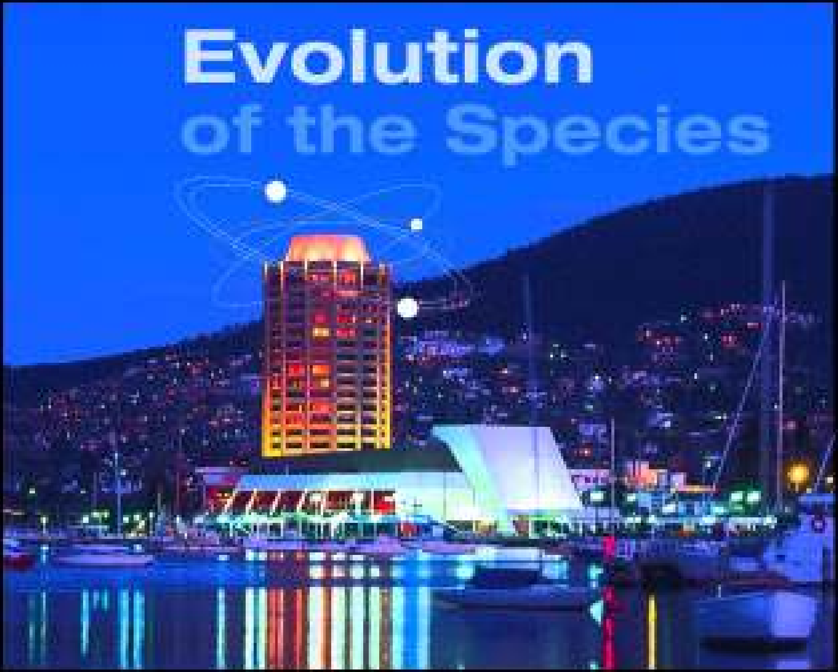


25 to 28 September 2005
Wrest Point Conference Centre, Hobart

Using Mac OS-X to drive immersive displays for science visualisation and education.

Paul Bourke
Centre for Astrophysics and Supercomputing
Swinburne University

Contents: Exploiting the capabilities of the human visual system

Three aspects of the human visual system not generally catered for by traditional flat displays.

- Binocular vision - Stereoscopic projection
- High resolution - Tiled (flat) displays
- Peripheral vision - Dome environments

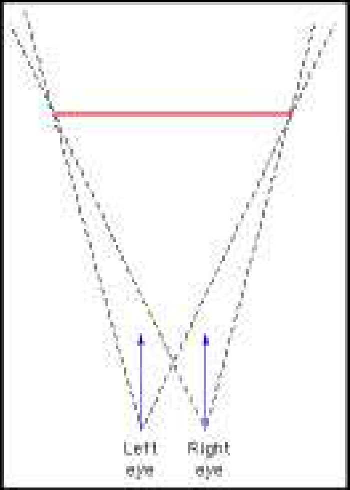
Unfortunately all these require special hardware that is difficult to transport.

Motivation

- Visualisation: insight into complicated/large datasets. Examples mostly from data rather than illustrative visualisation.
- Compelling and visually rich representations of data.
- Engaging content for school education.
- Content and displays for public outreach.
- Museum and science exhibitions.
- Commercial opportunities that support science research within the Centre

