Abstract# 2111

OpenSpace: Setting the Universe Free

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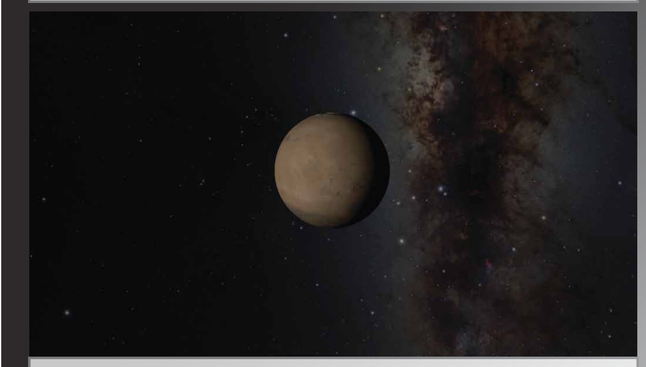
Lamont-Doherty Earth Observatory
Columbia University | Earth Institute

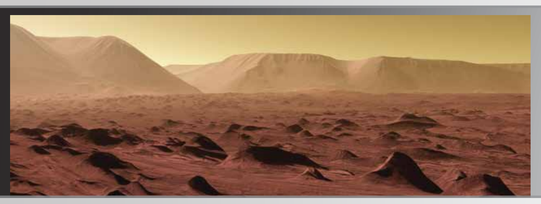
American Museum of Natural History

Planet-Perspective

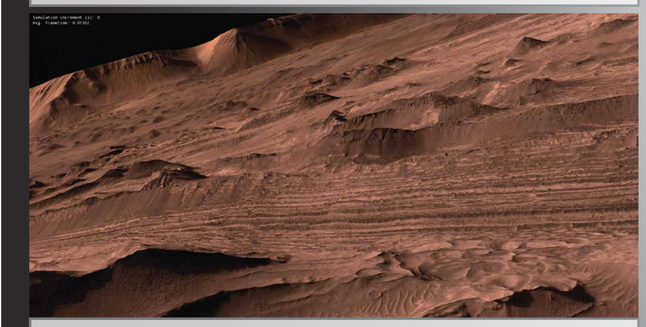
- Center on any planet in the Solar System
- View datasets draped on topography from landers, rovers and orbiters
- Easily change perspective and orientation



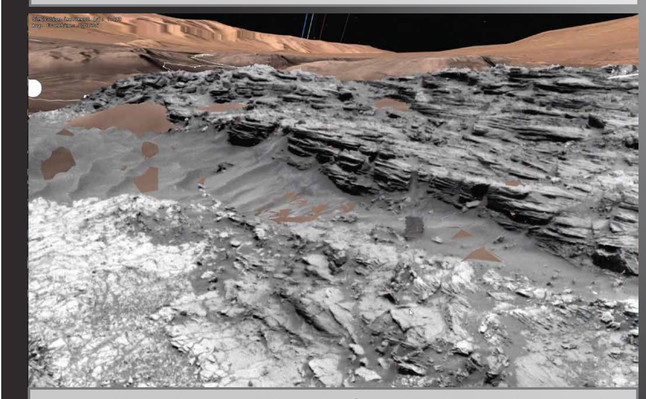
Mars and the Milky Way galaxy.
Viewpoint is 36500km from Mars.



Western Candor Chasm, Mars made with high resolution Mars Reconnaissance Orbiter data.



Mars: Orbital mapping combined from MRO CTX and HiRISE, and MGS MOLA and MOC data [7].



Mars Gale Crater: Blend of multiple scale terrain maps from orbit with rover terrain overlays [7].

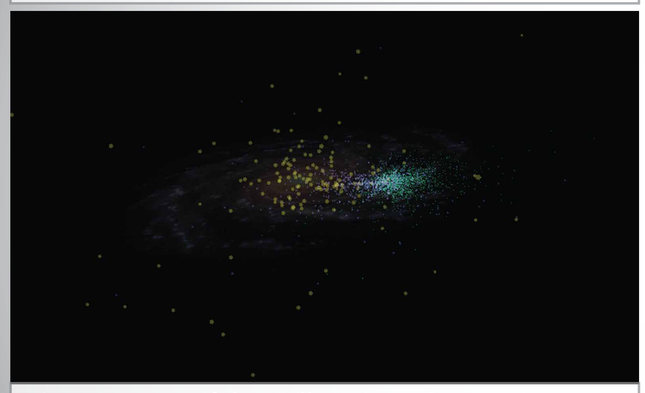
★ Capable of displaying ANY global dataset, including chemical, not shown here. ★

