

Astronomical Imaging Initiatives

Jason McEwen

www.jasonmcewen.org

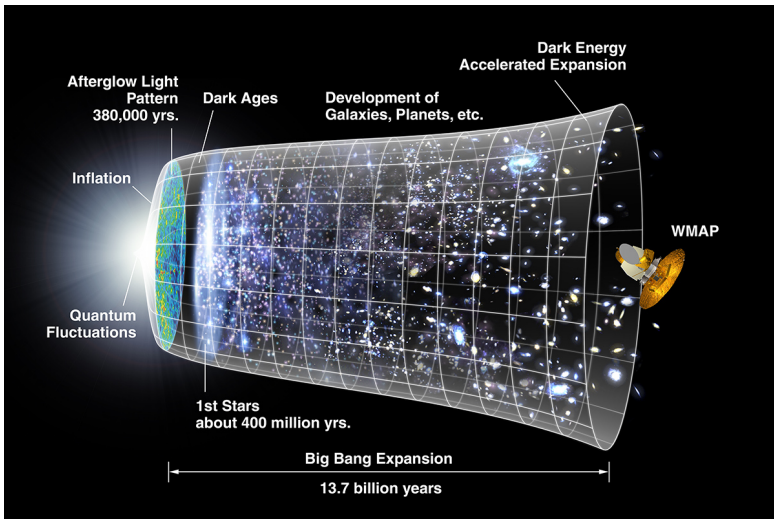
@jasonmcewen

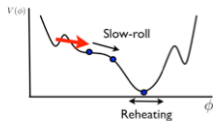
*Mullard Space Science Laboratory (MSSL)
University College London (UCL)*

