NASA/IPAC Extragalactic Database

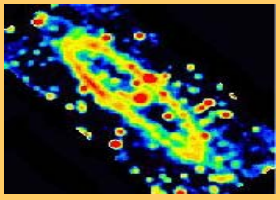
The NASA/IPAC Extragalactic Database (NED) is a thematic online research facility designed to support scientists, educators, space missions and astronomical observatories in the planning, execution and publication of research on objects beyond our Milky Way galaxy. NED's ongoing mission is to provide the most comprehensive and easy-to-use multi-wavelength database of fundamental measurements for known (cataloged and published) objects beyond the Milky Way. NED is a portal into a systematic fusion of data linked from hundreds of sky surveys and thousands of research publications. The contents and services span the entire spectrum from gamma rays through radio frequencies, and they are continuously updated to reflect the current literature and releases of large-scale sky survey catalogs. NED has been on the Internet since 1990, growing in content and capabilities with the evolution of information technology. NED is operated by the Jet Propulsion Laboratory, California Institute of Technology, under contract with the National Aeronautics and Space Administration.

Inside you will find descriptions of NED's primary features, samples of its rapidly growing contents, and illustrations of powerful new services to facilitate your research.

The NED team may be contacted at ned@ipac.caltech.edu

GALEX UV

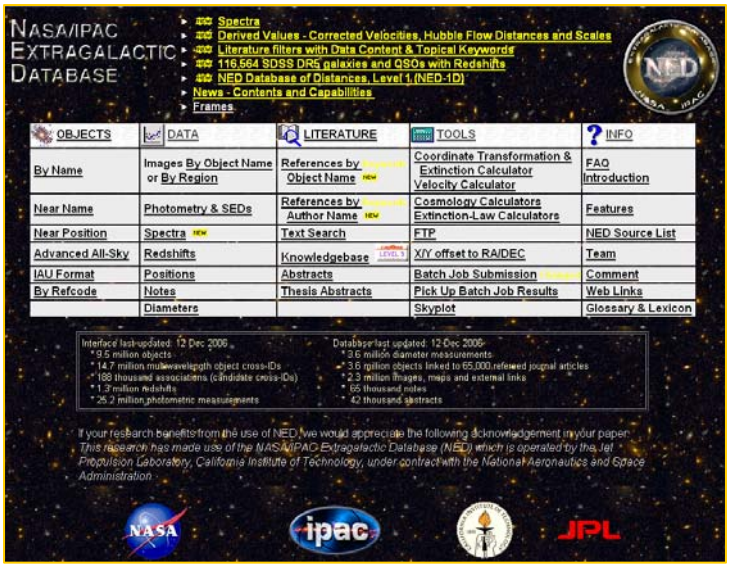
SPITZER MID-IR

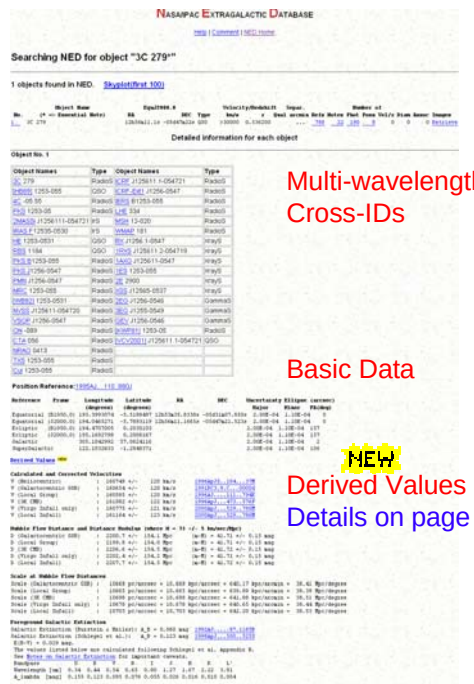


EFFELSBERG RADIO

http://nedwww.ipac.caltech.edu

NED in a Nutshell

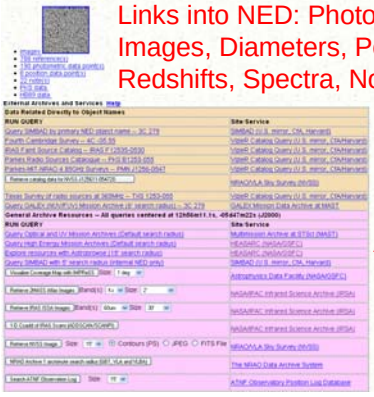




Multi-wavelength Cross-IDs

Basic Data

NEW
Derived Values
Details on page 4.



Links into NED: Photometry, Images, Diameters, Positions, Redshifts, Spectra, Notes.

Links to External Archives

Primary NED Services

NED is the world's largest database of cross-identified extragalactic objects, containing approximately 10 million unique objects and 15 million multi-wavelength cross-IDs. Over 3 thousand catalogs and published lists covering the entire electromagnetic spectrum have had their objects cross-identified or associated and their data fused into the database for easy queries and retrieval.

Objects can be queried By Name (any alias) using the NED name interpreter; Near Name or Near Position (cone search); By Reference (Refcode), and By Author. By Parameter (Advanced All-Sky) queries utilize joint constraints on Redshift, Sky Area, Object Types, Survey Names, and Flux density/magnitude to construct galaxy samples. The complexities of SQL are hidden from the user by the NED software and interface.

Available data include Positions, Redshifts, Morphological and Spectral Classifications, Photometry, Images, Spectra (New!), Diameters, Cross-IDs, Associations, Reference Abstracts and detailed Notes. Measurement uncertainties are included where available, and all information is cited and linked to the on-line literature via ADS.