For a full list of datasets, contributors, downloads, and more. ←

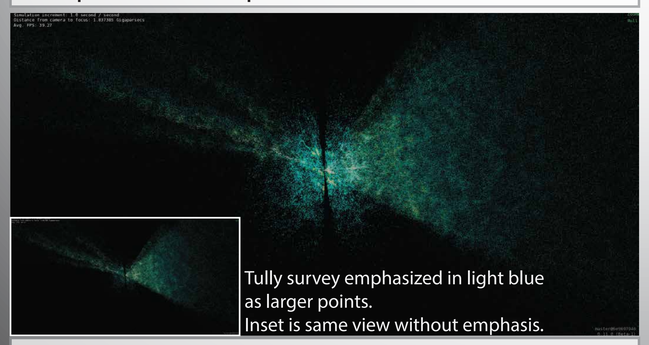
Universe-Perspective

- Zoom from planet perspective to Solar System to galaxy to cosmic microwave background
- Ability to emphasize specific datasets
- Gain a sense of scale

Stars with names and constellation outlines. Relative position in multidimensions is evident from this viewpoint (3.5 parsecs from Earth). Size of text is proportional to proximity of star to Earth.

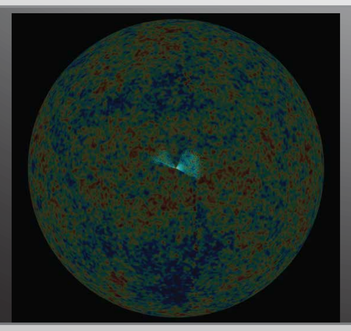


Edge-on view of the Milky Way galaxy with color-coded clusters: globular (yellow), stellar (green), planetary nebulae (blue/purple). Viewpoint is 49.5 Kpc from Earth.



Tully survey emphasized in light blue as larger points.
Inset is same view without emphasis.

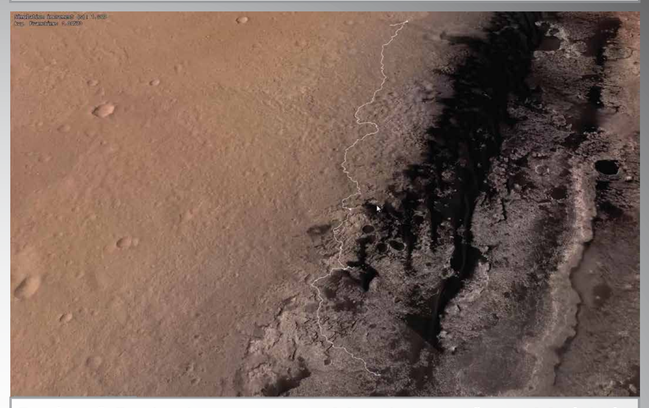
Tully and Sloan galaxy surveys. Each point is a galaxy. Viewpoint is 1.84 Gpc from Earth.



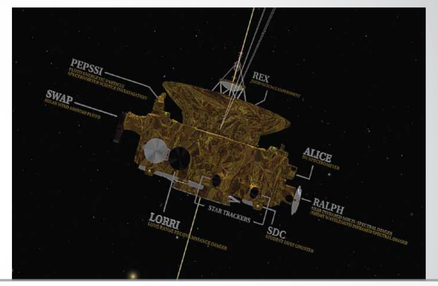
WMAP cosmic microwave background overlieing Sloan galaxy survey. Viewpoint 46 Gpc from Earth.