BioImagingUK, June 2014

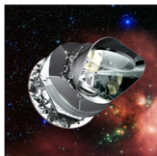


We have entered an era of **concordance cosmology**





Theory



Data

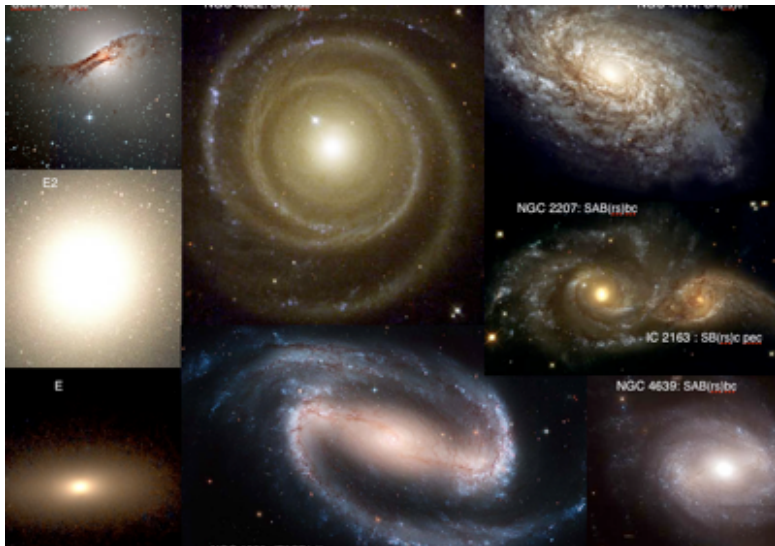


**Informatics
& Statistics**



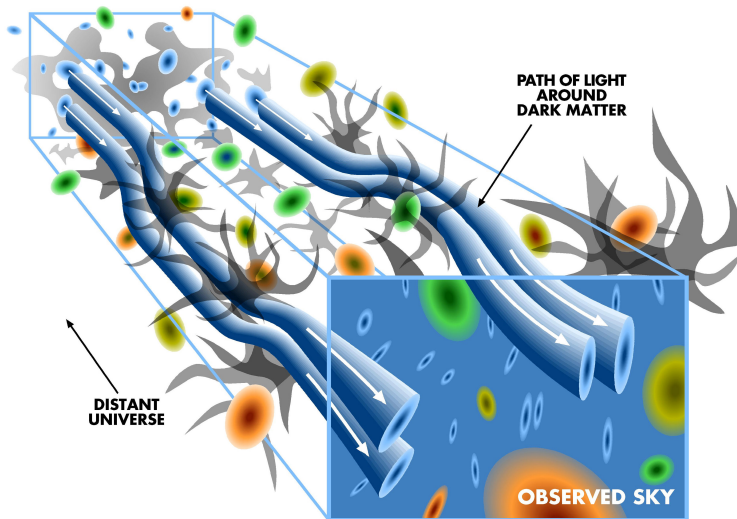
Astronomical & Cosmological Imaging

Galaxy Morphology



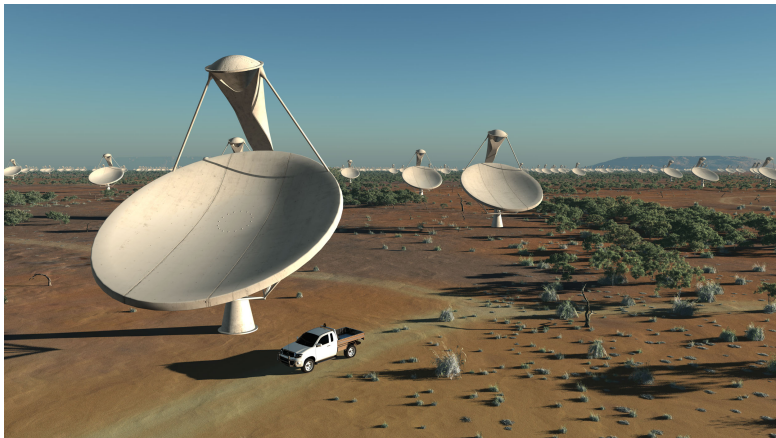
Astronomical & Cosmological Imaging

Weak Lensing & Galaxy Shape Estimation



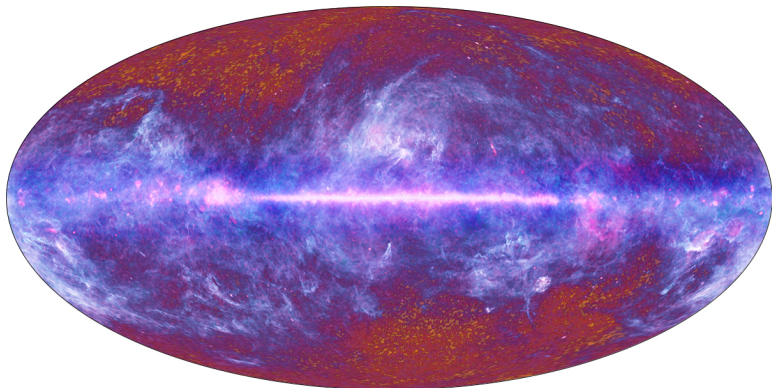
Astronomical & Cosmological Imaging

Radio Interferometric Imaging



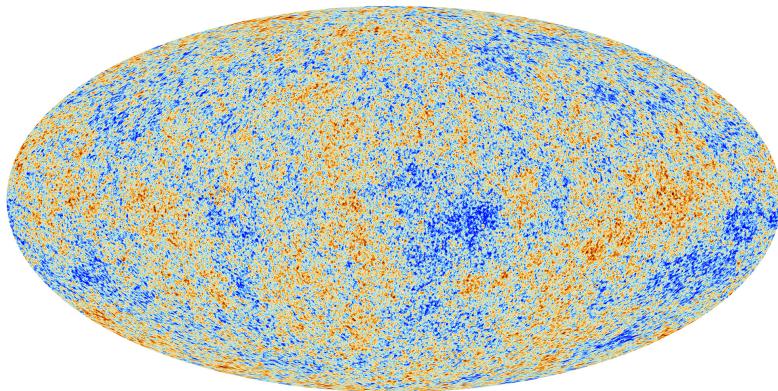
Astronomical & Cosmological Imaging

Cosmic Microwave Background (CMB) Component Separation

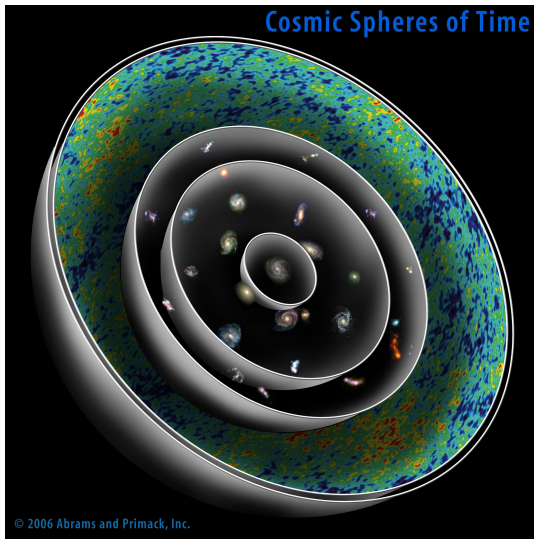


Astronomical & Cosmological Imaging

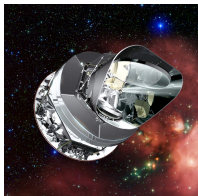
Cosmic Microwave Background (CMB) Component Separation



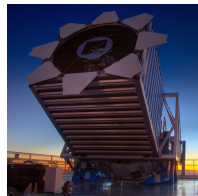
Observations on the Celestial Sphere



Open-Data



Open-data is becoming the norm

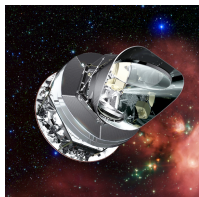


- SDSS: ~100 collaboration publications; ~10,000 community publications
- WMAP: ~40 collaboration publications; ~4,000 community publications

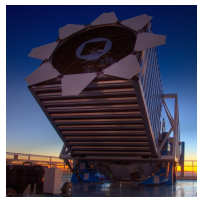
Community publications ~100x that of collaboration



Open-Data



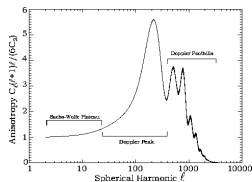
Open-data is becoming the norm



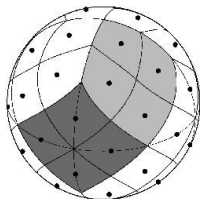
