

The Astronomer's IT Toolkit

From observation to publication

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CAASTRO
The University of Sydney

October 1, 2014



THE UNIVERSITY OF
SYDNEY



- ▶ Academic level: Honours, PhD, postdoc...?
- ▶ PhD: 1st, 2nd, 3rd year?
- ▶ Operating system: Mac, Linux, Windows?
- ▶ Do you even lift program?
- ▶ Language: Python, IDL, C, Fortran...?
- ▶ Wavelength of choice: RADIO, optical, infrared...?
- ▶ Future plans: academia, industry, education...?

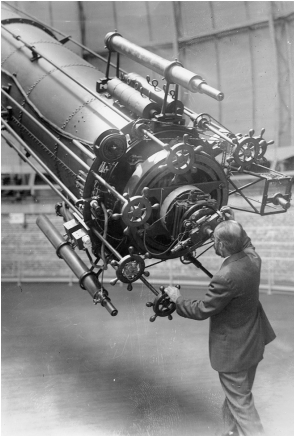


Part I

Why?



1. Technological advances¹

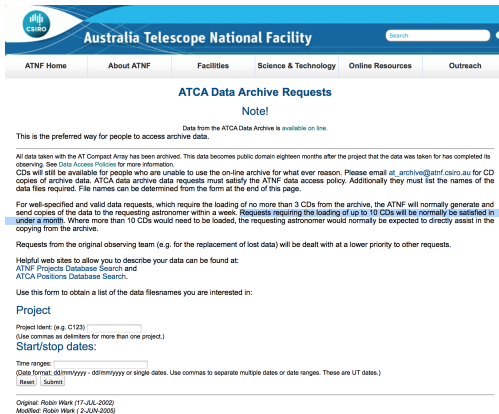


¹Thanks **IFLS** and **NOAO**



3. Big data





ATCA Data Archive Requests

Note!

Data from the ATCA Data Archive is available on line.

This is the preferred way for people to access archive data.

All data taken with the AT Compact Array has been archived. This data becomes public domain eighteen months after the project that the data was taken for has completed its observing. See [Data Access Policies](#) for more information. CDs will still be available for people who are unable to use the on-line archive for what ever reason. Please email at_archive@atnf.csiro.au for CD copies of archive data. ATCA data archive data requests must satisfy the ATNF data access policy. Additionally they must list the names of the data files required. File names can be determined from the form at the end of this page.

For well-specified and valid data requests, which require the loading of no more than 3 CDs from the archive, the ATNF will normally generate and send copies of the data to the requesting astronomer within a week. Requests requiring the loading of up to 10 CDs will be normally be satisfied in under a month. Where more than 10 CDs would need to be loaded, the requesting astronomer would normally be expected to directly assist in the copying from the archive.

Requests from the original observing team (e.g. for the replacement of lost data) will be dealt with at a lower priority to other requests.

Helpful web sites to allow you to describe your data can be found at:
[ATNF Projects Database Search](#) and
[ATCA Positions Database Search](#).

Use this form to obtain a list of the data filenames you are interested in:

Project

Project Ident: (e.g. C123)

(Use commas as delimiters for more than one project.)

Start/stop dates:

Time ranges:

(Data format: dd/mm/yyyy - dd/mm/yyyy or single dates. Use commas to separate multiple dates or date ranges. These are UT dates.)

Original: Robin Wark (17-JUL-2002)
 Modified: Robin Wark (2-JUN-2005)

²Get your CDs from **ATNF** while they're hot

CABB Scheduler

Sched Listing

File Edit Tools

1..xx

Scan Parameters

Freq1 2000MHz

Continuum (MHz)	Fixed	Chn.BW (MHz)	Vol.Res. (km/s)	Vel.Range (km/s)	#Channels
2000	<input checked="" type="radio"/>	3209	150	306987	2048

Line	Channel	Width	Vel
1 3	1419.75	16	1794.8
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			

Freq2 2000MHz

New Scan Search Cal
Delete Pick Source

Data rate = 11.43GB/h, or 4GB every 21m

Daily raw data generated by the
Square Kilometer Array:

15 million



64GB iPods



2x

daily global internet traffic



³IBM × ASTRON



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FOR ALL-SKY ASTROPHYSICS

An astronomer's IT toolkit



Part II

Choose your tool wisely



- 1 Professor Smith⁴ presents you with a problem



- 2 You solve it

⁴Visiting lecturer from phdcomics.com



Prof-lem #0

“So... err... hello, new PhD student. Welcome to astronomy. What’s your programming experience?”



- ▶ You've never programmed any code before
- ▶ Your supervisor recommends Fortran, C, Basic...
- ▶ You inherit all of your supervisor's code from the last 30 years
- ▶ You spend the first six months of your PhD deciphering these codes and learning your supervisor's language of choice

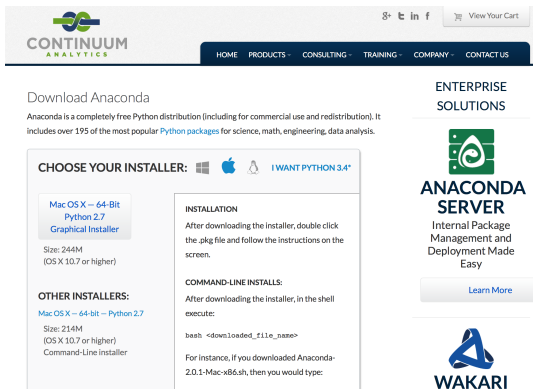


- ▶ 1) You have programming experience in [LANGUAGE] - you should use what you know (to some extent)
- ▶ 2) You haven't coded much but would like to learn
- ▶ Bias warning: I ♥ Python
- ▶ Other popular languages in astronomy include: IDL, C/C++, Fortran, R



- ▶ Free and open source
- ▶ Beginner-friendly
- ▶ Expert-friendly
- ▶ Usually readable
- ▶ Does almost everything
- ▶ Widely used in astronomy
- ▶ Widely used elsewhere
- ▶ Widespread support

⁵Found at python.org



The screenshot shows the Continuum Analytics website. At the top, there is a navigation bar with the logo and menu items: HOME, PRODUCTS, CONSULTING, TRAINING, COMPANY, CONTACT US. Below the navigation bar, the main heading is "Download Anaconda". A sub-heading states: "Anaconda is a completely free Python distribution (including for commercial use and redistribution). It includes over 195 of the most popular Python packages for science, math, engineering, data analysis." Below this, there is a section titled "CHOOSE YOUR INSTALLER:" with icons for Windows, Mac OS X, and Linux, and a link "I WANT PYTHON 3.4*". Under the Mac OS X icon, there is a button for "Mac OS X - 64-Bit Python 2.7 Graphical Installer" with details: "Size: 244M (OS X 10.7 or higher)". Below that, under "OTHER INSTALLERS:", there is a link for "Mac OS X - 64-bit - Python 2.7" with details: "Size: 214M (OS X 10.7 or higher) Command-Line installer". To the right of these options, there is a section titled "INSTALLATION" with instructions: "After downloading the installer, double click the .pkg file and follow the instructions on the screen." Below that, "COMMAND-LINE INSTALLS:" with instructions: "After downloading the installer, in the shell execute:" followed by a code block: `bash <downloaded_file_name>`. Below the code block, it says: "For instance, if you downloaded Anaconda-2.0.1-Mac-x86.sh, then you would type:". To the right of the installation instructions, there is a section titled "ENTERPRISE SOLUTIONS" with a sub-heading "ANACONDA SERVER" and a description: "Internal Package Management and Deployment Made Easy". Below this is a "Learn More" button. At the bottom right of the screenshot, there is a logo for "WAKARI".