Other tools include a Coordinate Calculator that performs conversions and precession and displays line-of-sight Galactic extinction estimates; a Velocity Calculator that converts between Heliocentric, Local Group, Galactic Standard of Rest, and 3K Microwave Background; and an XY-Offset to RA/Dec converter.

Seamless Connectivity

Globally distributed services are linked by object names and positions in NED. See page 5 for details.

IPAC
ads NASA Astrophysics Data System
NVO
MAST
Telescope Data Center
SMITHSONIAN ASTROPHYSICAL OBSERVATORY
HEASARC High Energy Astrophysics Science Archive Research Center
NRAO National Radio Astronomy Observatory

Knowledgebase for Extragalactic Astronomy & Cosmology

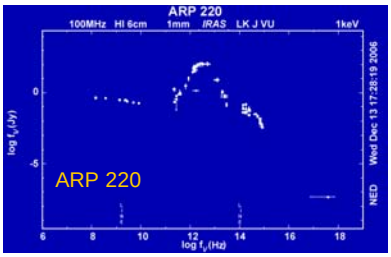
See page 10 for details.

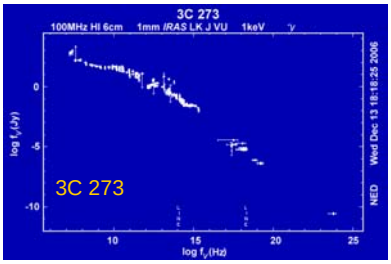
CHANDRA LEVEL 5

Links to On-line Literature

Data in NED are cited and linked to the on-line journals via ADS. Abstracts may be queried individually from specific data entries, or in groups By Object, By Author, or full Text Search.

NED in a Nutshell





Spectral Energy Distributions

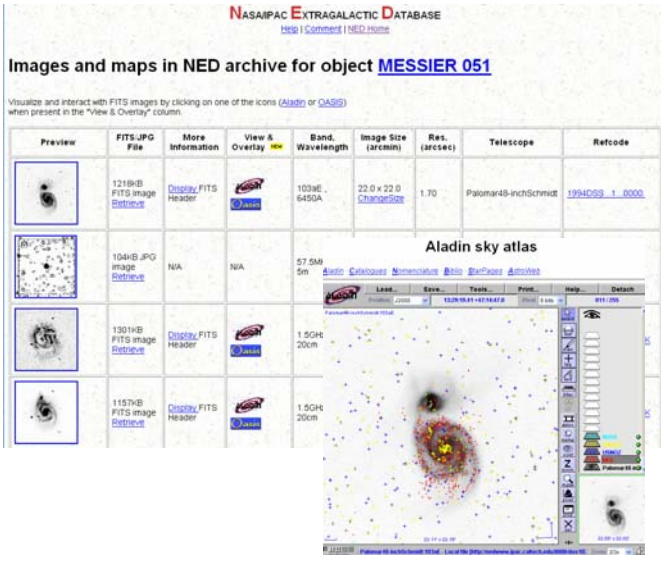
NED provides Spectral Energy Distributions (SEDs) covering the whole electromagnetic spectrum. Fluxes and their uncertainties (or upper limits), gathered from large survey catalogs and from the literature, are displayed in various user-requested standardized units. Aperture information and ties to the originating literature are provided for every data point. Great care goes into understanding and documenting the details of the measurements (metadata), and the data are provided to users in original published units (magnitudes, Janskys, etc.), and uniformly converted to various standard units for display and SED plotting.


NASA/IPAC EXTRAGALACTIC DATABASE

Photometric data point(s) for object ARP 220

26 photometry data points found in NED.

No.	Frequency Targeted	Measurement	+/-	Unc	Units	Reference Code
1	U (U_T)	14.27	+/-	0.15	mag	1991RC3.9.C..00004
2	U (U_T*0)	13.07			mag	1991RC3.9.C..00004
3	B (B_T)	13.94	+/-	0.14	mag	1991RC3.9.C..00004
4	B (m_B)	13.90	+/-	0.20	mag	1991RC3.9.C..00004
5	B (B_T*0)	13.61			mag	1991RC3.9.C..00004
6	V (V_T)	13.20	+/-	0.14	mag	1991RC3.9.C..00004
7	V (V_T*0)	12.96			mag	1991RC3.9.C..00004
8	IRAS 12 microns	4.837E-01	+/-	5 %	Jy	1990IRASF.C..0000M
9	IRAS 12 microns	0.64	+/-	0.029	Jy	1988AJ....95.7602
10	IRAS 25 microns	7.92	+/-	0.038	Jy	1988AJ....95.7602
11	IRAS 25 microns	7.907E+00	+/-	5 %	Jy	1990IRASF.C..0000M
12	IRAS 60 microns	1.030E+02	+/-	4 %	Jy	1990IRASF.C..0000M
13	IRAS 60 microns	102.33	+/-	0.144	Jy	1988AJ....96.7602
14	IRAS 100 microns	1.134E+02	+/-	3 %	Jy	1990IRASF.C..0000M
15	IRAS 100 microns	113.93	+/-	0.207	Jy	1988AJ....95.7602
16	100 microns	10.3	+/-	3.3	Jy	1989ApJ...339..859E
17	450 microns	3	+/-	1.1	Jy	1989ApJ...339..859E
18	800 microns	1.1	+/-	0.4	Jy	1989ApJ...339..859E
19	1100 microns	<0.6			Jy	1989ApJ...339..859E
20	1.25 mm	0.226	+/-	0.01	Jy	1992PASP..104.1066C
21	4.85 GHz	204	+/-	27	mJy	1991ApJS...77.1011O
22	4.85 GHz	200	+/-	13 %	mJy	1991ApJS...73...1B
23	HI (21 cm line)	13.96	+/-	0.30	m_21 mag	1991RC3.9.C..00004
24	HI (21 cm line)	21.11			Jy km s^-1	1989MNRAS.237..779W
25	1.40 GHz	302			mJy	1992ApJS...79..331W
26	151 MHz	0.45	+/-	10.1%	Jy	1996MNRAS.282..779W