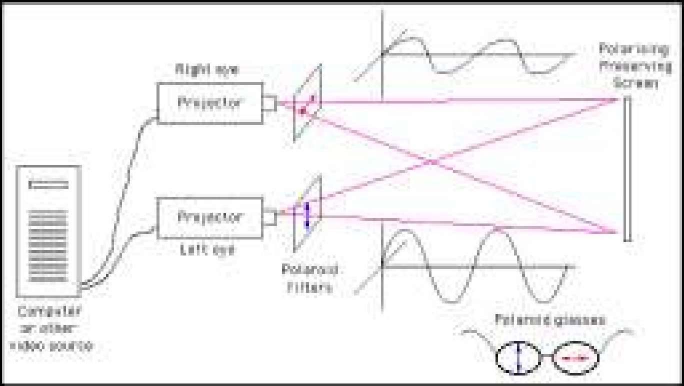
Stereographics

- In the real world our eyes get two independent views of the world. Our visual system uses these two views to give us a sense of depth.
- The goal of stereoscopic projection is to present two synthetic images to the eyes. If the images are constructed and presented correctly the same depth perception will occur.
- Offaxis perspective frustum. Direct support in OpenGL for interactive applications, also possible in animation/rendering packages that don't have explicit stereoscopic support.



Technology options

- Frame sequential stereo: generally CRT for 120Hz switching. Also called active stereo because the glasses have active electronics. The most common form of monitor based stereoscopy.
- Polaroid (also Infitec): uses two DLP projectors and simpler glasses.
- Autostereoscopic: no glasses required but unfortunately still very low resolution.



Hardware for passive stereoscopy

- Active stereo (Frame sequential), not properly supported by graphics cards and drivers on the Mac.
- Passive stereo requires a G5 with an "above average" dual display card.

AUC

QuickTime for movie playback

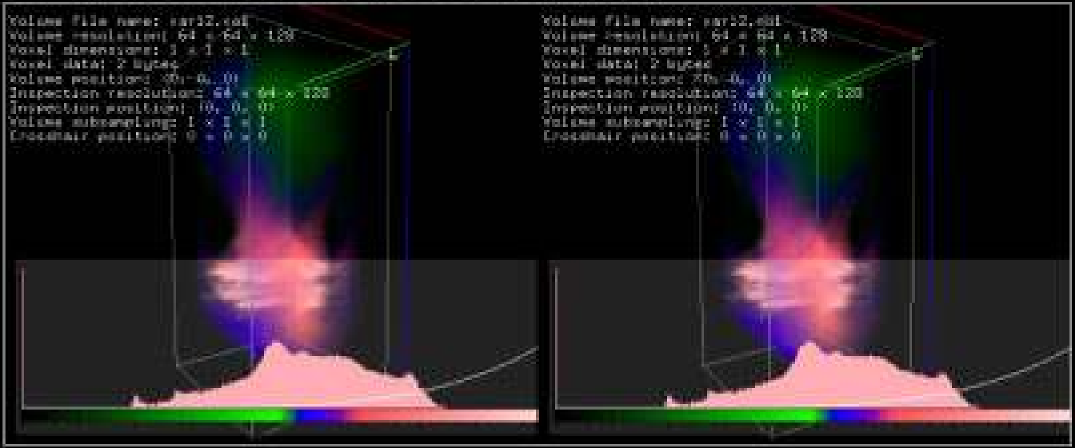
- Custom QuickTime player, 2048x768 pixel movies @ 25fps.
- Photo JPEG compression, high quality. (Pixlet?)
- Editing all in Final Cut Pro, immediate edit/view from G5.
- Requires the better graphics cards to achieve smooth playback at the image quality we aim for.

Stereoscopic movie example: After Stars

Discusses the death of a star, will it become a blackhole or pulsar?

Interactive applications

- Based upon OpenGL which has direct support for offaxis frustums [glfrustum()].
- Single window spanning dual displays, render geometry twice, once for each eye position.
- All our applications are portable between Linux and Mac OS-X by using GLUT and X-Windows based GUI libraries.



Victorian coal fired furnace

AUC

Stereoscopic photography and filming

- Dual digital still or video camera.
- Designed a custom rig.
- Recently tested HD cameras. (With assistance from the AUC)
- All editing and alignment of 2 video streams using Final Cut Pro.
- Main issues arise from camera size (hyperstereo eye separation) and progressive scan.