⁶Download via **Continuum Analytics**

- ▶ **aplpy*** (Python)
 - for plotting and generating astronomical images
- ▶ **ds9** (cross-platform)
 - for visualising FITS data
- ▶ **MIRIAD** (cross-platform)
 - for reducing and processing CASS/other data sets
- ▶ **KARMA** (cross-platform)
 - visualisation package for CASS/other data sets
- ▶ **sublime*** (cross-platform)
 - powerful text editor for code (free/\$70)
- ▶ **aladin** (cross-platform)
 - multi-wavelength sky atlas
- ▶ **git** (cross-platform)
 - version-control of code (great **tutorial** online)
- ▶ **texmaker*** (cross-platform)
 - visual editor for LaTeX (papers, posters, slides)



Google™



stackoverflow

Browsing Codes

Results 1-100 of 925 (922 ASCL, 3 submitted)

[Previous](#) [1](#) [2](#) [3](#) [4](#) [5](#) [6](#) [7](#) [8](#) [9](#) [10](#) [Next](#)

Order ▲ ▼ Mode Per Page

[[ascl:1102.023](#)] [21cmFAST: A Fast, Semi-Numerical Simulation of the High-Redshift 21-cm Signal](#)

Mesinger, Andrei; Furlanetto, Steven; Cen, Renyue

21cmFAST is a powerful semi-numeric modeling tool designed to efficiently simulate the cosmological 21-cm signal. The code generates 3D realizations of evolved density, ionization, peculiar velocity, and spin temperature fields, which it then combines to compute the 21-cm brightness temperature. Although the physical processes are treated with approximate methods, the results were compared to a state-of-the-art large-scale hydrodynamic simulation, and the findings indicate good agreement on scales pertinent to the upcoming observations ($> \sim 1$ Mpc). The power spectra from 21cmFAST agree with those generated from the numerical simulation to within 10s of percent, down to the Nyquist frequency. Results were shown from a 1 Gpc simulation which tracks the cosmic 21-cm signal down from $z=250$, highlighting the various interesting epochs. Depending on the desired resolution, 21cmFAST can compute a redshift realization on a single processor in just a few minutes. The code is fast, efficient, customizable and publicly available, making it a useful tool for 21-cm parameter studies.

[[ascl:1201.005](#)] [2LPTIC: 2nd-order Lagrangian Perturbation Theory Initial Conditions](#)

Crocce, M.; Pueblas, S.; Scoccimarro, R.

Setting initial conditions in numerical simulations using the standard procedure based on the Zel'dovich approximation (ZA) generates incorrect second and higher-order growth and therefore excites long-lived transients in the evolution of the statistical properties of density and velocity fields. Using more accurate initial conditions based on second-order Lagrangian perturbation theory (2LPT) reduces transients significantly; initial conditions based on 2LPT are thus much more appropriate for numerical simulations devoted to precision cosmology. The 2LPTIC code provides initial conditions for running cosmological simulations based on second-order Lagrangian Perturbation Theory (2LPT), rather than first-order (Zel'dovich approximation).



Prof-lem #1

“Remember eight months ago when you started, when you were reducing your 70 GB of ATCA data - which calibration task did you use on the secondary calibrator 1613–586 at 9 GHz?”



- ▶ You have a momentary panic - it's hard to remember what you did last week!
- ▶ Someone tells you it should be in the header of your reduced data
- ▶ You check there, eventually figuring out it was MFCAL:

```

history
UVFLAG: channel Originally Currently
UVFLAG: Good: 116124. 0. Changed to bad: 116124.
UVFLAG: Bad: 29076. 145200.
MFCAL: MFCAL: $Revision: 1.16 $, $Date: 2014/04/29 00:50:17 $
MFCAL: Executed on: 2014-08-17T16:28:07.0
MFCAL: Command line inputs follow:
MFCAL: vis=1613-586.9000
MFCAL: interval1
MFCAL: options=mpdassel
GPBOOT: Miriad gpboot: Revision 1.8, 2013/08/30 01:49:21 UTC
GPBOOT: Executed on: 2014-08-17T16:28:35.0
GPBOOT: Command line inputs follow:
GPBOOT: vis=1613-586.9000
  
```




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FOR ALL-SKY ASTROPHYSICS

Meet Evernote⁸

EVERNOTE Download MENU

Destinations

Call editor

Story ideas

Write article

Photographs

Your life's work

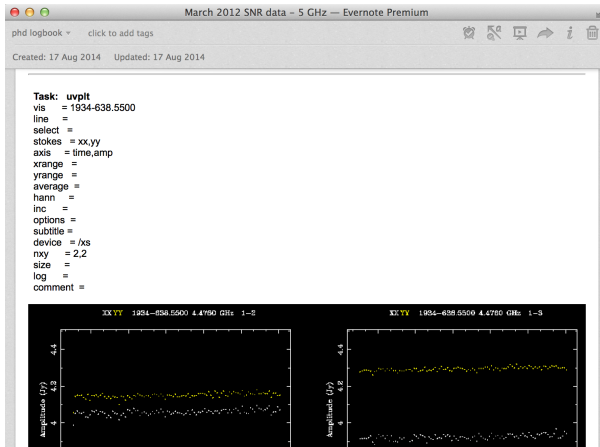
For everything you'll do, Evernote is the workspace to get it done.

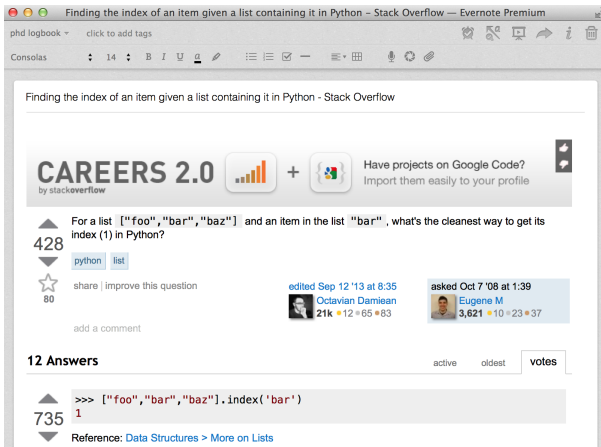
SIGN UP NOW
or Sign in

⁸Download at evernote.com




- ▶ Accessible everywhere
- ▶ Local storage
- ▶ Cloud storage = back-up
- ▶ Multi-platform (Linux)
- ▶ Searchable + OCR
- ▶ Integrated workflow
- ▶ Easy to share
- ▶ Web clipper
- ▶ Geo-tracking
- ▶ FREE! For most uses.







Finding the index of an item given a list containing it in Python - Stack Overflow

phd logbook click to add tags


Consolas 14 B I U 


Finding the index of an item given a list containing it in Python - Stack Overflow


CAREERS 2.0  +  Have projects on Google Code? Import them easily to your profile

428 For a list ["foo", "bar", "baz"] and an item in the list "bar", what's the cleanest way to get its index (1) in Python?

[python](#) [list](#)

 80 share | improve this question

edited Sep 12 '13 at 8:35  Octavian Damian 21k • 12 • 65 • 83

asked Oct 7 '06 at 1:39  Eugene M 3,621 • 10 • 23 • 37

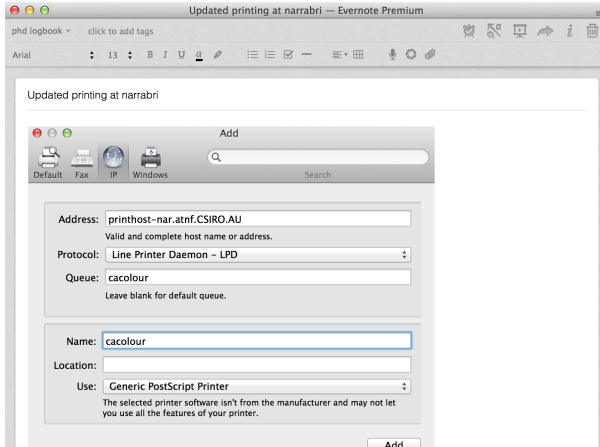
add a comment

12 Answers active oldest votes

735

```
>>> ["foo", "bar", "baz"].index('bar')
1
```

Reference: [Data Structures](#) > [More on Lists](#)





Eg. #4: Attached files/scripts

Greatest image in the world — Evernote Premium

phd logbook - click to add tags

Arial 13 B I U

Path: /Users/vmoss/Desktop/GASS/ecosystemimage/cuttlefish

Supershell layer, LAB/HVC layer and contour/points layer (depending on comments):

- `comp_pos2radec_comb.py` 5.8 KB

Milky Way background layer:

- `rgbplot.py` 1.3 KB

Cuttlefish layer:

- `rgbplot2.py` 1.1 KB

Final product:



Eg. #5: Record of your steps

LHVC candidates — Evernote Premium

phd logbook ▾ click to add tags

Arial 13 B I U

G213_gass.fits	100%	37MB	395.9KB/s	01:36
G296_gass.fits	100%	9529KB	433.1KB/s	00:22
G338_gass.fits	100%	2528KB	421.4KB/s	00:06
G339_gass.fits	100%	37MB	513.6KB/s	01:14

ok good.

