2016 3D Visualisation workshop – Abstracts (Sydney, Nov 16-18)

Stuart Anderson (CSIRO)

Title: *Putting 3D scans to work*

Abstract. Following the development of the world-first full colour 3D scanner for insects, members of the Quantitative Imaging team have been exploring different ways of deriving maximum value and benefit from 3D scans of high value objects. A prototype cloud-based platform has been developed for viewing, interacting with, annotating and collaborating over 3D objects on the web. This platform has since formed the basis of software deployed into the GLAM and education sectors.
In the demo I showcase a selection of 3D insect models captured by CSIROs InsectScan technology. The scans are visualised in 3D using a stereoscopic display, and using haptics (the application of tactile sensations to human-computer interaction), the scans can be virtually 'touched', giving a feel for the shape and features of the specimens beyond what the visualisation alone can provide.

Justin Baker and Peter Tyson (CSIRO)

Title: *Overview of our work on 3D TVs*

Abstract. A quick technical discussion around 3D TVs for scientific visualisation and a summary of how some of our deployments are being used, including some background on our remote visualisation service which can be accessed/displayed on a 3D TV as well.

Deidre Cleland (CSIRO)

Title: *Visualising molecular quantum effects*

Abstract. The CSIRO Molecular Quantum Monte Carlo (CMQMC) software package is being developed as a tool for performing accurate simulations of molecules at the quantum scale. Quantum Monte Carlo methods take a conceptually different approach to comparable techniques, and the quantities that enter into CMQMC molecular simulations can be complex, or have very high dimensionality. Presented here are a series of 3-dimensional visualisations, which depict the molecular quantum effects that are central to the CMQMC software. Such visualisations improve the understanding and communication of these important quantities.

Klaus Dolag (Munich Observatory & Max-Planck-Institute for Astrophysik, Germany)

Title: *Splotch (1): HPC Visualisation of Large Cosmological Particle-Based Simulations*

Abstract. SPLOTCH is a light weight, fast, and publicly available rendering algorithm for exploration and visual discovery in particle-based datasets coming from astronomical observations or numerical simulations The rendering algorithm is designed in order to deal with point-like data, optimizing the ray-tracing calculation by ordering the particles as a function of their "depth". This function is defined as a function of one of the coordinates or other associated parameters. Realistic three-dimensional impressions are reached through a composition of the final colour in each pixel, properly calculating emission and absorption of individual volume elements. Different datasets and configurations lead to remarkably different results in terms of the images and animations. The strengths of the approach are production of high quality imagery and support for very large-scale datasets through an effective mix of the OpenMP and MPI parallel programming paradigms and also contains hybrid approaches utilizing GPUs. It now utilize a new rendering machine, which allows to do arbitrarily projections. This enables us to render directly dome projection as well as full 3D boxes.

Tim Dykes (Portsmouth University, U.K.)

Title: *Splotch (2): Distributed particle visualization and real-time interaction at scale*

Abstract. Following on from the content of Splotch (1), we detail an on-going effort to improve the particle-based volume rendering algorithm, enabling more complex transfer functions through in-order integration of emission and absorption in a distributed memory regime. We also address the problem of remote visualization with a high performance client-server model, allowing interactive exploration of large particle based datasets via a high performance rendering server designed for supercomputing systems, combined with fast image compositing and streaming to a local client (e.g. on a laptop). We present performance results across a variety of hardware configurations for large Cray systems including GPU and KNL, and video demonstrations of recent visualization work for a large galaxy formation simulation.

Claudio Gheller (Swiss National Supercomputing Centre, Switzerland)

Title: *Access, processing and visualisation of astrophysical data through remote and distributed computing facilities*

Abstract. Turning massive raw datasets into useful scientific outcomes is a challenge that astronomers have to increasingly face. Providing astronomers with easy-to-use tools to access, analyse, visualise, and process this raw data and its derived data products is an outstanding step towards a better and more efficient utilisation of their datasets. HPC tools and Cloud-based data processing and analysing pipelines are thought to be a good aid in addressing such usability and accessibility challenges. They can provide on-demand access to large computational resources and data repositories, efficient tools for data processing, and customised data analysis pipelines via easy-to-use interfaces (or thin-clients). In the talk, we will present several cases based on the popular VisIt visualisation package, used client-server exploiting the Piz Daint CSCS HPC system, and on the Splotch ray-casting engine embedded in the Theoretical Astrophysical Observatory (TAO) framework, which is part of the All-Sky Virtual Observatory (ASVO) Australian project.

Christopher Hammang (CSIRO)

Title: *Scientific Storytelling with Animations*

Abstract. Christopher Hammang is a scientific animation artist, creating visualisations of the microscopic inner space of life. His animations allow us to step inside the invisible world of molecular biology. He works as part of a multi-disciplinary research group, the Biological Data Visualisation team, which is lead by Dr Seán O'Donoghue at CSIRO and the Garvan Institute. Christopher's vision is informed by a background in medical science and driven by a passion for understanding biology. In this presentation Christopher will present some of the animations he has produced and give a behind the scenes look at the production of his animations. He will dissect the processes and creative choices which result in engaging and insightful work.