NASA/IPAC EXTRAGALACTIC DATABASE

Images and maps in NED archive for object MESSIER 051

Visualize and interact with FITS images by clicking on one of the icons (Aladin or OASIS) when present in the "View & Overlay" column.

Preview	FITS/JPG File	More Information	View & Overlay	Band, Wavelength	Image Size (arcmin)	Res. (arcsec)	Telescope	Refcode
	1218KB FITS image Retrieve	Display FITS Header		103aE , 6450A	22.0 x 22.0 ChangeSize	1.70	Palomar48-inchSchmidt	1994DSS...1..0000
	104KB JPG image Retrieve	N/A	N/A					
	1301KB FITS image Retrieve	Display FITS Header		1.5GHz 20cm				
	1157KB FITS image Retrieve	Display FITS Header		1.5GHz 20cm				

Aladin sky atlas

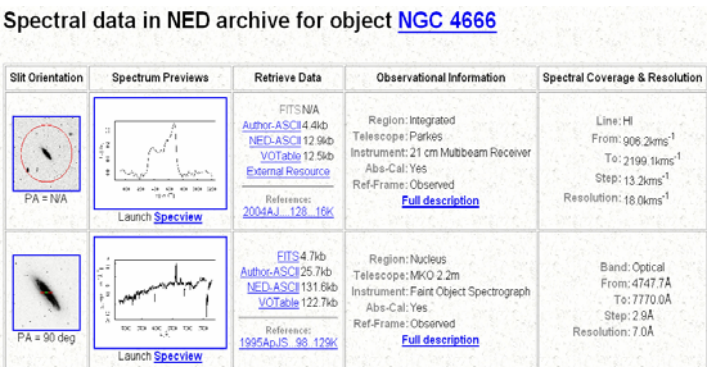
Multi-wavelength Images and Visualization

NED provides a unique collection of images which are interconnected, documented, and available for queries and immediate download. The science-grade images in FITS format are highly processed data submitted by researchers around the world after publication (in plot form) in the peer-reviewed literature. Galaxy images from 2MASS, DSS, and other major surveys are also available. In 2003 we introduced the capability to search the NED image archive by sky areal coverage. Sky visualization and interactivity between images and database entries are provided via Aladin (CDS) and OASIS (IRSA). Clicking on the the Aladin icon launches the Java applet with the corresponding image loaded along with marker overlays for objects in NED and separate planes for the USNO (optical), 2MASS (near-infrared) and NVSS (radio) catalogs.

Spectral Database

NEW

See page 8 for details.


Spectral data in NED archive for object NGC 4666

Slit Orientation	Spectrum Previews	Retrieve Data	Observational Information	Spectral Coverage & Resolution
PA = N/A	Launch Specview	FITS N/A Author-ASCII 4.4kb NED-ASCII 12.9kb VOTable 12.5kb External Resource Reference: 2004AJ....128..16K	Region: Integrated Telescope: Parkes Instrument: 21 cm Multibeam Receiver Abs-Cal: Yes Ref-Frame: Observed Full description	Line: HI From: 906.2kms^{-1} To: 2199.1kms^{-1} Step: 13.2kms^{-1} Resolution: 18.0kms^{-1}
PA = 90 deg	Launch Specview	FITS 4.7kb Author-ASCII 25.7kb NED-ASCII 131.6kb VOTable 122.7kb Reference: 1995ApJS...98..129K	Region: Nucleus Telescope: MKO 2.2m Instrument: Faint Object Spectrograph Abs-Cal: Yes Ref-Frame: Observed Full description	Band: Optical From: 4747.7Å To: 7770.0Å Step: 2.9Å Resolution: 7.0Å

Data Content and Topical Keywords

NEW

See page 7 for details.

NEW!
Corrected Velocities & Distances

One of the most frequently requested NED enhancements has arrived! When redshifts are available, data for galaxies now include corrected velocities, Hubble flow distances and scales, and cosmology-corrected quantities.

Derived Values based on the object's redshift (if known) and position:

- Calculated and Corrected Velocities, with errors:
  1. V (Heliocentric) in km/s with its error (if known) and source, calculated from V = z/c. No relativisitc correction is applied to these apparent redshifts (see John Huchra's discussion of extragalactic redshifts for more information)
  2. V (Galactocentric GSR) in km/s calculated as in RC3,
  3. V (Local Group) in km/s based on the formulation by Karachentsev and Makarov (AJ 111, 794, 1996)
  4. V (3K CMB) in km/s using the CMB dipole model presented by Fixen et al. (ApJ 473, 576, 1996)
  5. V (Virgo Infall only) based on the local velocity field model given in Mould et al. (ApJ 529, 786, 2000) using only the term for the influence of the Virgo Cluster
  6. V (Local Infall) based on the local velocity field model given in Mould et al. (ApJ 529, 786, 2000) using the terms for the influence of the Great Attractor and the Shapley Supercluster, as well as the Virgo Cluster (we thank Jim Condon for his code for this model, on which we have based ours. Note that the declinations of the Great Attractor and the Shapley Supercluster given in Table A1 of Mould et al are negative, and that the minus signs in their Equation A2 should all be positive).