Check the files
Are they the correct regions?

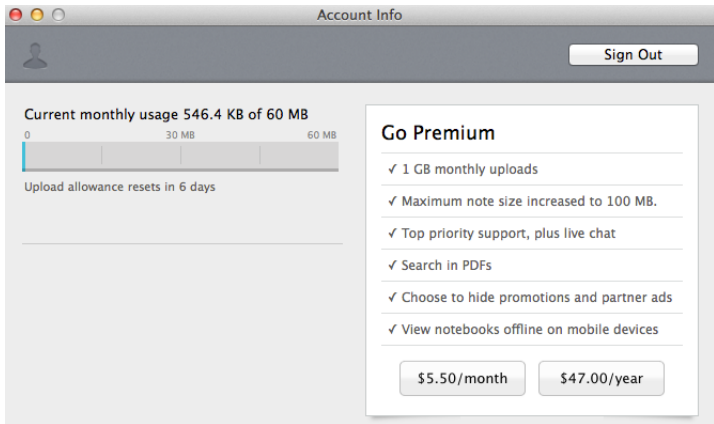
G213

GAVC_G213-0-24.0-076

Dec (2000)

RA (2000)

(as in catalogue)



Account Info

Sign Out

Current monthly usage 546.4 KB of 60 MB

0 30 MB 60 MB

Upload allowance resets in 6 days

Go Premium

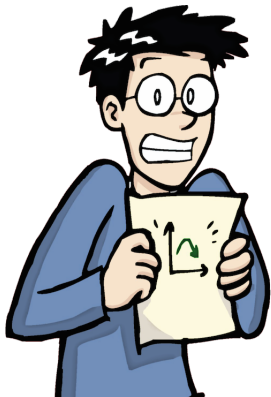
- ✓ 1 GB monthly uploads
- ✓ Maximum note size increased to 100 MB.
- ✓ Top priority support, plus live chat
- ✓ Search in PDFs
- ✓ Choose to hide promotions and partner ads
- ✓ View notebooks offline on mobile devices

\$5.50/month \$47.00/year



Prof-lem #2

“Here is a list of 57 papers that I think it is pivotal for you to read. Please read them. And keep track of the papers and their bibliographical references, you will need them for your paper. And follow newly released papers as well, yeah? Good.”



- ▶ You're no fool! You know NASA ADS is the way to go
- ▶ You type in the details of each paper, and download their PDF versions
- ▶ You print out each paper and make detailed notes
- ▶ You slowly grow your very own (sorted!) paper forest:



⁹ADS accessible via [SAO/NASA](#)



- ▶ You download the Papers software by Mekentosj
- ▶ You use inbuilt search tools to automatically add papers and PDFs to your library
- ▶ Over time, you grow your own digital paper forest
- ▶ This library is exportable, compatible with BibTex, searchable and sharable
- ▶ Free/Linux alternatives:
Mendeley or **BibDesk**

¹⁰Papers is downloadable **online**



The screenshot shows a web browser window with a library interface. On the left, there is a sidebar with navigation options: ALL PAPERS, READING LIST, RECENT (Last Import, Last Read), MY COLLECTIONS, SHARED COLLECTIONS, Archive, and Trash. The main area displays a list of papers with columns for Title, Author, Source, Year, Imported, and Cited. The selected paper is 'High-velocity Clouds... V A Moss et al. The Astrophysical Journal Letters 2013'. Below the list, the full text of the paper is displayed, including the title, authors (V. A. Moss, N. M. McClure-Griffiths, T. Murphy, D. J. Pringle, J. K. Kommerfeldt, and J. R. Clark), affiliations, abstract, and keywords.

HIGH-VELOCITY CLOUDS IN THE GALACTIC ALL SKY SURVEY. I. CATALOG

V. A. MOSS^{1,2}, N. M. MCCLURE-GRIFFITHS³, T. MURPHY^{3,4},
D. J. PRINGLE⁵, J. K. KOMMERFELDT⁶, AND J. R. CLARK⁶

¹Physics Institute for Astronomy, School of Physics, Adelaide University of South Australia, M50, Adelaide, 5048, Australia; vcoss@physics.usg.edu.au
²CSIRO Astronomy and Space Science, ATNF, PO Box 76, Epping, NSW 1510, Australia
³School of Information Technology, University of Sydney, Sydney, NSW 2006, Australia
⁴Department of Physics, West Virginia University, PO Box 6013, Morgantown, WV 26506, USA
⁵Received 2013 April 20; accepted 2013 August 26; published 2013 October 23

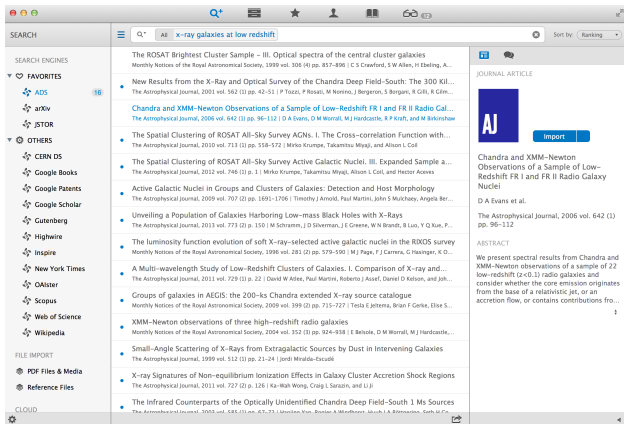
ABSTRACT

We present a catalog of high-velocity clouds (HVCs) from the Galactic All Sky Survey (GASS) of southern sky neutral hydrogen, which has 57 mK sensitivity and 1 km s⁻¹ velocity resolution and was obtained with the Parkes Telescope. Our catalog has been derived from the stray-radiation-corrected second release of GASS. We describe the data and our method of identifying HVCs and analyze the overall properties of the GASS population. We catalog a total of 1693 HVCs at declinations <0°, including 1111 positive velocity HVCs and 582 negative velocity HVCs. Our catalog also includes 295 anomalous velocity clouds (AVCs). The cloud line-widths of our HVC population have a median FWHM of ~19 km s⁻¹, which is lower than that found in previous surveys. The completeness of our catalog is above 95% based on comparison with the HIPASS catalog of HVCs upon which we improve by an order of magnitude in spectral resolution. We find 756 new HVCs and AVCs with no HIPASS counterpart. The GASS catalog will shed unprecedented light on the distribution and kinematic structure of southern sky HVCs, as well as delve further into the cloud populations that make up the anomalous velocity gas of the Milky Way.

Key words: catalog – Galaxy: halo – ISM: clouds – radio lines: general – surveys

Online-only material: color figures, machine-readable tables

¹¹Papers is downloadable online



SEARCH Q* All x-ray galaxies at low redshift

SEARCH ENGINES

- FAVORITES
 - ADS
 - arXiv
 - JSTOR
- OTHERS
 - CERN DS
 - Google Books
 - Google Patents
 - Google Scholar
 - Gutenberg
 - Highwire
 - Inspire
 - New York Times
 - OAlister
 - Scopus
 - Web of Science
 - Wikipedia

FILE IMPORT

- PDF Files & Media
- Reference Files

CLOUD

Sort by: Ranking

JOURNAL ARTICLE

AJ Import

Chandra and XMM-Newton Observations of a Sample of Low-Redshift FR I and FR II Radio Galaxy Nuclei

D A Evans et al.

The Astrophysical Journal, 2006 vol. 642 (1) pp. 96-112

ABSTRACT

We present spectral results from Chandra and XMM-Newton observations of a sample of 22 low-redshift ($z < 0.1$) radio galaxies and consider whether the core emission originates from the base of a relativistic jet, or an accretion flow, or contains contributions from...

• The ROSAT Brightest Cluster Sample - III. Optical spectra of the central cluster galaxies
Monthly Notices of the Royal Astronomical Society, 1999 vol. 306 (4) pp. 857-896 | C S Crawford, S W Allen, H Ebeling, A...

• New Results from the X-Ray and Optical Survey of the Chandra Deep Field-South: The 300 Kil...
The Astrophysical Journal, 2001 vol. 562 (1) pp. 42-51 | P Tozzi, P Rosati, M Norino, J Bergeron, S Borgani, R Gibi, R Giem...

