a href="#">Summary</a>
HD_6963	17.674677	42.931870	<a href="#">Summary</a>
HD_7661	19.100732	-12.097035	<a href="#">Summary</a>
HIP_6276	20.134426	-11.467659	<a href="#">Summary</a>
HD_8941	22.101518	17.079216	<a href="#">Summary</a>
HD_8907	22.143117	42.267727	<a href="#">Summary</a>
HD_9472	23.329291	23.975590	<a href="#">Summary</a>
RE_J0137+18A	24.414203	18.592560	<a href="#">Summary</a>
HD_11850	29.197001	23.051142	<a href="#">Summary</a>
HD_12039	29.454036	-21.901459	<a href="#">Summary</a>
HD_13382	32.846260	21.377337	<a href="#">Summary</a>
HD_13507	33.229154	40.668365	<a href="#">Summary</a>
HD_13531	33.305596	40.507626	<a href="#">Summary</a>
HD_13974	34.262654	34.224396	<a href="#">Summary</a>
HD_15526	37.395970	-12.402380	<a href="#">Summary</a>
1RXS_J025216.9+361658	43.073285	36.280052	<a href="#">Summary</a>


<https://irsa.ipac.caltech.edu/data/SPITZER/FEPS/links.html>


**FEPS: HD\_224873 Summary**

[Click here](#) for the FEPS data delivery document (pdf), or here for a [simple text explanation](#) of the naming conventions used below.


**IRAC Data**


 IRAC1: [FITS](#), [Preview JPEG](#)

 IRAC2: [FITS](#), [Preview JPEG](#)

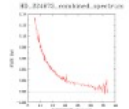
 IRAC4: [FITS](#), [Preview JPEG](#)

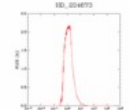
**MIPS Data**

 MIPS24: [FITS](#), [MIPS24 Preview JPEG](#)

 MIPS70: [FITS](#), [MIPS70 Preview JPEG](#)

**IRS Data**

 IRS\_01475: [ASCII](#), [Preview JPEG](#)

 Kurucz Model: [ASCII](#), [Preview JPEG](#)

# Summary

Creating Legacy pages and storing the Legacy Project and ancillary data at IRSA as Enhanced Contributed Data would:

- Ensure long-term access to some of SOFIA's most valued data products
- Provide access to all SOFIA data from a single location
- Enable users to find legacy and ancillary data using the Data Discovery Tool (on the main IRSA home page) or simple searches
- Allow for customized pages tailored to each project while maintaining a consistent look across all legacy project pages
- Give the community access to a variety of legacy data and ancillary products, such as images, catalogs, models, and scripts