From Planets to Stars to Galaxies:
Putting things in their places

By
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Smithsonian Astrophysical Observatory
It All Started With Mars

MIT Vidicon Spectrometer with camera monitoring slit in mirror

Spectrometer slit reprojected across Mercator projection of Mars surface
(\textit{Mink, MIT S.M. Thesis 1974})
It All Started With Mars

Aperture photos projected on observed planet disk and reprojected onto Mercator projection of Mars
(Mccord, Huguenin, Mink, and Pieters, Icarus 31, 1977)
Finding Stars to be Occulted
Mapping observability

Geocentric prediction of Uranus 16

Sun down, Uranus up for Uranus 16
Predicting Occultations

Palomar Sky Survey overlay for stars occulted by Uranus

Sky plane map of Uranus ring occultation of KMU102
All-Sky IR Mapping from Space

Spacelab 2 Infrared Telescope
(Space Shuttle Challenger, July 1985)
All Sky IR Mapping from Space

1985 Day 213, Orbit 4, 50,964 0.1-sec frames

Spacelab 2 Infrared Telescope
(Space Shuttle Challenger, July 1985)
Galactic Center from Spacelab 2

Fig. 5.—Contour map of the 2.4 μm emission from the Galactic plane region. The contours are spaced logarithmically in 10 steps between $0.67 \times 10^{-10}$ and $16 \times 10^{-10}$ W cm$^{-2}$ μm$^{-1}$ sr$^{-1}$.

(Kent, Mink, Fazio, Koch, Melnick, Tardiff, Maxson, ApJS 78:403-408, 1992)
Mapping Multiple Catalogs
All-Sky Maps meet Catalogs

IRAS Point Source Catalog (IRAS.ps)
Onto the World Wide Web

The Smithsonian Astrophysical Observatory (SAO) is part of the Harvard–Smithsonian Center for Astrophysics in Cambridge, Massachusetts. The SAO/TDC creates and maintains software to process and archive data from optical and infrared telescopes in Harvard, Massachusetts and on Mt. Hopkins in Arizona.

The SAO TDC distributes several pieces of software:
- RVSAO: an IRAF package for finding radial velocities from spectra
- RGSC: a program for searching the Hubble Space Telescope Guide Star Catalog.
- SKYMAP: a program for mapping star catalogs onto the sky

The staff of the TDC are:
- Doug Mink, software developer
- Mike Kurtz, software philosopher

Astronomical Software Elsewhere

Other Astronomical Resources

Navigating the Internet

A useful introduction to the World–Wide Web (WWW) is available from NASA/Goddard.

Last updated 12 November 1993
Occultations by Solar System Objects

For tables describing the occultations and observing conditions, click on the appropriate planet names. To view abstracts of the papers, click anywhere else in the titles of the papers.

Pluto
- Occultations by Pluto and Charon: 1990–1999

Neptune

Uranus

Chiron

Saturn
- Occultations of IRAS Point Sources and SAO Stars by Planets: 1988–1999

Jupiter
- Occultations of IRAS Point Sources and SAO Stars by Planets: 1988–1999

Mars
- Occultations of IRAS Point Sources and SAO Stars by Planets: 1988–1999

Mercury

Last updated 31 March 1994 by Doug Mink
Fitting a WCS using WCSTools

USNO-B1.0 Catalog plotted over image using telescope pointing

FITS header with limited WCS keywords from telescope
Fitting a WCS using WCSTools

USNO-B1.0 Catalog plotted over image after imwcs WCS fit

FITS header with WCS keywords after WCS fit using imwcs
# More Catalogs

These catalogs are available and supported by SAO/TDC search and mapping software.

<table>
<thead>
<tr>
<th>Catalog or Format</th>
<th>No. Stars</th>
<th>Bytes</th>
<th>Region Search</th>
<th>Image Search</th>
<th>Mapping</th>
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<td>1,036,968,787</td>
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<td>intmc (imcat)</td>
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<td>2MASS Extended Source Catalog</td>
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<td>48,366,996</td>
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<td>SDSS Photometry Catalog</td>
<td>53 million (DR1)</td>
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<td>1,231,787,520</td>
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</table>
Testing Catalog Accuracy

216 1x1 degree fields from the 8K array on the KPNO 36-inch telescope cover half of the CfA Century survey, 50 degrees across the sky.
Testing Catalog Accuracy

The 2MASS Point Source Catalog plotted over one of the 1728 test images
Testing Catalog Accuracy

Differences between the 2MASS Point Source Catalog and a WCS fit to all of the images
Testing Catalog Accuracy

Differences between the Sloan Digital Sky Survey Catalog and a WCS fit to all of the images
Testing Catalog Accuracy

Differences between the GSC 2.3 Catalog and a WCS fit to most of the images
Testing Catalog Accuracy

Differences between the 3rd USNO CCD Astrometric Catalog (UCAC3) and a WCS fit to half of the images

File "ucac3fits", read 15/976 points

X Mean = 0.140 Sigma = 0.045
X Median = 0.140 Half-width = 0.040
Redshifting Into the Universe

12,553 Spectra from the Hectospec SHELS survey

Before Sky Removal

After Sky Removal