  The errors in the model parameters for each correction are added in quadrature to the error in the galaxy's redshift as follows: 4% of the GSR correction, 6% of the Local Group correction, 7% of the 3K CMB correction, and 7% of the velocity field correction. No derived distance is given if the corrected velocity is negative.
- Hubble Flow Distances and Distance Moduli, with their errors, calculated from the apparent corrected velocities assuming $H_0 = 73 \pm 5$ km/s/Mpc.
- Scale at the Hubble Flow Distances, in parsec/arcsec, kiloparsec/arcsec, kiloparsec/arcmin, and megaparsec/degree.
- Several quantities derived from the redshift corrected to the reference frame defined by the 3K background, and further corrected for a cosmological model with $H_0 = 73$ km/s/Mpc, $\Omega_{matter} = 0.27$, and $\Omega_{vacuum} = 0.73$. We thank Dr. Chris Burns (OCIW) for the code behind these calculations. Further explanation of the calculated quantities is available through Ned Wright's Cosmology Calculator web site, and through Alberto Cappi's CosmoTools web site.

Sample output for IRAS F10214+4724 at heliocentric z = 2.28560

Derived Values NEW

Calculated and Corrected Velocities

V (Heliocentric)	: 685206 +/-	9 km/s	1993ApJ...414L..13D
V (Galactocentric GSR)	: 685234 +/-	9 km/s	1991RC3.9.C...0000d
V (Local Group)	: 685234 +/-	9 km/s	1996AJ....111..794K
V (3K CMB)	: 685418 +/-	17 km/s	1996ApJ...473..576F
V (Virgo Infall only)	: 685380 +/-	14 km/s	2000ApJ...529..786M
V (Local Infall)	: 685317 +/-	14 km/s	2000ApJ...529..786M

Hubble Flow Distance and Distance Modulus (where H = 73 +/- 5 km/sec/Mpc)

D (Galactocentric GSR)	: 9387 +/-	657 Mpc	(m-M) = 44.86 +/- 0.15 mag
D (Local Group)	: 9387 +/-	657 Mpc	(m-M) = 44.86 +/- 0.15 mag
D (3K CMB)	: 9389 +/-	657 Mpc	(m-M) = 44.86 +/- 0.15 mag
D (Virgo Infall only)	: 9389 +/-	657 Mpc	(m-M) = 44.86 +/- 0.15 mag
D (Local Infall)	: 9388 +/-	657 Mpc	(m-M) = 44.86 +/- 0.15 mag

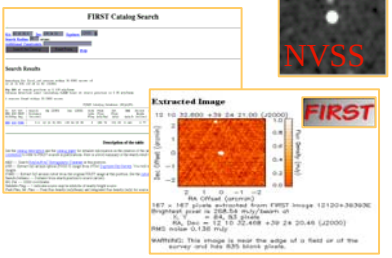
Scale at Hubble Flow Distances

Scale (Galactocentric GSR)	: 45508 pc/arcsec	= 45.508 kpc/arcsec	= 2730.50 kpc/arcmin	= 163.83 Mpc/degree
Scale (Local Group)	: 45508 pc/arcsec	= 45.508 kpc/arcsec	= 2730.50 kpc/arcmin	= 163.83 Mpc/degree
Scale (3K CMB)	: 45520 pc/arcsec	= 45.520 kpc/arcsec	= 2731.23 kpc/arcmin	= 163.87 Mpc/degree
Scale (Virgo Infall only)	: 45518 pc/arcsec	= 45.518 kpc/arcsec	= 2731.08 kpc/arcmin	= 163.86 Mpc/degree
Scale (Local Infall)	: 45514 pc/arcsec	= 45.514 kpc/arcsec	= 2730.83 kpc/arcmin	= 163.85 Mpc/degree

Cosmology-Corrected Quantities [H_o = 73 km/sec/Mpc, Omega(matter) = 0.27, Omega(vacuum) = 0.73]
[Redshift 2.286307 corrected to the Reference Frame defined by the 3K Microwave Background Radiation]

Luminosity Distance	: 18059 Mpc	(m-M) = 46.28 mag
Angular-Size Distance	: 1672 Mpc	(m-M) = 41.12 mag
Co-Moving Radial Distance	: 5495 Mpc	(m-M) = 43.70 mag
Co-Moving Tangential Dist.	: 5495 Mpc	(m-M) = 43.70 mag
Co-Moving Volume	: 695 Gpc^3	
Light Travel-Time	: 10.447 Gyr	
Age at Redshift 2.286307	: 2.852 Gyr	
Age of Universe	: 13.299 Gyr	
Scale (Cosmology Corrected)	: 8107 pc/arcsec	= 8.107 kpc/arcsec = 486.41 kpc/arcmin = 29.18 Mpc/degree
Surface Brightness Dimming	: Flux Density per Unit Area = 0.00857; Magnitude per Unit Area = 5.167 mag	

Global Connectivity



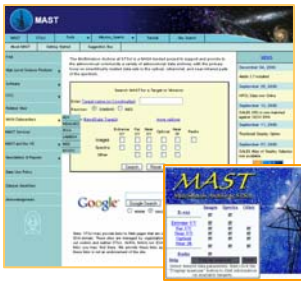
NED provides seamless connectivity to globally distributed services, serving as a thematic Virtual Observatory portal.

The External Archives and Services section of NED query result pages contains simple 1-click access to distributed images, catalog data, and observation log entries.