Craig James (CSIRO)

Title: *Reaching Through the Looking Glass – Augmenting Science and Industry with AR and VR*

Abstract. A wave of high-quality, affordable, Augmented and Virtual Reality (ARVR) devices are now entering the consumer market. With ARVR in the Infotainment industry set to reach a market value of $120 billion by 2020, we have an opportunity to present our science and impact by leveraging this investment. This talk aims to give a brief history of ARVR technologies to date, discuss current and near-future offerings, and raise awareness of potential opportunities.

Guyla Jozsa (Capetown University, South Africa)

Title: *Galaxy tomography with TiRiFiC* (talk & demo)

Abstract. TiRiFiC is a software to fit parameterised models of the gas distribution in galaxies to astronomical observations. It is tailored to create a 6-dimensional galaxy model consisting of tilted rings to be projected onto three dimensions and artificially observed with a (radio-) telescope. These observations can then be compared to the original measurements and the parameters can be adjusted to reach an optimal fit. The data cubes to be compared consist of two spatial and one velocity component. Only once the optimal fit has been found, the results can be used to reconstruct the three-dimensional spatial structure of the galaxies. TiRiFiC also offers the possibility to extend over the simple tilted-ring model by introducing a number of additional descriptive components. I will introduce / demonstrate TiRiFiC.

Bärbel S. Koribalski (CSIRO)

Title: *3D Visualisation of gas and stars in galaxies*

Abstract. I will give an overview of some visualisation tools used in astronomy and give examples of 3D visualisations of gas and stars in nearby galaxies based on data from optical and radio telescopes.

Juan Madrid (CSIRO)

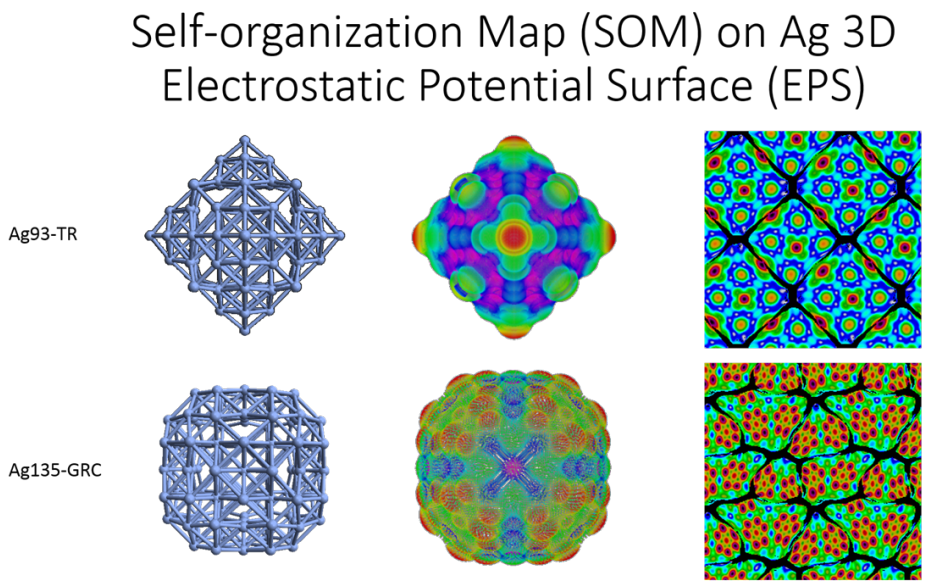
Title: *The Australian SKA Pathfinder (ASKAP) – Data processing and visualization on Pawsey*

Abstract. The Australian Square Kilometre Array Pathfinder (ASKAP) is a wide field interferometer using state-of-the-art Phased Array Feeds (PAFs). ASKAP is operated by CSIRO and is located in the radio-quiet zone of the Murchison Radio Observatory in remote Western Australia. When fully built, ASKAP will be producing data at a rate of a few GB per second. A dedicated data reduction pipeline ASKAPSoft is designed to reduce ASKAP data and produce science-ready images and spectral cubes. All data reduction will be carried out at the Pawsey Supercomputer Centre in Perth. The challenges of analysing and visualizing data cubes of 1 TB in size will be discussed.

