

# Virtual Reality Application

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**Aiichiro Nakano**

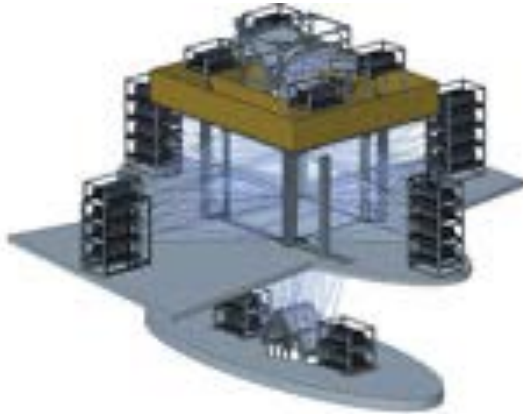
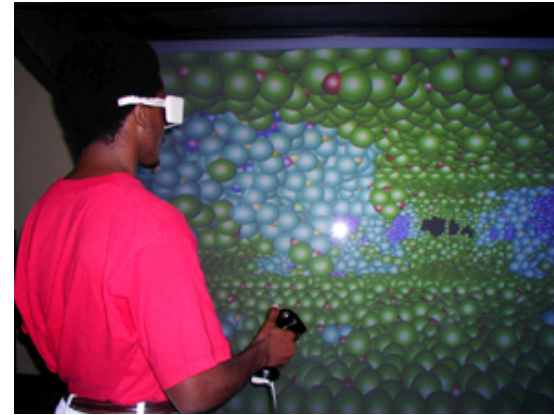
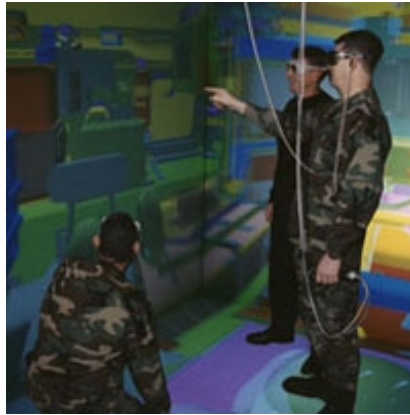
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# CAVE Visualization System

- **CAVE (CAVE Automatic Virtual Environment):** A fully immersive & interactive  $10^3$  virtual environment (VE)
- **ImmersaDesk:** A semi-immersive with a 4'×5' display