Distributed data are dynamically cross-linked using source names and positions indexed and maintained by NED. New services are linked as they become available. Further VO connectivity is in development.

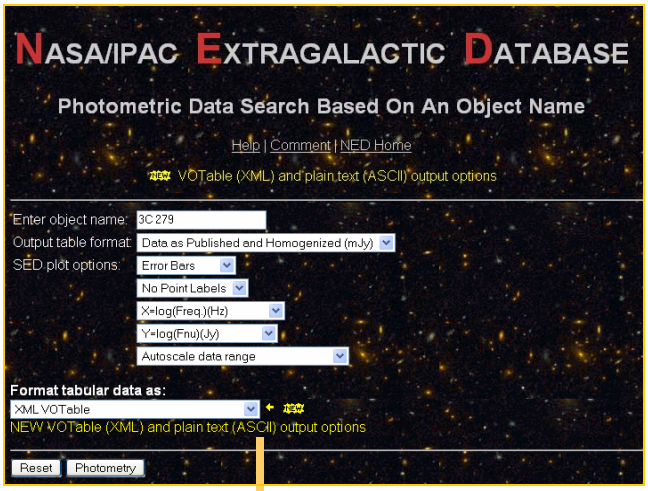
Distributed services are also highly connected to NED.

Observatory control systems and various Internet sites query NED for a variety of services, including accessing positions, redshifts and basic data on galaxies, resolving names, receiving images, etc.



New!
NED VO Capabilities & Tabular Output

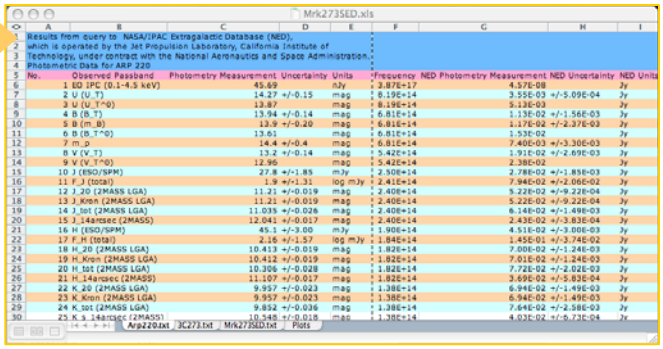
Spectral Energy Distribution Data Tables



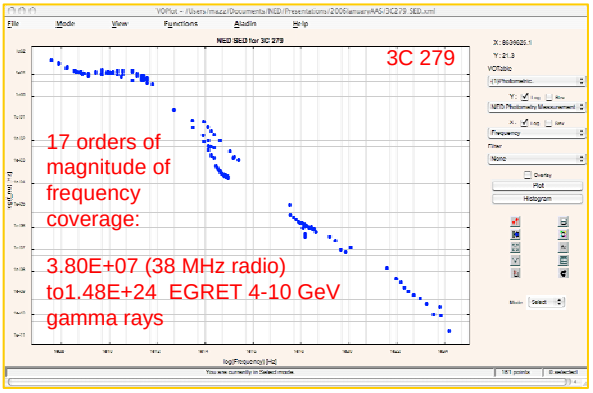
VOTable and simple ASCII output options

HTML Preformatted text (faster to display)
HTML table
Text (ASCII) table - Bar Separated Values of Main Source Table
Text (ASCII) table - Tab Separated Values of Main Source Table
XML VOTable

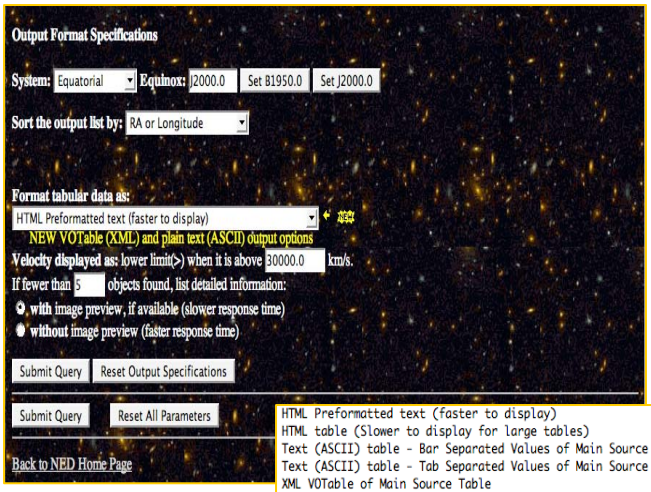
Plain ASCII ➔ Easy import into Excel, etc.



VOTable ➔ Interactive visualization with VOPlot, Specview, etc.

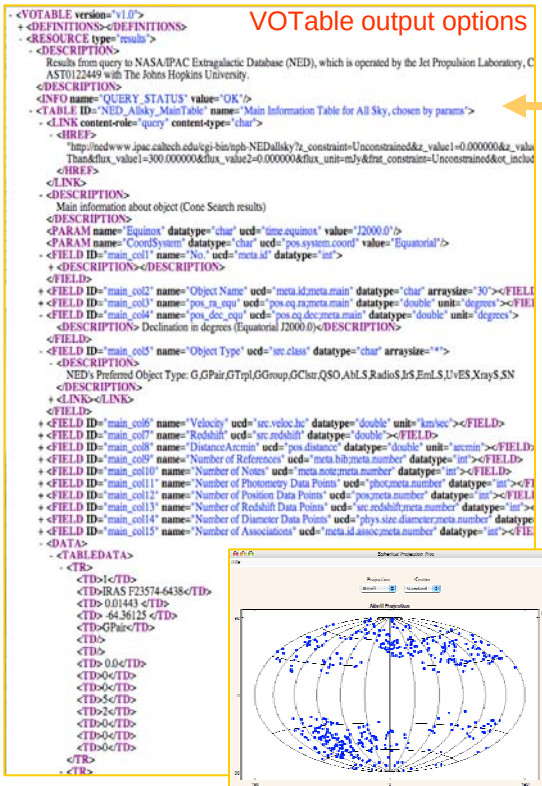


Plot the spatial distribution of an Allsky (By Parameter) query with constraints on redshift, flux density (mag), object types, survey membership and cross-IDs