• Chandra and XMM-Newton Observations of a Sample of Low-Redshift FR I and FR II Radio Gal...
The Astrophysical Journal, 2006 vol. 642 (1) pp. 96-112 | D A Evans, D M Worrall, M J Hardcastle, R P Kraft, and M Birkirkshaw

• The Spatial Clustering of ROSAT All-Sky Survey AGNs. I. The Cross-correlation Function with...
The Astrophysical Journal, 2010 vol. 713 (2) pp. 518-572 | Mirko Krumpal, Takamitsu Miyaji, and Alison L. Coil

• The Spatial Clustering of ROSAT All-Sky Survey Active Galactic Nuclei. III. Expanded Sample a...
The Astrophysical Journal, 2012 vol. 748 (1) p. 1 | Mirko Krumpal, Takamitsu Miyaji, Alison L Coil, and Hector Aceves

• Active Galactic Nuclei in Groups and Clusters of Galaxies: Detection and Host Morphology
The Astrophysical Journal, 2009 vol. 707 (2) pp. 1691-1766 | Timothy J Arnold, Paul Martini, John S Mulchaey, Angela Ber...

• Unveiling a Population of Galaxies Harboring Low-mass Black Holes with X-Rays
The Astrophysical Journal, 2013 vol. 773 (2) p. 150 | M Schramm, J D Silverman, J E Greene, W H Brandt, B Luo, Y Q Xue, P...

• The luminosity function evolution of soft X-ray-selected active galactic nuclei in the RXOS survey
Monthly Notices of the Royal Astronomical Society, 1998 vol. 281 (2) pp. 579-590 | M J Page, F J Carrera, G Hainger, K O...

• A Multi-wavelength Study of Low-Redshift Clusters of Galaxies. I. Comparison of X-ray and ...
The Astrophysical Journal, 2011 vol. 729 (1) p. 22 | David W Allen, Paul Martini, Roberto J Assef, Daniel D Kelson, and Joh...

• Groups of galaxies in AEGIS: the 200-ks Chandra extended X-ray source catalogue
Monthly Notices of the Royal Astronomical Society, 2009 vol. 399 (2) pp. 715-727 | Tesla E jettema, Brian F Gerke, Elke S...

• XMM-Newton observations of three high-redshift radio galaxies
Monthly Notices of the Royal Astronomical Society, 2004 vol. 352 (1) pp. 924-938 | E Beisole, D M Worrall, M J Hardcastle...

• Small-Angle Scattering of X-Rays from Extragalactic Sources by Dust In Intervening Galaxies
The Astrophysical Journal, 1999 vol. 512 (1) pp. 21-24 | Jordi Miralda-Escudé

• X-ray Signatures of Non-equilibrium Ionization Effects in Galaxy Cluster Accretion Shock Regions
The Astrophysical Journal, 2011 vol. 727 (2) p. 126 | Ka-Wah Wong, Craig L Sarazin, and Li J

• The Infrared Counterparts of the Optically Unidentified Chandra Deep Field-South 1 Ms Sources
The Astrophysical Journal, 2003 vol. 585 (1) pp. 67-73 | Muelken Van, Douglas A Moulden, Akshay I A Bhatnagar, Seth M Co...

¹²Papers is downloadable online



The screenshot shows the arXiv interface for a paper titled "The Australian Square Kilometre Array Pathfinder: System Architecture and Specifications of the Boolardy Engineering Test Array [IMA]". The paper is posted on September 6, 2014, by arXiv. The URL is <http://arxiv.org/abs/1409.1225>. The abstract describes the system architecture of a newly constructed radio telescope - the Boolardy Engineering Test Array, which is a prototype of the Australian Square Kilometre Array Pathfinder telescope. It features array feed technology to enable beam multiple simultaneous beams per antenna, providing antennas with unprecedented survey speed. The test array described here is a 6-antenna interferometric, fixed with prototype signal processing hardware capable of forming at least 8 dual-polarization beams simultaneously allowing several square degrees to be imaged in a single pointed observation. The main purpose of the test array is to develop beamforming and water-fall calibration methods for use with the full telescope, but it will also be capable of limited early science demonstrations.

The paper includes two figures: a grayscale image of the Boolardy Engineering Test Array (BETA) showing the antenna layout and a plot of the system architecture showing the relationship between the antenna array and the system architecture.

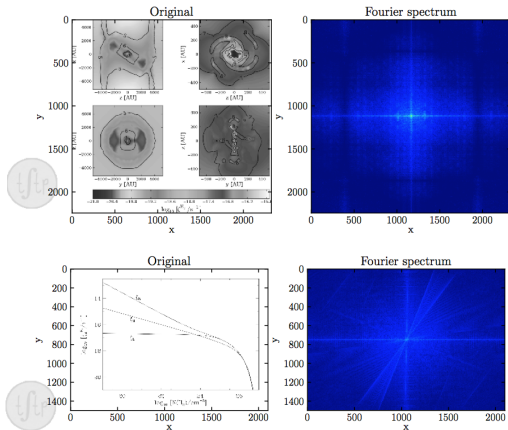
Updates: 27 Jul 2014
As of now, arXiv supports author choice of figures to specify which figures you want to appear alongside your paper; please leave a comment on your paper as follows:
submitter@arxiv.org

Note: do "not" include the path to the figure (just the figure name) - the arXiv code will find linked figures automatically. See the FAQ for more details on this new feature!

Categories:
Cosmology and Extragalactic Astrophysics
Classical and Planetary Astrophysics
Galaxies and Galaxies
High Energy Astrophysical Phenomena
Instrumentation and Methods for Astrophysics
Solar and Stellar Astrophysics

Read this paper on arXiv...

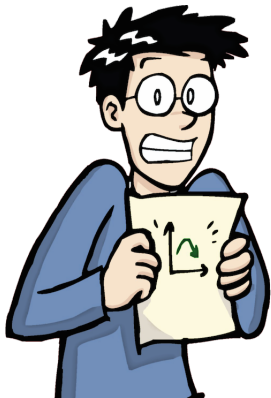
A. Wilson, J. Burton, L. Harvey-Smith, et al.
RS, 5 Sep 14
1409





Prof-lem #3

“The updated WISE catalogue of infrared sources, ALLWISE, is out. It’s about 1 TB, with over 747 million sources. Could you crossmatch it with the 370,000 sources in the 3XMM X-ray catalogue?”



- ▶ You go to the website:



ALLWISE Source Catalog Download

The ALLWISE Source Catalog is available for bulk download in compressed (gzip or bzip2) ASCII form. Catalog records are listed in a single file for each filter.

Users should be aware that the Catalog files are extremely large. Due to its size the complete Catalog has been split into 40 parts, each available in 10 GB or 5 GB high-compression parts and 6.4 GB or 3.2 GB each. High-compression parts are 6.7 GB each. You will need approximately 40 GB of disk space to download all 40 gzip-compressed Catalog parts, or 388 GB of disk space to download all 40 high-compression Catalog parts, or an additional 115 GB to decompress the parts. Compressing the parts results in a Catalog with 70 GB of disk space. See the [ALLWISE Source Catalog](http://www.ipac.caltech.edu/2MASS/allwise/allwise.html) for more information.

Each Catalog part contains records corresponding to a specified declination range. If a user desires only the sources within a specified declination range, that user may choose to download only those Catalog parts corresponding to that range. The declination range for each of the Catalog parts is indicated in the table below.

The Catalog is downloadable online through IRSA's General Catalog Search service (GCS), accessible from the main IRSA site at www.irsaf.edu.

- ▶ Over several days you download all the files:



- ▶ You script a crossmatch of ALLWISE vs. XMM; (many weeks later you have a list

¹⁵ ALLWISE accessible via **IRSA**



- ▶ You decide to use X-Match, an online crossmatch tool
- ▶ You put in *ALLWISE* and *IX/44/xmm3r4s*:



- ▶ You wait a few minutes:



- ▶ ... and you're done!