Baichuan Sun (CSIRO)

Title: *Self-organization Map (SOM) on Ag 3D Electrostatic Potential Surface (EPS)*

Abstract. Artificial Neural Network (ANN) imitates information processing in human brain. A variety of ANN models has been developed and optimized for different tasks, especially the non-linear classifiers. Kohonen network, or known as Self-organization Map (SOM), is a special case of ANN, as it classifies high-dimensional data into low-dimensional (normally 2D) space without supervision, while retaining the intrinsic topological relationship of the dataset. This algorithm is ideal for representing 3D molecular electrostatic potential surface (EPS) with a single 2D snapshot, or fingerprinting of the molecule. The 2D image could possibly be fed into conventional classifier models, to correlation the EPS with other corresponding chemical properties of the molecules.



Frederic Vogt (European Southern Observatory)

Title: *The X3D Pathway: new features for added scientific values*

Abstract. In this talk, I will describe the concept of the X3D pathway: a new approach to share and publish 3-D models and diagrams interactively on the web and/or in online scientific journals. I will highlight the advantages offered by the X3D pathway using practical examples; the HI content of a compact group of galaxies observed with the VLA, and optical integral field spectroscopy observations of a supernova remnant acquired with the WiFeS spectrograph. I shall also focus on new features accessible within the X3DOM framework (including clip planes), and describe how these can add significant scientific value to any interactive 3-D model. Step-by-step tutorials and examples are freely accessible on Github: http://fpavogt.github.io/x3d-pathway/

Dany Vohl (Swinburne University)

Title: *Colouring redshift and velocity: a novel visual cue to inspect spectral cubes in real-time*

Abstract. Observational astronomers have increasing access to three dimensional (3D) data from instruments and facilities like integral field units and radio interferometers. A 3D astronomical data file is typically composed of two angular dimensions along with a spectral or a velocity dimension. Considering the popularity of GPU for general purpose computing, one should not neglect the suitability of GPU for fast scientific visualisation. Despite their growing availability, 3D visualisation techniques like volume rendering tend to be under utilised in astronomy. As most 3D visualisation techniques have been developed for fields of research like medical imaging and fluid dynamics, many transfer functions are not intuitive for astronomical data. Instead, most astronomers tend to visualise 3D data in 2D. Common practices consist of computing "moment maps", that is, representing statistical moments of spatial pixels based on their respective spectral channels. Moments give insight on physical quantities like overall gas distribution (0th moment), gas velocity field (1st moment) and gas velocity dispersion (2nd moment). Inspired by moment maps visualisation, we present novel transfer functions specifically designed to visualise astronomical data with volume rendering methods. By mapping spectral coordinates to color, and mapping voxel scalar or derived quantities to transparency and/or brightness, we provide astronomers intuitive visual cues to explore their data. We discuss how this can be achieved by utilising the parallelism of modern GPUs along with dynamic shading language, letting astronomers comprehensively explore their 3D data at interactive rate.

Dany Vohl (Swinburne University)

Title: *Collaboration, Visual Analytics and the Cloud in the Big Survey Era*

Abstract. Radio survey datasets comprise an increasing number of individual observations stored as sets of multidimensional data. In large survey projects, astronomers commonly face limitations regarding: 1) interactive visual analytics of sufficiently large subsets of data; 2) synchronous and asynchronous collaboration; and 3) documentation of the discovery workflow. To support collaborative data inquiry, we present encube, a large-scale comparative visual analytics framework. Encube can utilise advanced visualization environments such as the CAVE2 (a hybrid 2D and 3D virtual reality environment powered with a 100 Tflop/s GPU-based supercomputer and 84 million pixels) for collaborative analysis of large subsets of data from radio surveys. It can also run on standard desktops, providing a capable visual analytics experience across the display ecology. We discuss the potential for integration with graphTIVA - our GPU-accelerated terascale visualisation and analysis framework, which has now been deployed successfully via Amazon Web Services. Encube builds a bridge between high-end display systems (such as CAVE2) and the classical desktop, preserving all traces of the work completed on either platform — providing a research process that can be continuous regardless of location.

Matthew Whiting (CSIRO)

Title: *CSIRO's ASKAP Science Data Archive (CASDA) – Visualisation Tools*

Abstract. The CSIRO ASKAP Science Data Archive (CASDA), a project developed jointly between CSIRO IMT and CASS, is the public repository of all ASKAP data products, and will provide the interfaces through which astronomers will access ASKAP data. It will present two-dimensional images, one-dimensional spectra, three-dimensional (and large) data cubes, as well as tabular catalogues and other metadata. Part of the challenge of this archive is providing users with a clear indication of what is in the data products. After introducing CASDA, I will present some of CASDA's solutions that allow visualisation of the data and discuss potential future enhancements.

Xinyu Wu (CSIRO)

Title: *Visualisation of ASKAP Operations via OMP*

Abstract. OMP - a web application for scientists to submit and manage their observation, for operators to manage, schedule and monitor the observations. One endeavour of OMP is to be more visual based rather than text based. Great effort was made to display information in visually clear, concise and beautiful ways rather than a great amount of texts. In this talk I will introduce frameworks which made the aspirations possible, and some interesting visualisation concepts.