HTML Preformatted text (faster to display)
HTML table (Slower to display for large tables)
Text (ASCII) table - Bar Separated Values of Main Source Table
Text (ASCII) table - Tab Separated Values of Main Source Table
XML VOTable of Main Source Table
XML VOTable of Source Names(Cross-IDs)
XML VOTable of Position Data
XML VOTable of Basic Data
XML VOTable of External Archives and Services
XML VOTable of all tables for the object(s)

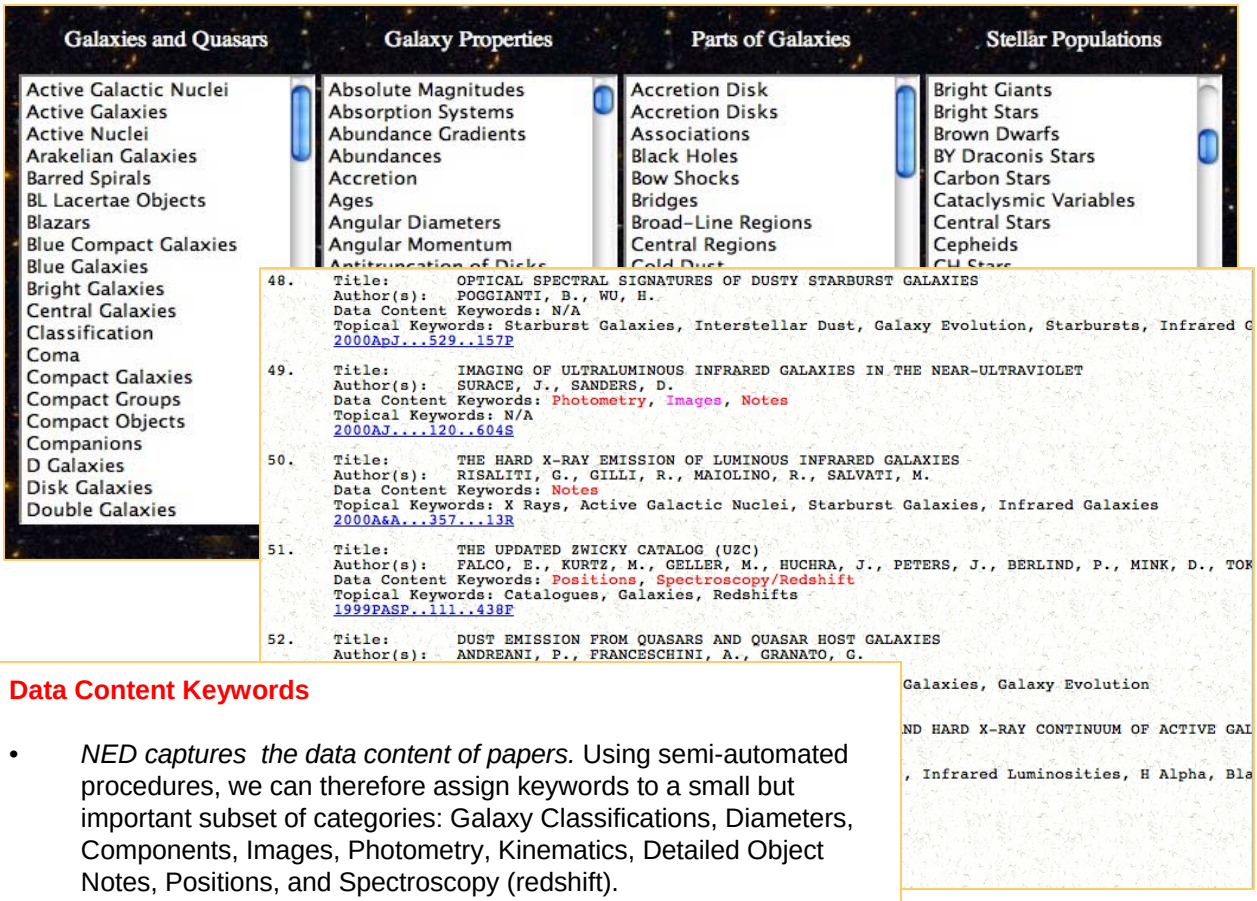
VOTable output options



Aitoff plot with VOTable

New!
Literature Data Content & Topical Keywords

- NED users (2003 user survey, Advisory Committee, others) asked for a way to filter the growing literature based on data content and specific extragalactic topics
- The technical literature on text search is filled with debates on the merits of free-text search versus use of a controlled vocabulary (e.g., http://en.wikipedia.org/wiki/Controlled_vocabulary)
- The latter often results in more precise results due to normalization of terminology (synonyms, etc.)
  - Examples: “starburst” = “H II” (context: nuclear spectral type); “ultraviolet” = “UV”
- NED is assigning and displaying two types of journal article keywords
  - Data Content Keywords (all papers)
  - Topical Keywords: currently pre-2000 only via ARIBIB (http://www.ari.uni-heidelberg.de/aribib/)
- Both keyword sets are displayed and utilized in new (optional) filters on NED literature searches based on object names and author names



Data Content Keywords

- *NED captures the data content of papers.* Using semi-automated procedures, we can therefore assign keywords to a small but important subset of categories: Galaxy Classifications, Diameters, Components, Images, Photometry, Kinematics, Detailed Object Notes, Positions, and Spectroscopy (redshift).
- Such information often cannot be inferred from titles and abstracts alone, but requires knowledge of the content of tables, figures, etc.