¹⁶X-Match accessible via [CDS](#)



Choose tables to cross-match

AllWISE IX/44/xmm3r4s

VizieR SIMBAD My store VizieR SIMBAD My store

AllWISE Data Release (Cutri+
2013)
747,634,026 rows

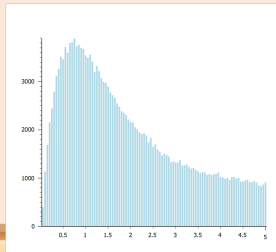


XMM-Newton Serendipitous
Source Catalogue 3XMM-DR4
(XMM-SSC, 2013)
372,728 rows



Show options

Begin the X-Match



Visualize and manage your cross-match jobs

List of X-match jobs

Table 1	Table 2	Options	Begin	Status
AllWISE	IX/44/xmm3r4s	fixed radius	16/09/2014 at 16:20	completed

Get result

Job executed in 2min7s
34s to correlate
1min33s to generate file
Result: 193,042 rows (58MB)

job(s):

© UDS/CNRS



Choose tables to cross-match

AIWISE IX/44/xmm3r4s

VizierR SIMBAD My store VizierR SIMBAD My store

[AIWISE Data Release \(Cutri+ 2013\)](#)
747,634,026 rows

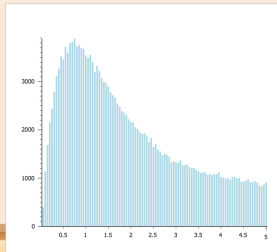


[XMM-Newton Serendipitous Source Catalogue 3XMM-DR4 \(XMM-SSC, 2013\)](#)
372,728 rows



Show options

Begin the X-Match



Visualize and manage your cross-match jobs

List of X-match jobs

Table 1	Table 2	Options	Begin	Status
AIWISE	IX/44/xmm3r4s	fixed radius	16/09/2014 at 16:20	completed

Get result

Job executed in 2m
34s to correlate
1min33s to generate
Result: 193,042 row

Download as CSV

Download as ASCII

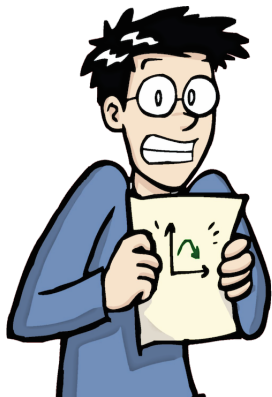
Download as VOTable

© UDS/CNRS



Prof-lem #4

*“Great work! Of that list of X-ray/WISE sources, I’d like to know which ones have WISE colours of $(S_{3.4\mu m} - S_{4.6\mu m}) > 1$ **and** also have an X-ray flux $> 10^{-12} \text{ mW m}^{-2}$, those could be most interesting.”*



- ▶ You write a Python script to read the crossmatch file, column by column
- ▶ For each line, you check if:

```
>>> col[8] - col[9] > 1  
>> col[7] - col[8] > 1  
>> col[37] > 10-12
```
- ▶ You write those lines to a new file, *sources.txt*
- ▶ You get a list of 317 sources meeting the criteria

```
xray_read.py
1 from astropy.io import ascii
2 import os
3 import sys
4 from math import *
5 from numpy import *
6 from pylab import *
7
8 # Out file
9 out = open('sources.txt','w')
10
11 # Read file
12 for line in open('XMM_ALLWISE.csv','rU'):
13     col = line.split(',')
14
15     if line.startswith('ang'):
16         continue
17
18 # Account for no flux
19 if len(col[7]) > 1 and len(col[8]) > 1:
20
21     w12 = float(col[7]) - float(col[8])
22     xflux = float(col[37])
23
24 # Criteria
25 if w12 > 1 and xflux > 1e-12:
26     out.write(line)
27     out.flush()
28
```

```
ForTalk -- bash -- 76x37
vmossl:ForTalk vmos$ ipython --pylab
Python 2.7.7 |Anaconda 2.0.1 (x86_64)| (default, Jun 2 2014, 12:48:16)
Type "copyright", "credits" or "license" for more information.

IPython 2.1.0 -- An enhanced Interactive Python.
Anaconda is brought to you by Continuum Analytics.
Please check out: http://continuum.io/thanks and https://binstar.org
?          -> Introduction and overview of IPython's features.
%quickref  -> Quick reference.
help       -> Python's own help system.
object?    -> Details about 'object', use 'object??' for extra details.
Using matplotlib backend: MacOSX

In [1]: import xray_read

In [2]:
Do you really want to exit ([y]/n)?
vmossl:ForTalk vmos$ wc -l sources.txt
    317 sources.txt
vmossl:ForTalk vmos$
```



- ▶ You use `astropy.io.ascii` to read the file into Python
- ▶ You define a mask based on the Professor's criteria
- ▶ You then use that mask to create a subset of the data
- ▶ This subset can then be manipulated within Python for calculations, plotting, etc

¹⁷`astropy.io.ascii` is part of the **astropy** package

```
xray_process.py x
1 from astropy.io import ascii
2 import os
3 import sys
4 from math import *
5 from numpy import *
6 from pylab import *
7
8 # Get matches
9 data = ascii.read('XMM_ALLWISE.csv', guess=False, delimiter=',')
10 print data.keys()
11 print
12 print 'Number of WISE sources with X-rays:', len(data)
13
14 # Selection criteria
15 w12 = data['W1mag'] - data['W2mag']
16 xflux = data['Flux8']
17 mask = (w12 > 1) & (xflux > 1e-12)
18 sources = data[mask]
19 print 'Number of sources meeting criteria:', len(sources)
20 print
21 print
```

```
ForTalk — python — 72x33
vms$ ipython --pylab
Python 2.7.7 [Anaconda 2.0.1 (x86_64)] (default, Jun 2 2014, 12:48:16)
Type "copyright", "credits" or "license" for more information.

IPython 2.1.0 -- An enhanced Interactive Python.
Anaconda is brought to you by Continuum Analytics.
Please check out: http://continuum.io/thanks and https://binstar.org
?          -> Introduction and overview of IPython's features.
%quickref -> Quick reference.
help      -> Python's own help system.
object?   -> Details about 'object', use 'object??' for extra details.
Using matplotlib backend: MacOSX

In [1]: import xray_process
['angDist', 'AllWISE', 'RAJ2000_', 'DEJ2000_', 'eeMaj', 'eeMin', 'eePA',
 'W1mag', 'W2mag', 'W3mag', 'W4mag', 'Jmag', 'Hmag', 'Kmag', 'e_W1mag',
 'e_W2mag', 'e_W3mag', 'e_W4mag', 'e_Jmag', 'e_Hmag', 'e_Kmag', 'ID', 'cc
f', 'ext', 'var', 'qph', 'pmRA', 'e_pmRA', 'pmDE', 'e_pmDE', 'd2M', '_RAJ
2000', '_DEJ2000', '3XMM', 'RAJ2000', 'DEJ2000', 'srcML', 'Flux8', 'e_Fl
ux8', 'HR1', 'HR2', 'HR3', 'HR4', 'ext', 'V', 'S', 'Nd', 'xcatDB', 'LEDA
5']

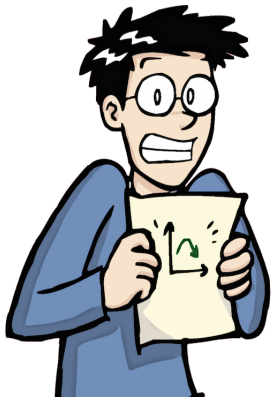
Number of WISE sources with X-rays: 193042
Number of sources meeting criteria: 317
```

¹⁸ astropy.io.ascii is part of the **astropy** package



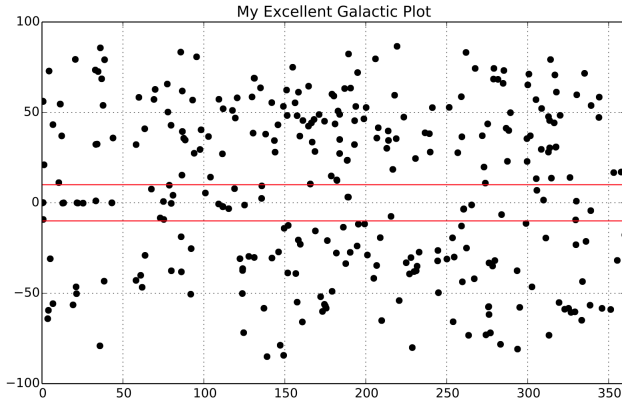
Prof-lem #5

“There are 317 sources, huh? Where are these sources distributed on the sky? I’d like to see if any of them correlate with the Milky Way, or if they are mostly extragalactic. Plot them in Galactic coordinates, and show where the Milky Way is located.”