Stereoscopic panorama

- Developed a stereoscopic version of QuickTime VR+.
- Two panoramic images: currently support spherical, cylindrical, or cubic.
- High resolution (eg: 8000x4000 pixels).
- Remove "up" constraint.

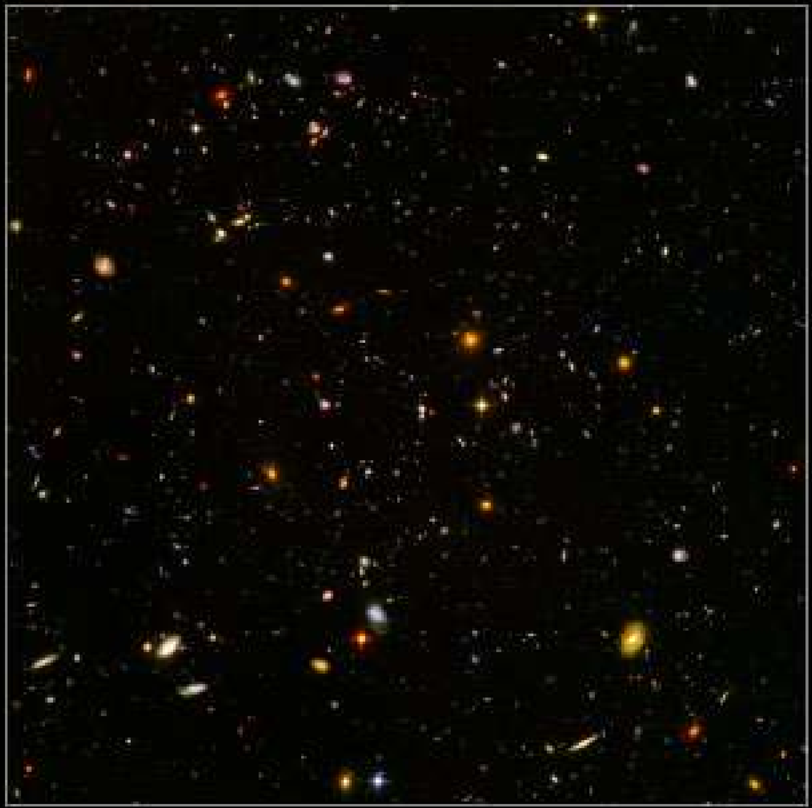
Jeffrey Shaw

AUC

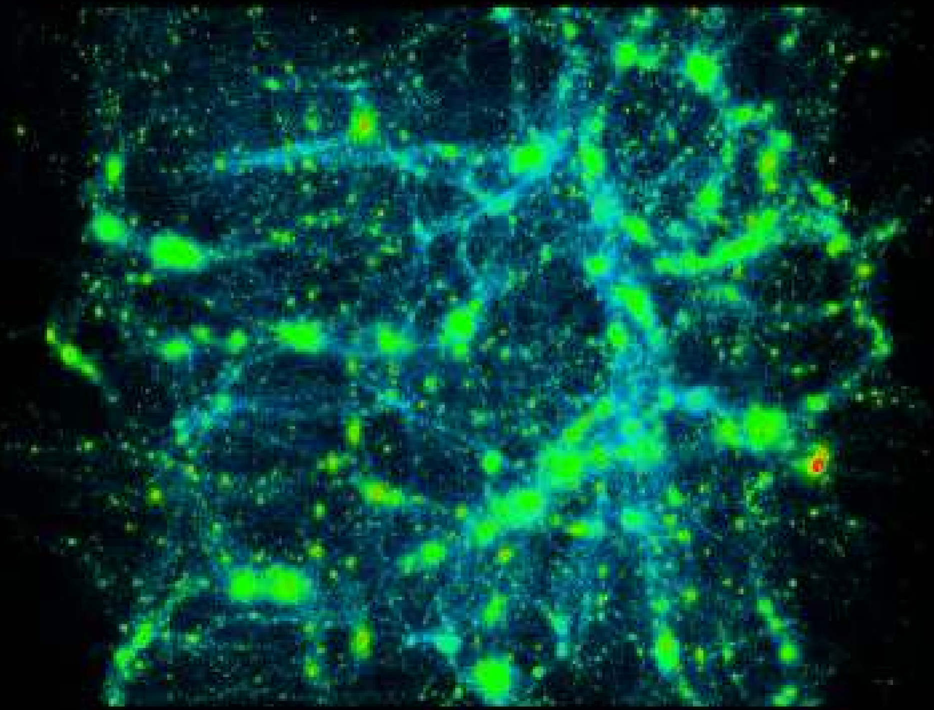
Tiled displays
(Early stages of development)