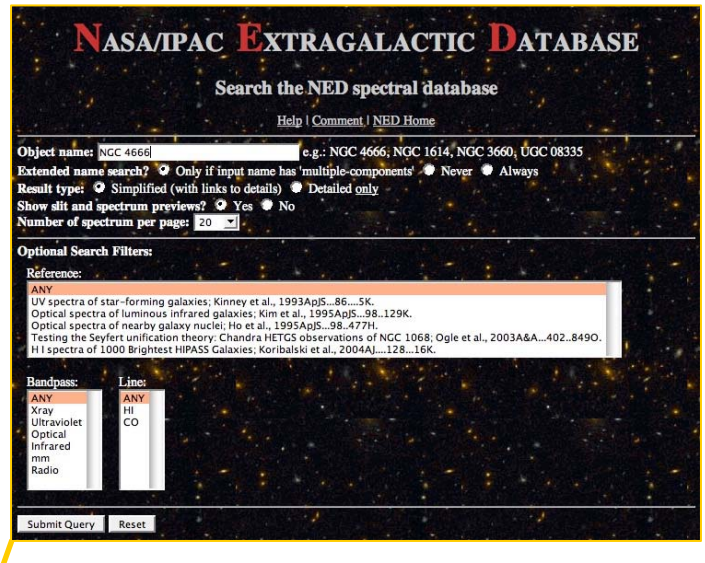
Topical Keywords

- Leverages decades of work prepared and published in the Astronomy & Astrophysics Abstracts (ARIBIB: 1964-2000)
- The ARIBIB activity (humans classifying paper content) ended in 2000
- Detailed classification of article content cannot be extracted from titles and abstracts alone, but requires analysis of the paper content

New!
NED Spectral Archive

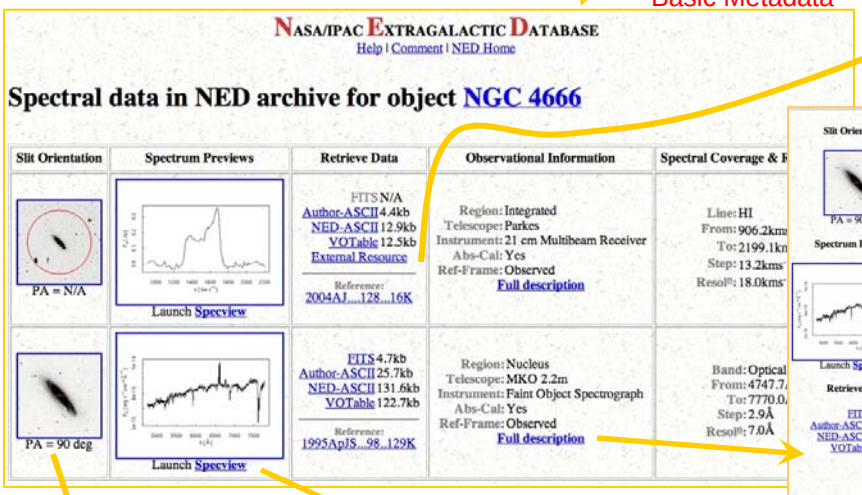
Primary design goals are to provide:

1. A repository for spectra corresponding to rendered plots in journal articles, as submitted to NED by authors; also supports other available spectral archives
2. Preview plots for each spectrum
3. Preservation of the original data format submitted by authors and archive curators
4. Value-added standardized (MKS) units and a uniform VOTable data format
5. ASCII and VOTable download options
6. A query service to enable users to locate spectra by object name, journal article (refcode), passband, spectral lines, and combinations thereof
7. Quick-look visualization and analysis, facilitating fusion and comparison of spectra
8. VO Interoperability

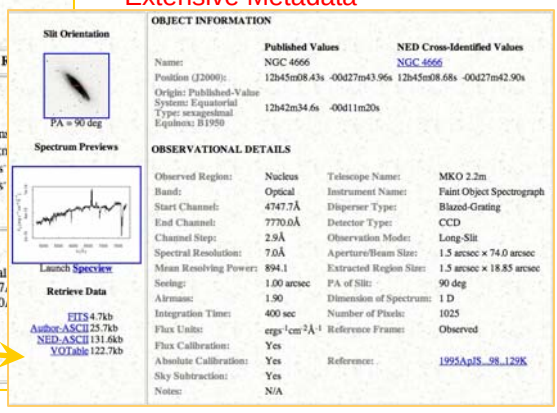


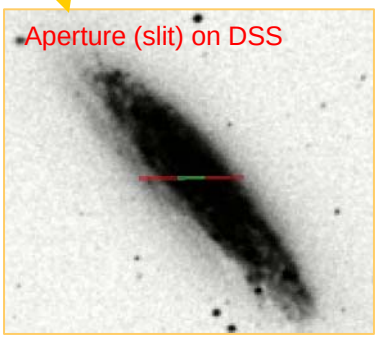
External Resource

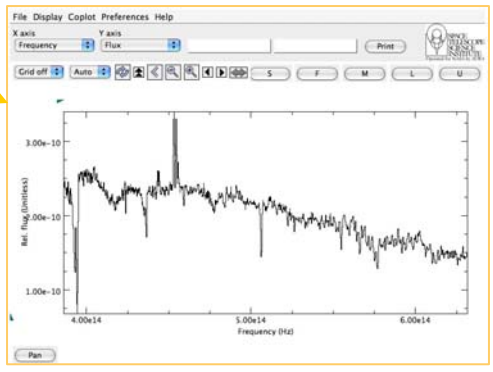
Basic Metadata



Extensive Metadata







Launch Specview (STScI)