- ▶ You use scripts you have (radec.py and `coords.py`) to convert each source to Galactic coordinates
- ▶ You then plot them in a Cartesian plot
- ▶ ... The Milky Way is like, $\pm 10^\circ$ right? Or something...
- ▶ You go talk to the resident Galactic expert, who tells you that "BAH! None of those are Galactic."

```
29
30 ls = []
31 bs = []
32
33 for line in open('sources.txt','rU'):
34
35     col = line.split(',')
36     ra = float(col[34])
37     dec = float(col[35])
38     print ra,dec
39     l,b = eq2gal(ra,dec)
40     l,b = l[0],b[0]
41     ls.append(l)
42     bs.append(b)
43
44 figure(figsize=(10,6))
45 plot(ls,bs,'ko')
46 plot([0,360],[10,10],'r-')
47 plot([0,360],[-10,-10],'r-')
48 xlim(0,360)
49 grid(True)
50 title('My Excellent Galactic Plot')
51 savefig('winfig.pdf')
52
```

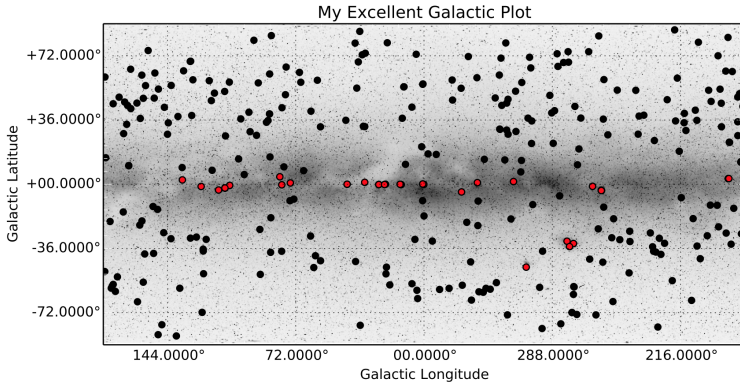




- ▶ You use **aplpy** to plot the 317 sources on an optical image of the Milky Way
- ▶ You use **astropy** to convert the coordinates to Galactic
- ▶ You then plot the points over the optical map
- ▶ You notice that a few seem to follow Galactic and Magellanic structure closely, so you highlight them



```
27
28 # Initialise figure
29 f = aply.FITSFigure('mosaic.fits',figsize=(10,6))
30 f.show_colourscale(cmap='Greys',stretch='arcsinh')
31
32 # Get coordinates
33 coords = ICRS(sources['RAJ2000'], sources['DEJ2000'], unit=(u.deg, u.deg))
34 gal = coords.galactic
35
36 # Sources of interest (MC)
37 mc_mask = (gal.l.deg > 270) & (gal.l.deg < 285) & (gal.b.deg > -40) & (gal.b.deg < -28)
38 mc_l = gal.l.deg[mc_mask]
39 mc_b = gal.b.deg[mc_mask]
40
41 # Sources of interest (MC2)
42 mc2_mask = (gal.l.deg > 300) & (gal.l.deg < 305) & (gal.b.deg > -48) & (gal.b.deg < -45)
43 mc2_l = gal.l.deg[mc2_mask]
44 mc2_b = gal.b.deg[mc2_mask]
45
46 # Sources of interest (Gal)
47 g_mask = (gal.b.deg > -5) & (gal.b.deg < 5)
48 g_l = gal.l.deg[g_mask]
49 g_b = gal.b.deg[g_mask]
50
51 # Show markers
52 f.show_markers(gal.l.deg,gal.b.deg,marker='o',c='k')
53 f.show_markers(mc_l,mc_b,marker='o',c='r')
54 f.show_markers(mc2_l,mc2_b,marker='o',c='r')
55 f.show_markers(g_l,g_b,marker='o',c='r')
56 title('My Excellent Galactic Plot')
57 grid(True)
58 savefig('celfig.pdf')
59
```





Prof-lem #6

“Let’s look closer at the sources you’ve highlighted. I’d like to see combined radio, infrared and optical images of them, to see if they have anything in common. Also, do a check of the literature to see what they’ve previously been identified as.”



- ▶ One by one, you put each source into **Simbad/NED** and find out its ID
- ▶ One by one, you download data for each source from DSS2R, WISEW1, SUMSS and NVSS
- ▶ ... this takes a while
- ▶ You open them in **KVIS** and make RGB plots for each
- ▶ ... this also takes a while



Portal **Simbad** VizieR Aladin X-Match Other- Help

coord 83.8666441 -69.2697166 (FK5, 2000, 2000), radius: 2 arcmin

other query
modes :

Identifier
query

Coordinate
query

Criteria
query

Reference
query

Basic
query

Script
submission

Output
options

Help

Object query : coord 83.8666441 -69.2697166 (FK5, 2000,
2000), radius: 2 arcmin

C.D.S. - SIMBAD4 rel 1.223 -
2014.09.30CEST15:13:12

Number of rows : 34

plot this list of objects

Equat.

Gal

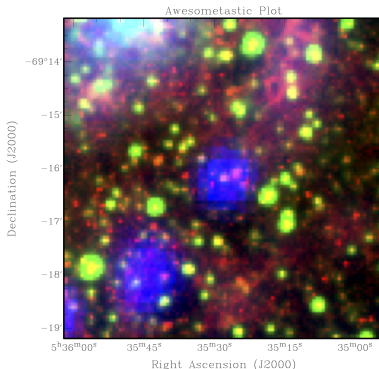
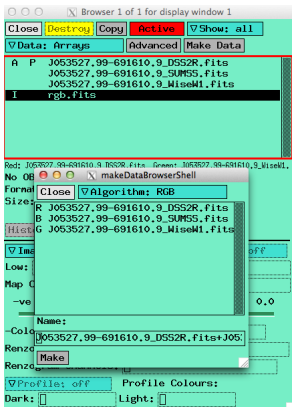
SGal

Ecl

N	Identifier	dist(asec)	Otype	ICRS (J2000) RA	ICRS (J2000) DEC	Sp type	#ref 1850 - 2014	#notes
1	NAME SNR 1987A	0.04	SNR	05 35 28.0	-69 16 11	~	14	0
2	SN 1987A	0.16	SN*	05 35 28.020	-69 16 11.07	SN.IIPec	3743	2
3	[WLJ87] Star 1	0.29	*	05 35 27.942	-69 16 11.07	B3Ia	3	0
4	CPD-69 402	0.41	*	05 35 27.92	-69 16 11.1	OB	246	1
5	KMK88 80	1.02	CI*	05 35 28	-69 16.2	~	5	0
6	MACHO 82.8888.54	1.66	V*	05 35 28.181	-69 16 12.31	~	1	0
7	[WS90] 3	1.87	*	05 35 28.267	-69 16 12.17	~	17	0
8	[NP99] BS 2	2.33	?	05 35 28.27	-69 16 12.8	~	1	0
9	[NPK87] BS	2.55	?	05 35 28.26	-69 16 13.1	~	2	0
10	[LSB2000] Star 2	2.83	*	05 35 27.591	-69 16 09.13	BOV	20	0



Prof. #6: A solution





- ▶ To check the literature, you use **astroquery** for each source in **Simbad/NED**
- ▶ You use **SkyView's** .jar script to get DSS2R, WISEW1, SUMSS and NVSS maps of all $< 2''$ matches
- ▶ You then use **aplpy** to combine these into an RGB image automatically
- ▶ (... curse you, **Montage**)



Prof. #6: A (better) solution

```

49 from astroquery.simbad import Simbad
50
51 # Get names of sources
52 a = sources[nc_mask]
53 b = sources[nc2_mask]
54 c = sources[g_mask]
55
56 # Concatenate into one table
57 la.add_row(b[1]) for i in range(0,len(b))
58 la.add_row(c[1]) for i in range(0,len(c))
59
60 # Only sources < 2" separation
61 mask = a['angDist'] < 2
62 a_mask = a[mask]
63
64 # query SIMBAD on position
65 for i in range(0,len(a)):
66
67     name = a['ALLWISE'][1]
68     ra,dec = a['RAJ2000_'][1],a['DEJ2000_'][1]
69     print name,ra,dec
70
71 # Get information from Simbad
72 c = ICRS(ra,dec, unit=(u.deg, u.deg))
73 r = 5 * u.arcminute
74 result_table = Simbad.query_region(c, radius=r)
75 result_table.pprint(show_unit=True, max_width=50, max_lines=10)
76 print result_table[0]
77 r,d = result_table['RA'][0],result_table['DEC'][0]
78 c2 = ICRS(r+'d', unit=(u.hourangle, u.deg))
79 print 'Coordinates:',c.ra.deg,c.dec.deg,c2.ra.deg,c2.dec.deg
80 d = c.separation(c2)
81 print 'Separation ["]:',d.arcsec

