Visualization of ASH Simulations of Stellar MHD with SDvision

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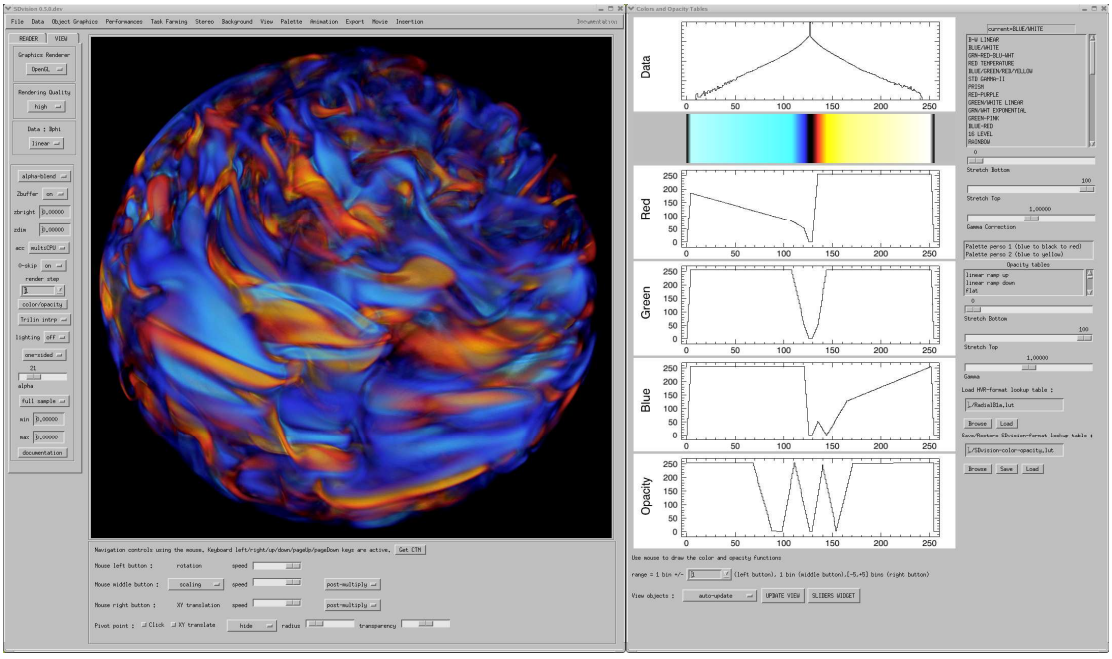
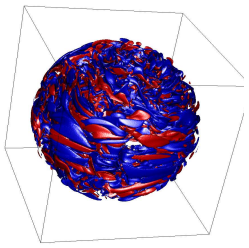
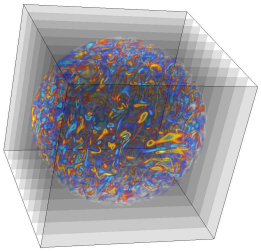
With the growing power of high performance computing centers, simulation is playing a leading role in the study of astrophysical objects. The ASH Anelastic Spherical Harmonics program is used to perform high-resolution three-dimensional simulations on massively parallel mainframes with up to several thousands processors, with a special emphasis on the MHD processes occurring in the convection zone of the Sun and other stars. The size and complexity of the data produced in these simulations require to use special software tools at the post-treatment, visualization and analysis stages. The need for interactive and immersive visualization of such data has motivated the development of the SDvision graphical interface. This tool is deployed in the framework of IDL Object Graphics and offers several ways to visualize the scalar and vector fields produced in the simulations. Scalar fields are visualized through either a ray-casting volume rendering, an isosurface reconstruction, a texture mapping algorithm, or through volume slicing. In the volume rendering implementation, the RGB colors and transparencies lookup tables can be tuned interactively to enhance the visualization of the turbulent structures that characterize these data. Vector fields are visualized by hedgehog displays or by streamlines that can be seeded interactively. The SDvision tool provides a visualization of the scene though either an OpenGL, hardware-based rendering or through a pure software computation.



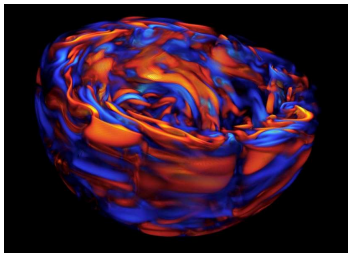
The SDvision graphical interface used here to visualize the azimutal component of the magnetic field in the solar convection zone. The rendering is obtained with the ray casting technique with alpha-blending compositing. The color and opacity lookup tables are fine-tuned and displayed against the data distribution on the right-hand side widget.



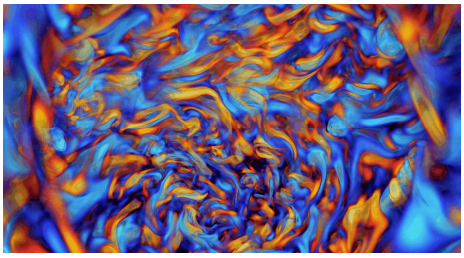
Rendering of isosurfaces (marching-cube algorithm)



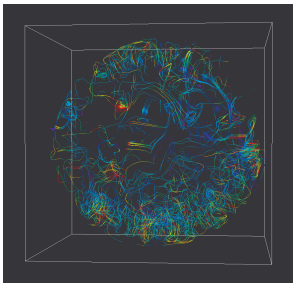
Rendering of volume with a stack of 2D textures



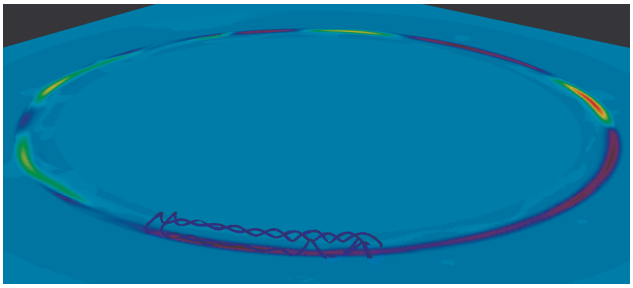
Volume clipping in the ray-casting rendering



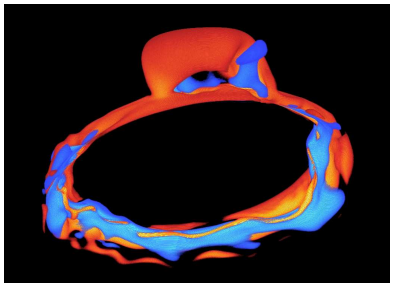
Wide-angle, immersive view, of a 500x500x500 simulation of the magnetic field in the solar convection zone



Visualization of the velocity field with color-coded streamlines seeded on a grid



Visualization of a streamtube seeded interactively in the scene. The image is a slice of the magnetic energy field



Development of a magnetic field loop visualized by the ray-casting technique

References
ASH simulations : *Global-Scale Turbulent Convection and Magnetic Dynamo Action in the Solar Envelope,* A.S. Brun, M.S. Miesch, J. Toomre, Ap.J. 614 (2004) 1073
Three-Dimensional Nonlinear Evolution of a Magnetic Flux Tube in a Spherical Shell: Influence of Turbulent Convection and Associated Mean Flows, L. Jouve, A.S. Brun, Ap.J. 701 (2009) 1300
SDvision : *Interactive Visualization of Astrophysical Plasma Simulations with SDvision*, D. Pomarède, *et al.*, ASP Conf Series, 385 (2008) 327

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