

# The advantage and the disadvantage for 3-dimensional scientific visualization with computer graphics

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## 1 Introduction

In scientific visualization for astronomical phenomena, we choose 3-dimensional stereoscopic visualization with Computer Graphics (hereafter, CG). Because CG has versatile expressiveness, we can depict phenomena or physical law more educationally-valid and beautifully. Since 2005, Four-Dimensional Digital Universe project<sup>1</sup> (hereafter, 4D2U) have been providing the instructive images which are originated by latest numerical simulation for astrophysics. Especially, stereoscopic viewing technique is helpful to understand the academic significance and gives us *immersive* environment in universe. Recent years, in fashion 3D cinema made full use of CG, scientific stereoscopic images attract rising attention.

## 2 The advantage of scientific stereovision

Our universe composed of 3-dimensional space and time. In the universe, position and shape of object changes with time. Ideally, stereoscopic view would express realistic 3-dimensional space on the 2-dimensional screen or display. And therefore, we can see phenomenon of nature which is regularly invisible such as galaxy, Sun, neutron star and so on. (See Fig. 1.) Such images will give us aesthetic satisfaction. From now on, it is important to produce the instructive images not only for entertainment of people but also reliable information and intellectual stimulation.

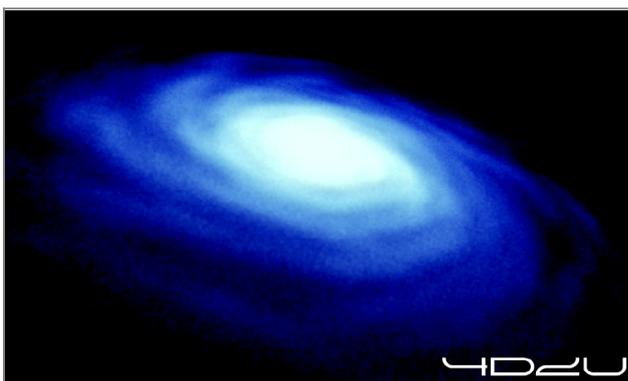


Fig. 1. Spiral Galaxy calculated by numerical simulation<sup>2</sup>. Image credit 4D2U.

## 3 Heteroptics by 3-dimensional drawing

CG can draw the object with quantitative parameters related physical quantity or state. It is convenient to visualize the result of numerical simulation. And therefore, the time evolution of system could be expressed in 3-dimensional CG space, easily. Although the stereoscopic view is useful to express the universe, there is possibility to cause misreading in some situations. The

visual recognition of human is sensitive about environment. In other words, we can not always recognize the shape or color of object in 3-dimensional CG space. Here, we introduce some examples of heteroptic in our works. It is noted that we could not avoid heteroptic because heteroptic is mostly caused physiologically.

### 3.1 Hollow face illusion

Fig. 2. shows time evolution of isosurface of entropy for magnetohydrodynamics simulation of supernova explosion<sup>3</sup>. For visualization, it is important to draw the time evolution of asymmetrical structure. View of camera directs the origin and revolves around. To verify the asymmetric structure of inside isosurface, the half of isosurface is cutaway. From 2 to 6 in Fig. 2, some people experience the inversion of depth. This is called hollow face illusion<sup>4</sup>. We confuse the depth and the structure of isosurface.

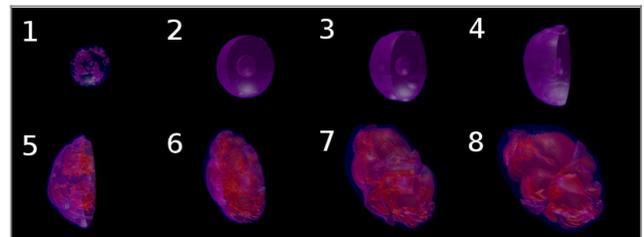
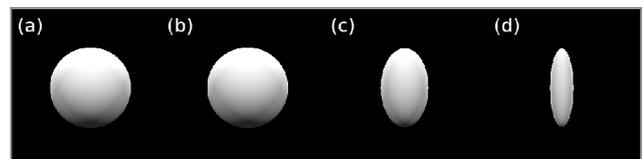


Fig. 2. Cutaway view of isosurface

### 3.2 Misreading of Scale

CG can treat various size and shape of object. It would be useful to distinguish the physical state. Fig. 3. shows misreading of the scale. Although many people think (a) and (b) are identical, (a) has two times larger radius than that of (b) but the distance from camera is two times farther than that of (b). Some people would feel vertical length of (d) is larger than that of (b). But the length of them is same. Slim structure causes



overestimating of length.

Fig. 3. Example of misreading of scale

#### **4 Conclusion**

We aim to produce reliable scientific images. And so, we focus on the expression to explain phenomena from physical standpoint. Stereoscopic view with CG is one of the best method to express the phenomena of nature. But we should not forget some situation leads misreading or heteroptics.

In Japan, Safety guidelines of 3D is proposed by 3D CONSORTIUM<sup>5</sup>. Although the large depth of vision make us eye fatigue in long time viewing of stereovision, discreet rendering would make less enjoyable. If we enjoy short time viewing in several minutes and eyestrain should be light, we could try more impressive expression. It is difficult to define the criteria of safety because the stereoscopic effect and heteroptic is felt different degree each other. In the future work, Improvement of images should be consider not just the geometrical effect such as parallax but the psychological effect. We will utilize the information gleaned from a questionnaire.

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#### **References**

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