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Community publications ~100x that of collaboration



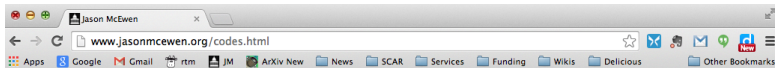


Open-source is becoming the norm



- Theory and simulations, e.g. CAMB
- Data manipulation and analysis, e.g. Healpix
- Informatics and statistical analysis techniques, e.g. CosmoMC, S2LET





[Home](#) | [Publications](#) | [Talks](#) | [Codes](#) | [Teaching](#) | [Research Opportunities](#) | [Blogs](#) | [CV](#)

Jason McEwen

academic webpage

Quick links

AniCosmo : Bayesian analysis of anisotropic cosmologies

BIANCHI : Bianchi VIIh simulations

BIANCHI2 : Dark Bianchi VIIh simulations

COMB : Compact embedded object simulations

FastCSWT : Fast directional continuous spherical wavelet transform

FLAG : Exact Fourier-Laguerre transform on the ball

FLAGLET : Exact wavelets on the ball

PURIFY : Next generation radio interferometric imaging

S2 : Functions on the sphere

S2DW : Steerable scale discretised wavelets on the sphere

S2FIL : Optimal filtering on the sphere

S2LET : Fast wavelets on the sphere

SIC : Sparse inpainting code

SOPT : Sparse optimisation

SSHT : Spin spherical harmonic

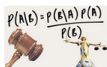
Codes

In the course of my research I have written a number of scientific codes and software packages. In the spirit of **reproducible research** I make these codes available publicly here.