```

```

In [1]: import xray_process_sim
//anaconda/lib/python2.7/site-packages/numpy/ma/core.py:3847: UserWarning: War
warnings.warn("Warning: converting a masked element to nan.")
J053527.99-691610.9 83.8666441 -69.2697166
WARNING: AstropyDeprecationWarning: The format function is deprecated and may
Use to_string instead. [astroquery.utils.misc]
WARNING: AstropyDeprecationWarning: The format function is deprecated and may
Use to_string instead. [astroquery.utils.misc]
MAIN_ID ... COO_BIBCODE
-----
NAME SNR 1987A ... 2010AJ...140..584D
SN 1987A ... 2008AJ...136...18W
[WLJ87] Star 1 ... 1987IAUC.4319...0W
...
BSDL 2550 ... 1999AJ...117..238B
[SOP2012] 1 199 ... 2012MNRAS.421...78S
[SOP2012] 1 196 ... 2012MNRAS.421...78S
<Row 0 of table
values=(NAME SNR 1987A, 85 35 28.0, -69 16 11, 5, 5, --, --, 0, D, , 2010AJ..
..140..584D)
dtypes=[('MAIN_ID', '<0')', ('RA', 'S13'), ('DEC', 'S13'), ('RA_PREC', '<12')', ('
DEC_PREC', '<12'), ('COO_ERR_MAJA', '<4')', ('COO_ERR_MINA', '<4')', ('COO_ER
R_ANGLE', '<12'), ('COO_QUAL', 'S1'), ('COO_WAVELENGTH', 'S1'), ('COO_BIBCODE'
, '0')]>
Coordinates: 83.8666441 -69.2697166 83.866666667 -69.269722222
Separation ("): 0.835165280623

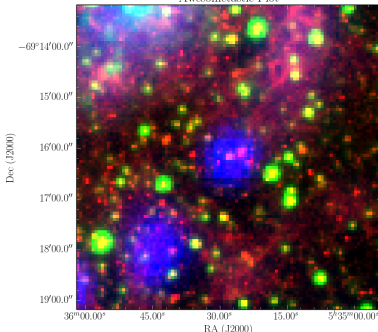
```



Prof. #6: A (better) solution

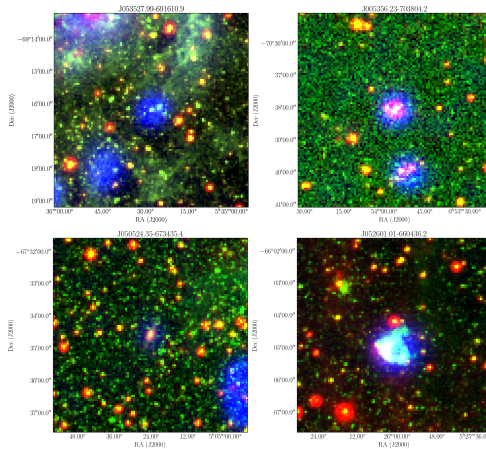
```
49 from astroquery.simbad import Simbad
50 import aplot
51 import pyfits
52 from matplotlib import rc
53 rc('text', usetex=True)
54 rc('font', **{'family': 'serif', 'serif': 'serif', 'size': 10})
55
56 # Get names of sources
57 a = sources[ec_mask]
58 b = sources[ec2_mask]
59 c = sources[g_mask]
60
61 # Concatenate into one table
62 [a.add_row(b[i]) for i in range(0, len(b))]
63 [a.add_row(c[i]) for i in range(0, len(c))]
64
65 # Only sources < 2" separation
66 mask = a['angdist'] < 2
67 a_mask = a[mask]
68
69 # query SIMBAD on position
70 for i in range(0, len(a)):
71     name = a['ALWISE'] [i]
72     ra, dec = a['RAJ2000_1'] [i], a['DECJ2000_1'] [i]
73
74 # Download maps from SkyView
75 surveys = ['DSS2R', 'WISE1', 'SHASSA_H', 'FIRST', 'SUMSS', 'IRIS100']
76 for survey in surveys:
77     os.system('java -jar skyview.jar coordinates=J2000 \
78               projection=tan iposition=%s_s size=2,4,1 pixels=100,100 \
79               survey="%s" output="figs/%s_%s.fits" % (ra, dec, survey, name, survey)')
80
81 os.system('rm -rf rgb.fits')
82
83 r = pyfits.open('figs/%s_WISE1.fits' % name) [0].data
84 g = pyfits.open('figs/%s_DSS2R.fits' % name) [0].data
85 b = pyfits.open('figs/%s_SUMSS.fits' % name) [0].data
86
87 rgb = np.dstack((r, g, b))
88
89 hdr = np.roIaxis(rgb, 2)
90 hdr.update('figs/%s_DSS2R.fits' % name) [0].header
91 hdr.update('COIN3' - 'VELD-LSR')
92 pyfits.writeto('rgb.fits', headers=hdr, data=rgb)
93
94 aploty.make_rgb_image('rgb.fits', '%s_rgb.png' % name,
95                      pixel_w=2.5, pixel_h=2.5, pixel_b=2.5,
96                      pixel_r=1, pixel_g=0.7, pixel_b=0.7, 3)
97 f = aplot.FITSPfigure('rgb.fits', dimensions=[0, 1], slices=[0])
98 f.show_rgb('%s_rgb.png' % name)
99
100 savefig('%s_rgb.png' % name, bbox_inches='tight')
```

Awesometastic Plot





Prof. #6: A (better) solution





Prof-lem #7

*"It's PAAAAAAAAAAPPPEER
TIIIIIIIMMMMEEEE! Show your
worth as an astronomer and write
up your results. We will be
submitting to MNRAS, so make
sure to follow their guidelines."*



- ▶ You print and read the MNRAS format guidelines
- ▶ You use your favourite text editor to start your paper
- ▶ You find yourself doing a lot of latex-bibtex-latex-latex
- ▶ You decide you rather dislike \LaTeX (and miss Word)
- ▶ Some months later, you emerge with a paper draft

```
MyExcellentJournalArticle
\documentclass[twoside]{article}

%-----
%      TITLE SECTION
%-----

\title{This is a really cool paper}
\author{Awesome Person}
\date{}

%-----

\begin{document}
\maketitle
\thispagestyle{fancy} % Because I'm feeling fancy today

%-----
%      ABSTRACT
%-----

\begin{abstract}

Chicken chicken, chicken chicken chicken. Chicken chicken chicken chicken? Chicken chicken
chicken chicken: chicken chicken chicken chicken chicken chicken. Chicken chicken chicken,
chicken chicken. Chicken chicken chicken chicken chicken chicken chicken chicken chicken
chicken chicken chicken chicken. CHICKEN! |

\end{abstract}

%-----
```



- ▶ You use texmaker as your \LaTeX editing software, which allows you to quickly see your changes and edits
- ▶ You download pre-made MNRAS \LaTeX templates, to save time building your own article from scratch
- ▶ You rather like \LaTeX by the end of it, and start making *everything* in \LaTeX

¹⁹texmaker can be found [online](#)



Abstract

We report on the discovery of a new Galactic supershell, GSH 006-15+7, from the Galactic All-Sky Survey data. Observed and derived properties are presented and we find that GSH-006-15+7 is one of the nearest physically large supershells known, with dimensions of $5 \text{ kpc} \times 7 \text{ kpc} \times 2 \text{ kpc}$. The shell wall appears in H I emission at 6 km s^{-1} and in H I self-absorption (H I SA) at 5 km s^{-1} . We use this feature along with H I SA diagnostics to estimate an optical depth of $\tau_{50} \approx 0.3$, a spin temperature of $T_{\text{spin}} \approx 40 \text{ K}$ and a swept-up mass of $M \approx 10^6 M_{\odot}$. We also investigate the origin of GSH-006-15+7, assessing the energy contribution of candidate powering sources and finding evidence in favour of a formation energy of 10^{51} erg . We find that this structure provides evidence for the transfer of mass and energy from the Galactic disk into the halo.