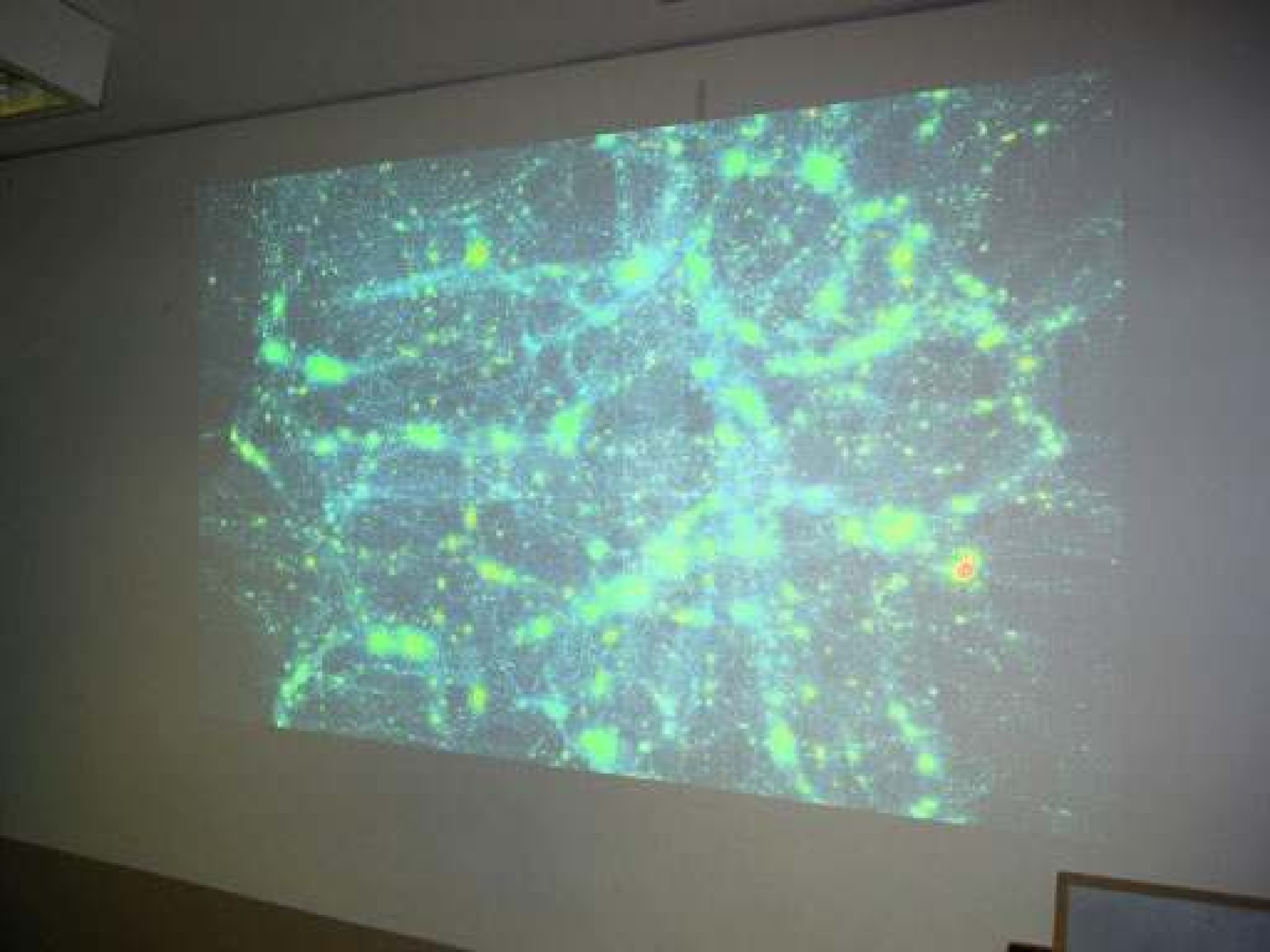
- Required for high resolution images or high density data.
- Three options for a seamless image
  - Projector based alignment.
  - Soft edge blending in software (gamma corrected).
  - Physical masks + softwware clipping.
- Ideally rear projection displays.
- One dual display G5 per display. Lack of support by Apple for genlock cards (eg: Wildcat & nVidai)!
- Examples
  - Hubble ultra deep field
  - Cosmology simulation