In many cases these codes have been developed in collaboration with other researchers. Careful attention has also been paid to the design of these software packages. Please see the webpage accompanying each code for further information.

To receive a copy of any code please click on the download icon and complete the download form. The requested software packages will then be automatically e-mailed to you. All codes are released under the **GNU General Public License** unless otherwise stated. If you use any of the codes in work that results in publication, we kindly request that you reference the appropriate code webpage and papers. Thanks!

AniCosmo: Bayesian analysis of anisotropic cosmologies



The AniCosmo code provides functionality to perform a Bayesian analysis of anisotropic cosmologies. It was used to study Bianchi models of universal rotation in our papers: **Bayesian analysis of anisotropic cosmologies: Bianchi VII_h and WMAP; Planck 2013 results: Background geometry and topology of the Universe**. AniCosmo is under intensive ongoing development. It is not yet publicly available but will be made available in future.

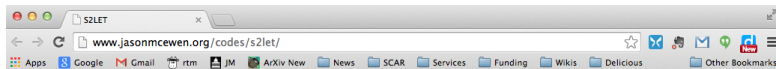


BIANCHI: Bianchi VIIh simulations

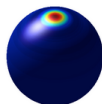


Open-Source

Wavelets on the sphere www.s2let.org



[Introduction](#) | [Wavelets](#) | [Installation](#) | [Download](#) | [Referencing](#) | [Version](#) | [License](#) | [Authors](#)



S2LET1.1b1

Fast wavelets on the sphere

Installation and usage

[Dependencies](#)

[C library](#)

[IDL interfaces](#)

[Java interfaces](#)

[Matlab interfaces](#)

Source documentation

[C documentation](#)

[IDL documentation](#)

[Java documentation](#)

[Matlab documentation](#)

News

October 2013

Public release of **S2LET 1.1b1**, fully supporting B-spline, scale-discretised and needlet wavelets.

August 2013

S2LET code paper accepted for publication in *Astronomy & Astrophysics*.

November 2013

Introduction

The **S2LET** code ([ArXiv paper](#)) provides high performance routines for fast wavelet analysis of signals on the sphere. It uses the **SSHT** code built on the **MW sampling theorem** ([ArXiv](#) | [DOI](#)) to perform exact spherical harmonic transforms on the sphere. The resulting wavelet transform implemented in **S2LET** is theoretically exact, i.e. a band-limited signal can be recovered from its wavelet coefficients exactly and the wavelet coefficients capture all the information. **S2LET** also supports the **HEALPix** sampling scheme, in which case the transforms are not theoretically exact but achieve good numerical accuracy.

In version 1.1 **S2LET** also supports needlets ([Marinucci et al 2008](#), [Baldi et al 2006](#)) and B-spline wavelets ([Starck et al 2006](#)), in addition to the scale-discretised wavelets ([Wiaux et al 2008](#)).

This page outlines the main features of **S2LET**, installation details as well as the core functionalities and interfaces. References, version, and license information then follows. The **S2LET** code requires the **SSHT** and **FFTW** libraries. The IO FITS features require **CFITSIO**. To support **HEALPix**, a valid installation of its Fortran implementation must be provided. More details about an installation from scratch can be found on the [Dependencies](#) page.

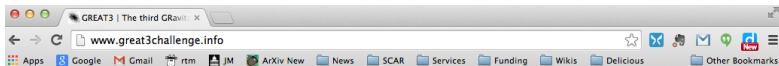
Scale discretised wavelets on the sphere

In **S2LET**, the scale-discretised wavelets are constructed through an exact tiling of harmonic space, following the scale-discretised approach described in [Wiaux et al \(2008\)](#) ([ArXiv](#) | [DOI](#)). The harmonic line is tiled into wavelet kernels which are localised (i.e. have compact support) in both real and frequency spaces, as shown on the image below for a particular set of wavelet parameters ($B=2, J_{\min}=2$, harmonic space on the left, corresponding kernels on the right).