Mission-Perspective

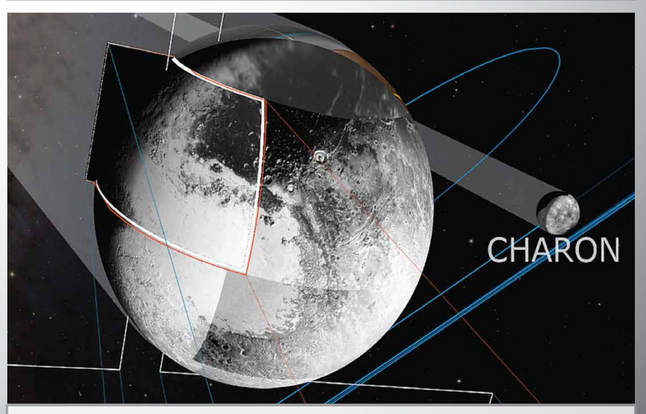
- Follow and visualize the paths of missions both in space and time
- View renderings of spacecraft
- Visualize high-resolution data *in situ*



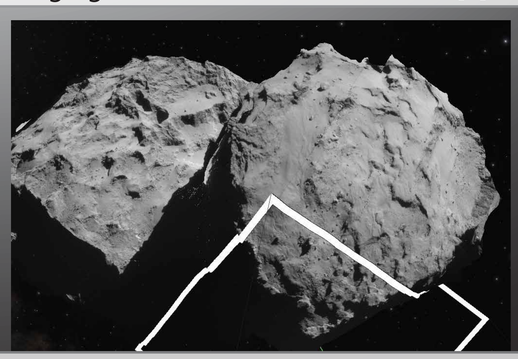
Path of Curiosity rover on Martian surface. Multiple datasets integrated for accurate 3D render [7].



New Horizons mission spacecraft, instrument labels turned on [7].



New Horizons' encounter with the Pluto system. Projection of LORRI camera images onto Pluto with accurate background stars (from DU) and pointing and imaging frustums from SPICE kernels [7].



Projection of Rosetta's NAVCAM images on to comet 67P/Churyumov-Gerasimenko [3].

Open Space

- OpenSpace [1] is an open source, interactive software designed to visualize the known universe and portray our ongoing efforts to investigate the entire cosmos.
- Bringing the latest techniques from data visualization research to the general public, OpenSpace supports interactive presentation of dynamic data from a multitude of observations and simulations, as well as space mission planning and operation on a variety of platforms, simultaneously across continents.

Datasets

- *Digital Universe (DU)*: The AMNH 3D atlas of the cosmos.
- *Missions*: Dynamically visualized within the DU.
- *Simulations and Atmospheres*: Accurately represented.
- Additional datasets continuously being added.

Platforms

- Scalable to nearly ANY platform from computer screens to classroom projectors to planetarium domes.
- Most of the images on this poster were obtained from OpenSpace run on a desktop PC: 16Gb ram, Intel i5 4670k cpu at 3.4 Ghz, and Nvidia GTX960 graphics card.

Team

- OpenSpace builds on a collaboration between Sweden's Linköping University and the AMNH by including computer science experts at University of Utah's Scientific Computing and Imaging Institute and NYU's Tandon School of Engineering.
- Multiple informal science institutions (ISI's) are actively engaged in the emerging OpenSpace ISI Network.
- The AMNH team has worked with scientists from OSIRIS-REx, New Horizons, MESSENGER, the NASA Goddard Community Coordinated Modeling Center, and others to incorporate their mission activities and data into the platform for public education and engagement.

Features and Capabilities

- A scale graph approach to handle coordinate systems of magnitudes from outcrops to the Universe.
- Volume visualization techniques to inspect, verify, and make simulation output available to the public.
- Interface to NAIF's SPICE navigation and spacecraft pointing kernels.
- Capability to display fields-of-view of instruments and missions.
- Seamlessly switch between single-user/machine operation to planetarium dome display.
- Synchronization for networked remote education.
- Globe browsing techniques across spatial and temporal scales to immersively explore scientific campaigns.
- ○ Record and image exploration sessions for education and research.
- ○ Ability to interface with PDS archives.

What would you use visualization software for? The possibilities with OpenSpace are infinite!

References

[1] http://openspaceproject.com/ Home [2] https://www.youtube.com/watch?v=26BEYD2XYzs OpenSpace video showing two New Horizons image cam-paigns on Pluto and representing the increase in image resolution that was achieved on July 14th, 2015 [3] https://www.youtube.com/watch?v=gqWBgL4wSjo Rosetta comet 67P imaging campaign visualization [4] https://www.youtube.com/watch?v=NWZAg6qpMIE Mars terrain from HiRISE orbiter data in OpenSpace [5] https://www.youtube.com/watch?v=3exuifro1aM VIIRS satellite Earth data renderings in OpenSpace [6] P. Schultz, pers. comm. 3-Nov-2017 [7] Carter Emmart Vimeo

Acknowledgements

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