Hubble ultra deep field



Simulation data: cosmology





Dome projection

- Viewing data with a wide field of view on a flat display introduces distortion, eg: spherical maps.
- Looking at a small section and panning/zooming loses the overall relationship between features.

Avela

Upright domes

iCinema, UNSW

Traditional approaches

- Multiple CRT projectors (Large fixed installations, eg; Perth, Brisbane, Melbourne).
- Multiple digital projectors (Fixed installations).
- Single (or double) projector with fisheye lens.
- Only single projector solutions are suitable for small portable domes.
- Until a year ago a fisheye lens was the only single projector option!

Panodome: QuickTime VR++

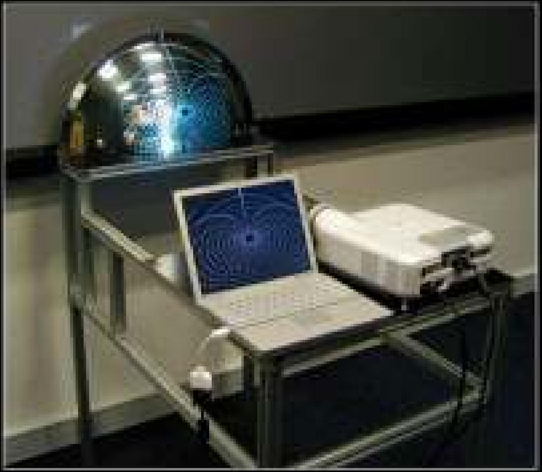
Peter Murphy

Spherical mirror

- Alternative solution to fisheye projector solutions at a fraction of the cost.
- Fisheye images need to be warped so the result in the dome appears undistorted.