Community Challenges

GREAT: GRavitational lEnsing Accuracy Testing (www.great3challenge.info)



[Home](#) [Details](#) [Timeline](#) [GalSim](#) [Links](#) [Contact the Team](#) [Blog](#) [Final Meeting May 2014](#)

This work is supported in part by NASA via the Strategic University Research Partnership (SURP) Program of the Jet Propulsion Laboratory, California Institute of Technology.



This work was supported in part by the IST Programme of

The third GRavitational lEnsing Accuracy Testing challenge, or **GREAT3**, is a blind data analysis competition held by the world-wide weak lensing community to test weak lensing measurement algorithms.

All simulated data are available, downloadable from our server on the GREAT3 Leaderboard web site, where you can also find the scores of all the challenge participants.

The challenge began in October 2013 and ended on April 30, 2014 (see the [timeline](#) page).

The GREAT3 Final Meeting is taking place on 27-29 May 2014 at Carnegie Mellon University, Pittsburgh PA

With several major astronomical surveys beginning to make large-scale cosmological weak lensing measurements in

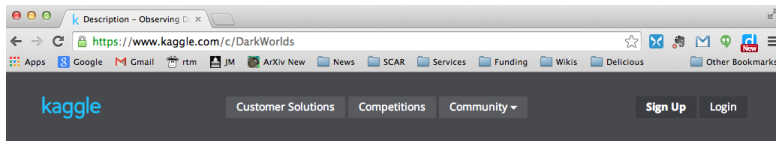
GREAT3 Shortcuts

- [The Leaderboard](#)
- [The Data](#)
- [The great3-public Code Repo](#) and useful [Wiki](#)
- [The Handbook](#)
- [The FAQ](#)
- [The Software \(GalSim\)](#)
- [The Timeline](#)
- [The Team](#)



Community Challenges

www.kaggle.com



Observing Dark Worlds

Friday, October 12, 2012

\$20,000 • 353 teams

Sunday, December 16, 2012

Finished

Dashboard

Home

Data

Information

Description

Evaluation

Rules

Prizes

About the Sponsor

An Introduction to Ellipticity

Getting Started (with code)

Submission Instructions

Winners

Forum

Leaderboard

Public

Can you find the Dark Matter that dominates our Universe? Winton Capital offers you the chance to unlock the secrets of dark worlds.

There is more to the Universe than meets the eye. Out in the cosmos exists a form of matter that outnumbers the stuff we can see by almost 7 to 1, and we don't know what it is. What we do know is that it does not emit or absorb light, so we call it **Dark Matter**.

Such a vast amount of aggregated matter does not go unnoticed. In fact we observe that this stuff aggregates and forms massive structures called **Dark Matter Halos**.

Although dark, it warps and bends spacetime such that any light from a background galaxy which passes close to the **Dark Matter** will have its path altered and



The screenshot shows a web browser window with the address bar displaying 'www.galaxyzoo.org'. The browser's bookmark bar includes links for 'Apps', 'Google', 'Gmail', 'rtm', 'JM', 'ArXiv New', 'News', 'SCAR', 'Services', 'Funding', 'Wikis', 'Delicious', and 'Other Bookmarks'. The website header features the text 'Galaxy Zoo is a Zooniverse project.' followed by 'Our Projects' and a login section with 'username' and 'password' input fields, 'Login' and 'Sign up' buttons, and a 'Forgot Password?' link. A navigation menu contains 'CLASSIFY', 'STORY', 'SCIENCE', 'GALAXY ZOO' (in a yellow banner), 'DISCUSS', 'PROFILE', and 'LANGUAGE'. Social media icons for Facebook, Twitter, Google+, and RSS are visible. The main content area has the headline 'Few have witnessed what you're about to see' and the subtext 'Experience a privileged glimpse of the distant universe as observed by the SDSS, the Hubble Space Telescope, and UKIRT'. Below this is a 'Classify Galaxies' section with a text block: 'To understand how galaxies formed we need your help to classify them according to their shapes. If you're quick, you may even be the first person to see the galaxies you're asked to classify.' and a yellow 'Begin Classifying' button. A large image of a spiral galaxy is shown on the right side of the page.