Introduction

The pervasiveness of neutral hydrogen (H I) in the universe has ensured its centrality in both Galactic and extragalactic studies, from star-forming regions to superovoids to disc-halo interaction. Large shell-like structures detected in H I, known as supershells (Heiles 1976; McClure-Griffiths et al. 2008), are an important driving force in the Galactic ecosystem, eroding material within the disc, evacuating

Key words: ISM: bubbles – ISM: structure – Galaxy: structure – radio lines: ISM – radiative transfer – stars: winds



The screenshot shows a LaTeX editor window with a source code file named 'talkit.tex' and a rendered slide titled 'Prof. #7: A (better) solution¹⁹'. The source code includes commands for frames, columns, and graphics. The rendered slide features the CAASTRO logo, a cartoon illustration of a woman dancing, and a list of bullet points. Below the slide is a 'Papers...' section with a preview of a document.

```
921 \end{center}
922 \end{frame}
923
924 \begin{frame}[t]\frametitle{Prof. #7: A (better) solution\footnote{tevmaker can be found
925 \href{http://www.sm1math.net/tevmaker/}{online}}}
926 \framesubtitle{Two columns}
927 \begin{columns}
928 \begin{column}[0.5\textwidth]
929 \begin{center}
930 \includegraphics[scale=0.25]{celea.png}
931 \end{center}
932 \end{column}
933 \begin{column}[0.5\textwidth]
934 \begin{itemize}
935 \item You use tevmaker as your \LaTeX-editing software, which allows you to quickly see your
936 changes and edits
937 \item You download pre-made MNRAS \LaTeX-templates, to save time building your own article
938 from scratch
939 \item You rather like \LaTeX--by the end of it, and start making \LaTeX{everything} in \LaTeX
940 \end{itemize}
941 \end{column}
942 \end{columns}
943 \begin{frame}[t]\frametitle{Papers...}
944 \begin{center}
945 \includegraphics[scale=0.18]{tevmaker.png}
946 \end{center}
947 \end{frame}
```

LOG FILE:
This is pdfTeX, Version 3.14159265-2.6-1.40.15 (TeX Live 2014) (preloaded format=pdfelatex 2014.7.29) 1 OCT 2014 11:38
entering extended mode

present.cls Warning: line 1: You have requested document class 'present',but the document class provi...
talkit.tex Warning: line 20: Option 'pdfauthor' has already been used,(hyperref) setting the option has ...
talkit.tex Badbox: line 43: Overfull \hbox (97.63335pt too wide) in paragraph at lines 43--43
talkit.tex Badbox: line 43: Overfull \hbox (82.98848pt too wide) in paragraph at lines 43--43
talkit.tex Warning: line 43: Font scheme 'OT1/cmmss/m/ot' in class 'cls' not available(Font) size=12,subset

Prof. #7: A (better) solution¹⁹

- You use tevmaker as your \LaTeX editing software, which allows you to quickly see your changes and edits
- You download pre-made MNRAS \LaTeX templates, to save time building your own article from scratch
- You rather like \LaTeX by the end of it, and start making *everything* in \LaTeX

¹⁹tevmaker can be found [online](http://www.sm1math.net/tevmaker/)

Papers...



198 \setheparter title
199 \[color\{white\}\bf
200 HVCs in the Galactic All Sky Survey
201 \setheparter\{s\}
202 \[color\{white\}\bfname
203 \[space\]\{1em\} Vanessa A. Moss^{1,11,215}, N.M. McClure-Griffiths, T. Murphy, D.J. Pisano, J.K.
204 Kummerfeld and J.R. Curran^{\[0.5em\]}
205 $\$N\{1\}$ Sydney Institute for Astronomy, School of Physics A29, University of Sydney, NSW 2006,
206 Australia[\]
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210 \setheparter logo (the logo on the right)
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212 \includegraphics[height=0.8\headerheight]{csiro.png}
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217 \setheparter\{intro\}[name=intro,column=0,row=0]
218 \begin{intro}[name=intro,column=0,row=0]
219 \begin{intro}[name=intro,column=0,row=0]
220 \setheparter We present a catalogue of high velocity clouds derived from the Galactic All Sky Survey
221 \setheparter The Galactic All Sky Survey has $\$N\{1\}$ mK sensitivity, 165° angular resolution and
222 $1\text{--}45\text{--}115$ velocity resolution \[color\{McClureGriffiths:2009p3462\}

HVCs in the Galactic All Sky Survey
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Introduction
 • We present a catalogue of high velocity clouds derived from the Galactic All Sky Survey.
 • The clouds lie 500 parsecs to 400 pc and exhibit 10° angular resolution and 1 km s⁻¹ in velocity resolution (McClure-Griffiths et al. 2009).
 • We use MCMC source fitting to identify 3933 high velocity clouds (HVCs).
 • The catalogue contains 1000 clouds in total.
 • 200 intermediate velocity clouds (IVCs) containing only the HI94+ IVC catalog (Pisano et al. 2002), we find 105 common and 675 exclusive HVCs.
 • We are currently using our catalogue to study high-velocity clouds in the Milky Way.

Properties of the GASS HVC and IVC populations

Type of cloud	Size	Velocity range	Height
GASS HVC	200 pc	10 km s ⁻¹ to 100 km s ⁻¹	100 pc
GASS IVC	200 pc	10 km s ⁻¹ to 100 km s ⁻¹	100 pc
GASS HVC + IVC	200 pc	10 km s ⁻¹ to 100 km s ⁻¹	100 pc

Distribution
 • The distribution of GASS HVCs and IVCs in the sky shows a clear gradient in density and velocity gradient of all HVCs with angular resolution as small as the size of the clouds.
 • The GASS data were used to fit a model to increase significance of detection.
 • It is possible to detect HVCs with a signal of 100 mK and a diameter of 10' (10 pc).

Gradients of HVCs
 • We have determined the gradient in column density and velocity gradient of all HVCs with angular resolution as small as the size of the clouds.
 • There is a strong gradient for the alignment of the clouds in the Galactic plane.

Comparison with HI94+55
 • To test the completeness of our catalogue we compared the GASS HVC catalogue with the HI94+55 catalogue.
 • We found that the GASS HVC catalogue is more complete than the HI94+55 catalogue.
 • We determined using a model matched to the HI94+55 catalogue that the GASS HVC catalogue is more complete than the HI94+55 catalogue.

References
 Curran, J. 2002, MNRAS, 329, 201
 Curran, J. P., McClure-Griffiths, N. M., Pisano, D. J., et al. 2006, MNRAS, 362, 17
 McClure-Griffiths, N. M., Curran, J., Curran, J. M., et al. 2006, MNRAS, 362, 17
 McClure-Griffiths, N. M., Curran, J. M., Pisano, D. J., et al. 2002, MNRAS, 329, 201
 Curran, J. P., Curran, J. M., Pisano, D. J., et al. 2006, MNRAS, 362, 17

The GASS catalogue paper
 UTF-8 Normal Mode

Part III

Components of the toolkit



0. Language: Python



<https://www.python.org>



1. Logbook: Evernote



<https://evernote.com>

2. Paper management: Papers



<http://papersapp.com>



3. Crossmatching: X-Match



<http://cdsxmatch.u-strasbg.fr/xmatch>



astropy

A Community Python Library for Astronomy

<http://www.astropy.org>



5. Astronomy plots: aplpy



<http://aplpy.github.io>



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6a. Multi-wavelength data: SkyView



SkyView



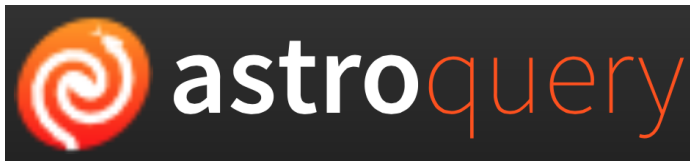
The Internet's Virtual Telescope

<http://skyview.gsfc.nasa.gov>



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6b. Source investigation: astroquery



<https://astroquery.readthedocs.org>



7. \LaTeX : texmaker



<http://www.xmlmath.net/texmaker>



8. Radio school: Fourier transforms