Database Contents

As of January 2007 release:

- 14.7 million multi-wavelength source cross-identifications (3x increase since 2002)
- 9.5 million unique extragalactic objects (2.5x increase since 2002)
- 25.2 million photometric measurements spanning gamma-rays through radio wavelengths (with uncertainties) and dynamic SEDs (7x increase since 2002)
- 3.6 million detailed size measurements with uncertainties (None in 2002)
- 3.6 million object pointers to 65 thousand journal articles (2x increase since 2002)
- 1.3 million redshifts (7x increase since 2002)
- 2.3 million FITS images, maps and links with previews (18x increase since 2002)
- 65 thousand detailed notes from catalogs and other publications (40% increase since 2002)
- 42 thousand journal article abstracts (2x increase since 2002)

Updates: New Objects in NED

- 103 thousand galaxies & 13 thousand QSOs with z's from SDSS DR5
- 4.8 thousand SDSS BAL QSOs from A Catalog of Broad Absorption Line Quasars from SDSS DR3 (2006ApJS..165....1T)
- 4.8 thousand Chandra sources in the NOAO Deep Wide-Field Survey field from 2006ApJ...641..140B
- 6.4 thousand galaxies around 11 clusters from the Las Campanas/Anglo-Australian Telescope Rich Cluster Survey (2006MNRAS.366..645P)
- 0.5-8 keV photometry for 950 objects from Chandra Deep Field North (2003AJ....126..539A)
- 70 & 160um photometry for 894 objects from Spitzer FLS (2006AJ....131..250F)
- 115 thousand objects in the Spitzer FLS and 5239 objects in the ELAIS-N1 fields from Spitzer IRAC images; detailed photometry at 3.6, 4.5, 5.8, and 8.0 microns, and positions from Lacy et al. (2005ApJS..161...41L)
- This is just a small sampling
- See NED release news and history for details
  - http://nedwww.ipac.caltech.edu/help/whats_new.html
  - http://nedwww.ipac.caltech.edu/help/nedhistory.html

Other NED Features

- A key NED activity is cross-identification and association of millions of entries in multi-wavelength survey catalogs and publications using a combination of computer software that utilizes positional uncertainty information to compute probability measures, followed by close inspection to resolve complex cases that cannot be fully automated.
- Galaxy attributes and data relationships are revised and augmented constantly to keep up with new survey data and knowledge appearing in the literature.
- Updates to the public database occur approximately every three months after periods of data entry, quality assurance, and testing using an internal development and test database.

LEVEL5

A Knowledgebase for Extragalactic Astronomy and Cosmology

- Available at http://nedwww.ipac.caltech.edu/level5/
- Hyperlinked review articles (e.g., ARA&A) and documents of current and lasting interest to cosmologists and extragalactic astronomers
- Contents include a glossary of terms, essays, recent research articles, detailed monographs and extensive reviews (where copyrights allow).
- Within each article
  - Cited extragalactic objects are cross-linked to NED Basic Data frames
  - Citations are hyperlinked to ADS
  - Tabular data, images and graphs are linked to and from relevant essays and review articles
- Total number of articles to date ⟶ 630

NEW ADDITIONS

- FIRST LIGHT - Abraham Loeb (2006)
- UNDERSTANDING GALAXY FORMATION AND EVOLUTION - Vladimir Avila-Reese (2006)
- GAMMA-RAY BURSTS - P. Mészáros (2006)
- ADVANCED TOPICS IN COSMOLOGY: A PEDAGOGICAL INTRODUCTION - T. Padmanabhan (2006)
- DARK MATTER AND BACKGROUND LIGHT - J.M. Overduin & P.S. Wesson (2004)
- THE GALEX ULTRAVIOLET ATLAS OF NEARBY GALAXIES - Armando Gil de Paz et al. (2006)
- PHYSICS OF COSMIC REIONIZATION - T. Roy Choudhury and A. Ferrara (2006)
- NON-BARYONIC DARK MATTER - Paolo Gondolo (2004)
- HOT GAS IN AND AROUND ELLIPTICAL GALAXIES - William G. Mathews & Fabrizio Brighenti (2003)
- COSMOLOGY WITH THE SUNYAEV-ZEL'DOVICH EFFECT - John E. Carlstrom et al. (2002)
- THE COSMIC MICROWAVE BACKGROUND RADIATION - Eric Gawiser and Joseph Silk (2000)
- TYPE Ia SUPERNOVAE - Bruno Leibundgut (2000)
- GALAXY FORMATION - Eric Gawiser (2005)
- GALAXY COLLISIONS - DAWN OF A NEW ERA - Curtis Struck (2005)

The Level 5 Glossary and Lexicon of Astronomical Terms received the Griffith Observatory Star Award in July 2003 for excellence in promoting astronomy to the public through the World Wide Web..

This document can be downloaded from
http://nedwww.ipac.caltech.edu/help/NED2007JanHandout.pdf