The screenshot shows a web browser window displaying the Zooniverse homepage. The browser's address bar shows the URL <https://www.zooniverse.org>. The page features a dark header with the Zooniverse logo and the tagline "We make citizen science websites so that everyone can be part of real research online". Below the header is a red banner with the text "daily.zooniverse.org" and "Something awesome from the Zooniverse every day", accompanied by a row of seven project thumbnails labeled FRI, SAT, SUN, MON, TUE, WED, and THU. The main content area has a navigation bar with categories: All, Space, Climate, Humanities, Nature, and Biology. The "Space" category is selected, and the page displays a grid of space-related images, including a galaxy, the moon, the sun, and a planet. A "Sort by" dropdown menu is set to "Category".

Zooniverse - Real Science x

<https://www.zooniverse.org>

Apps Google Gmail rtm JM ArXiv New News SCAR Services Funding Wikis Delicious Other Bookmarks

EN 1,112,339 people taking part worldwide

Projects Community About us Sign in Register

ZOONIVERSE

We make citizen science websites so that everyone can be part of real research online

daily.zooniverse.org


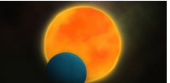
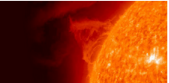


Something awesome from the Zooniverse every day

FRI SAT SUN MON TUE WED THU

All Space Climate Humanities Nature Biology

Space

Sort by Category



Conferences & Meetings

- Crick Institute meeting on *Biomedical Imaging and Astronomy: Shared Algorithms and Analyses*, 6 June
- *Royal Society Science on the Sphere Workshop*, 14–15 July
<http://lateuniverse.wordpress.com/2014/05/13/science-on-the-sphere>
- *Inverse Problems: From Theory to Application*, 26–28 August
<http://ipta2014.iopconfs.org/home>
- *Royal Statistics Society International Conference*, 1–4 September
<http://www.statslife.org.uk/events/annual-conference>
- *International Workshop on Cosmology and Sparsity*, 7–12 September
<http://iwcs2.cosmostat.org/Homepage.html>
- *International Conference on Computational and Methodological Statistics*, 6–8 December
<http://www.cmstatistics.org/ERCIM2014>



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International BASP Frontiers workshop 2015
January 25 - 30, 2015 - Villars-sur-Ollon, Switzerland

BASP
Biomedical and Astronomical Signal Processing

General Program Important dates Venue Contributions Prices & Registration

The international Biomedical and Astronomical Signal Processing (BASP) Frontiers workshop was created to promote synergies between selected topics in astronomy and biomedical sciences, around common challenges for signal processing.

Building on the success of the first two workshops in 2011 and 2013, the BASP Frontiers 2015 workshop will open its floor to many interesting hot topics in theoretical, astrophysical, and biomedical signal processing, with a particular focus on imaging.

The workshop is run by an internationally recognized scientific organizing committee and will gather around 75 participants.

Following our tradition, BASP Frontiers 2015 will take place in a very nice resort in the Swiss Alps named Villars-sur-Ollon, close to Lausanne and Lake Geneva. All participants will be accommodated in 4 star hotel in a full board regime. We believe that the most fruitful discussions often take place after the sessions themselves, on the terrace, or during breakfast, lunch, or dinner. We

BASP
Biomedical and Astronomical Signal Processing

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University College London (UCL)*