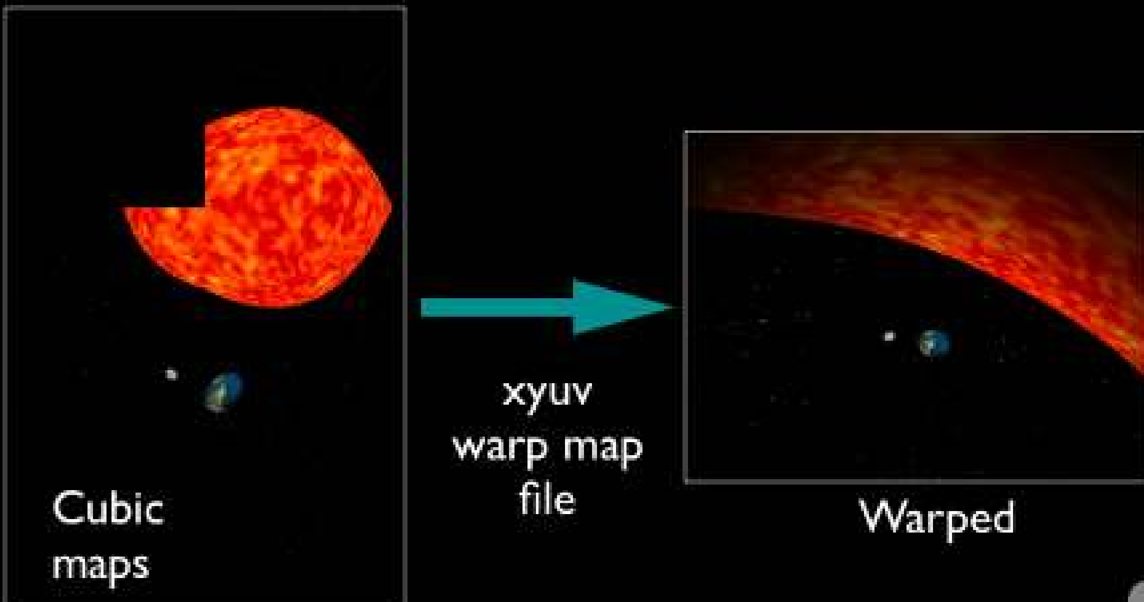
Advantages

- Frees up middle of dome.
- Flexibility in choice of projector.
- Control over dome coverage.
- Low cost.
- Scalable to 2 mirrors/projectors.

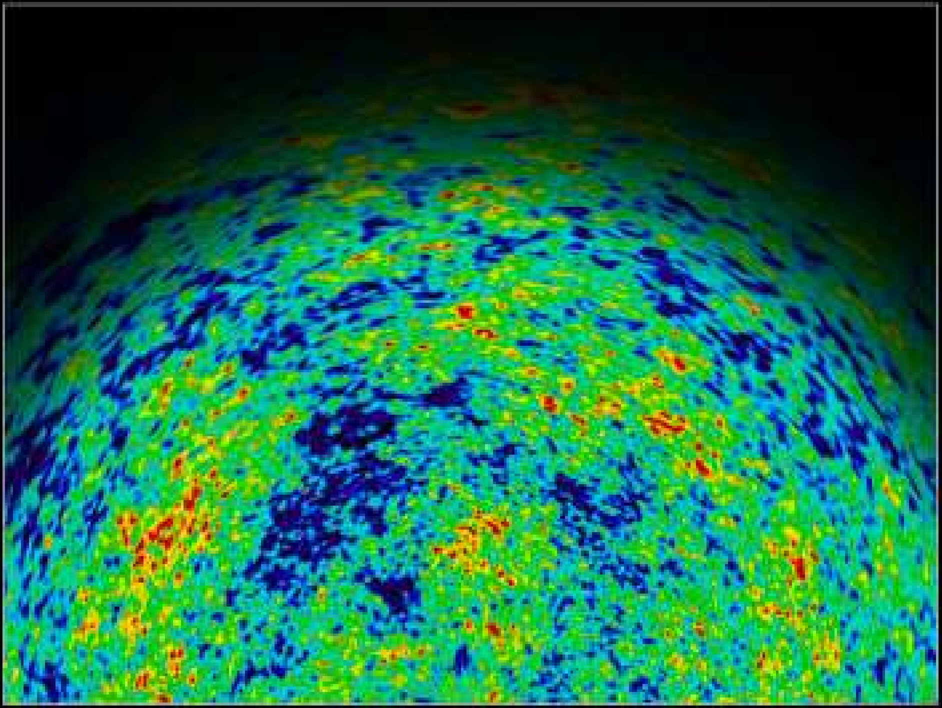


Warping for realtime applications

- Multipass rendering in OpenGL using cubic maps: 4 offscreen renders + 1 texture render pass per frame.
- The trick is computing the texture coordinates for the mesh onto which the textures are applied.



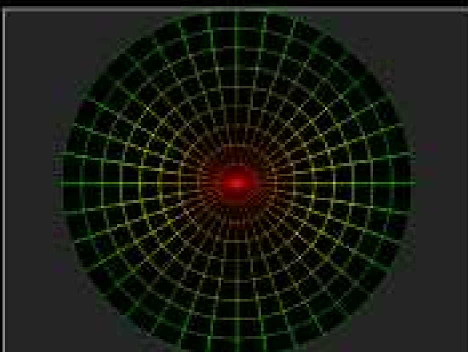
Cosmic background microwave radiation



The furthest back in time we can "see".

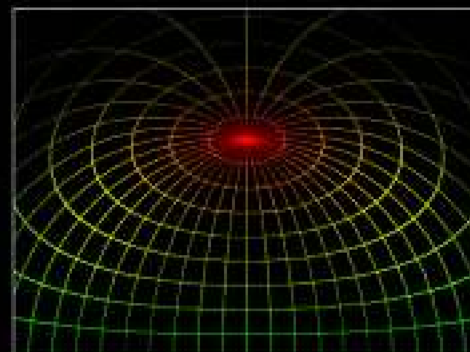
Warping fisheye images and movie frames

- Off line processing of movie frames.
- Realtime on-the-fly warping in QuickTime 7 (Experimental). Advantage that the same Quicktime (fisheye) movie can be used in different geometric environments.
- Typically use 30fps, high quality PhotoJPEG codec, playback from PowerBook.



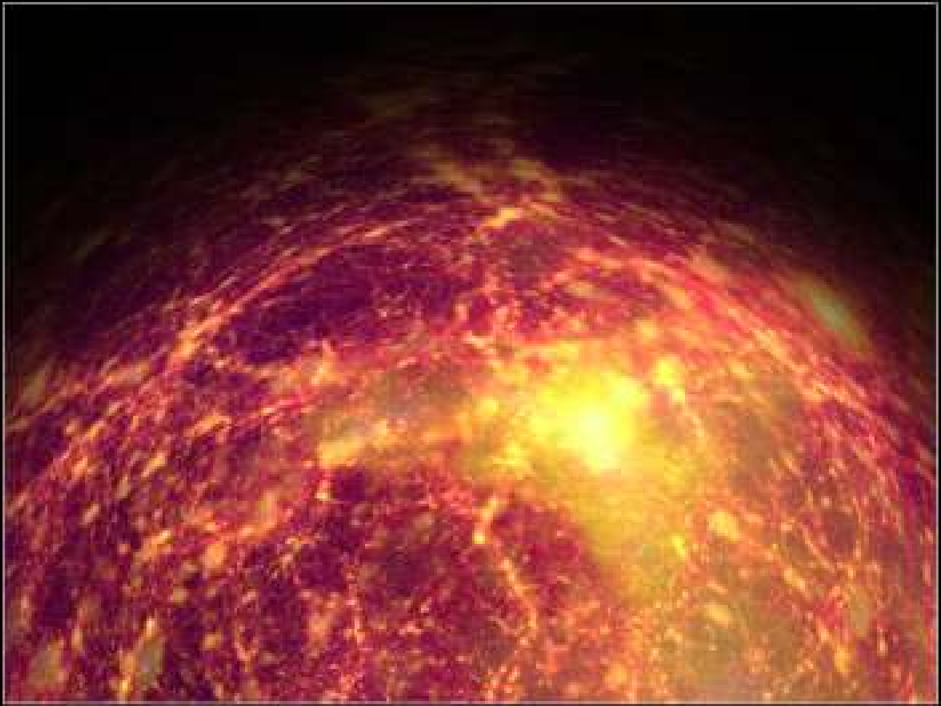
Fisheye

uvxy
warp map
file



Warped

Cosmological simulation



Dr Chris Power

Educational fulldome movies

Oasis in Space

Questions?