CAVE



C6 at Iowa-State VRAC



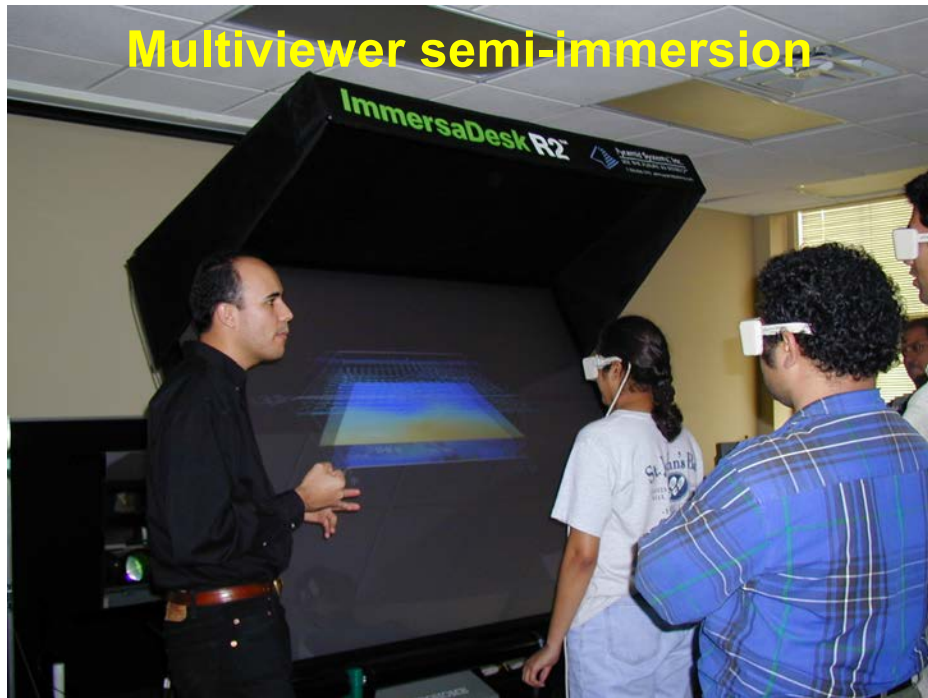
ImmersaDesk

<http://www.vrac.iastate.edu>

<http://www.mechdyne.com>

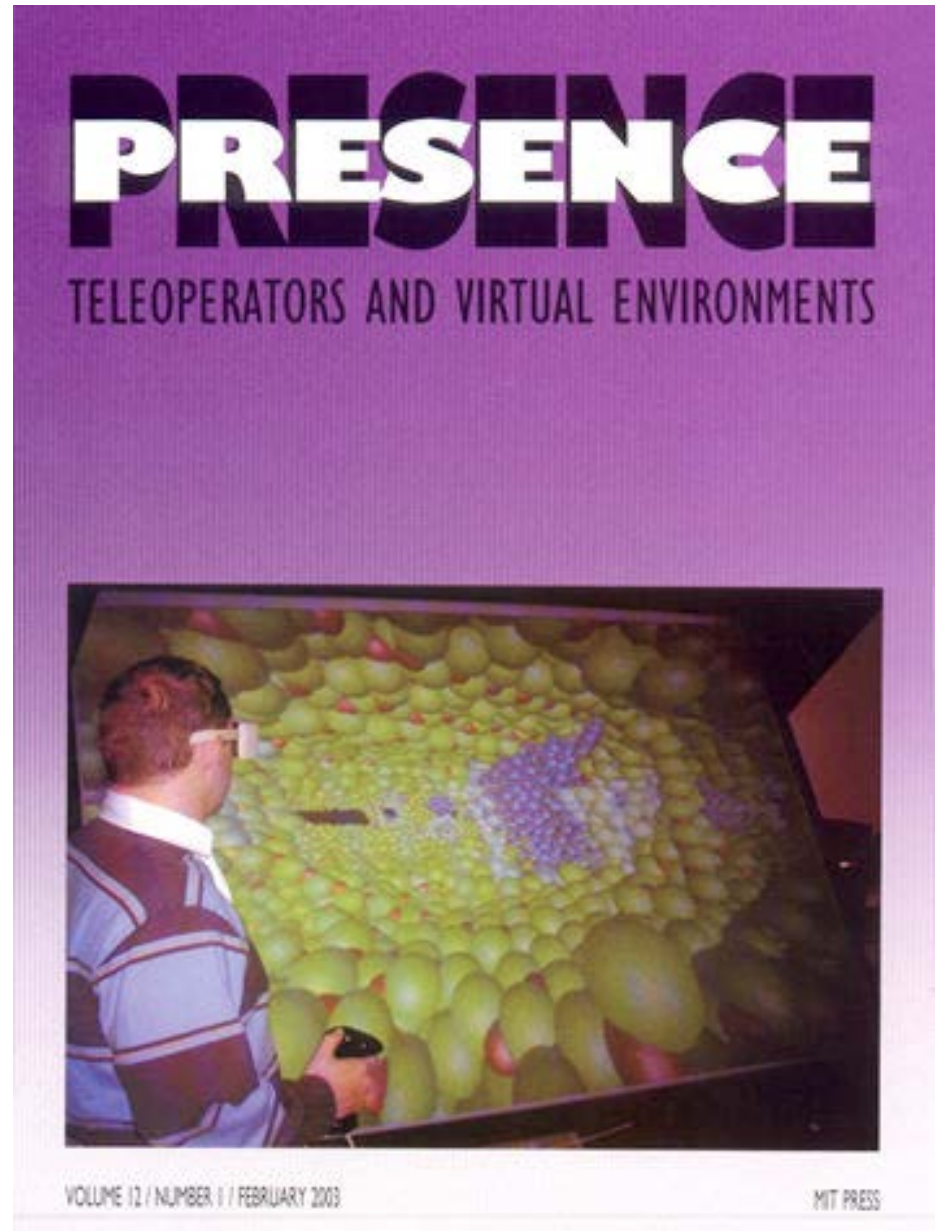
# Billion-Atom Walkthrough

- Achieved real-time walkthrough for a billion atoms in ImmersaDesk



*IEEE Virtual Reality Best Paper*

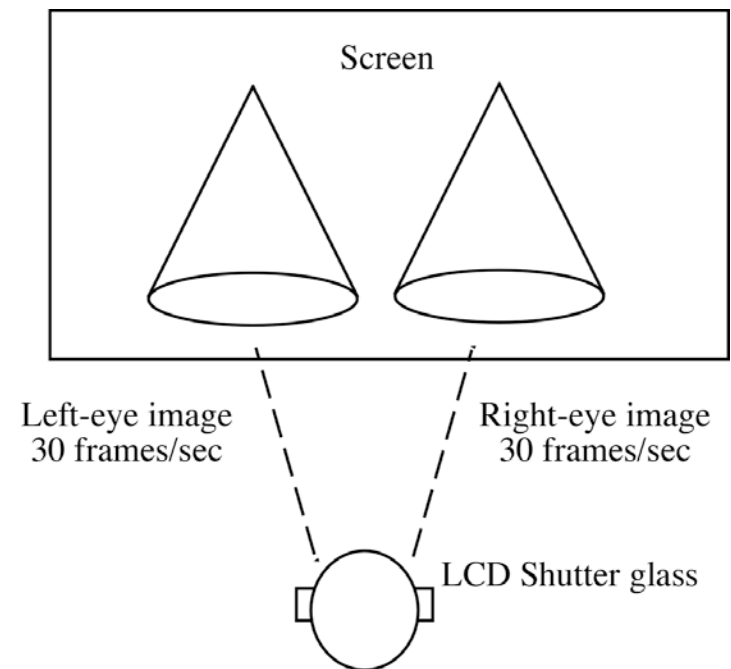
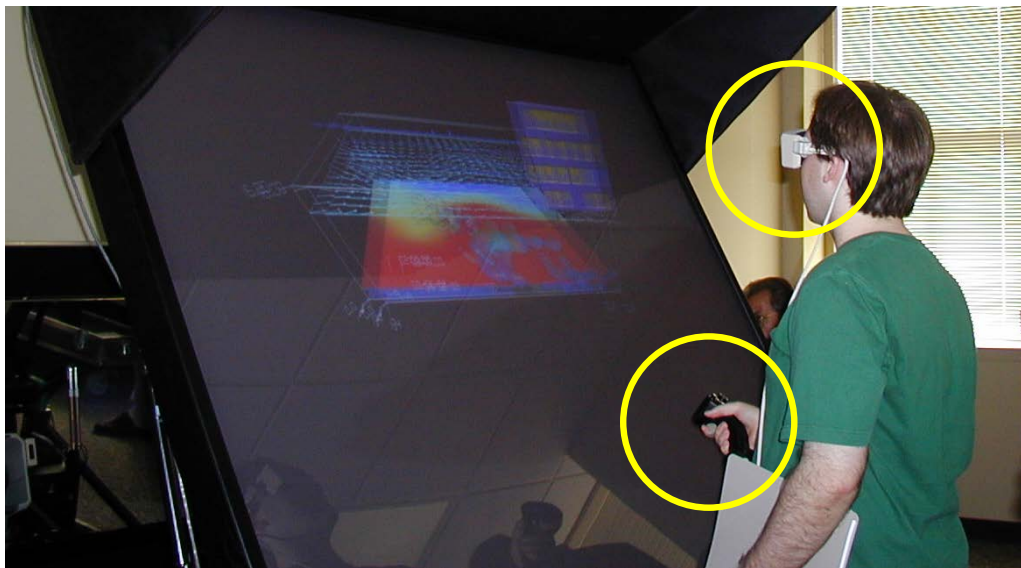
<https://aiichironakano.github.io/cs596/Sharma-Viz-Presence03.pdf>





# CAVE Components

- **Stereographics:** The projector interleaves images for left & right eyes at a rate of 120 frame/s synchronized with an LCD shutter glass via an infrared emitter; 3D perception is created by showing the two eyes slightly rotated objects
- **Wand:** A 3D mouse with buttons; the position & angle of the wand as well as button press are user inputs (*cf.* Wii)
- **Magnetic tracking system:** A sensor is attached to a user's head so that the scene can be changed according to the user's position (*cf.* `gluLookat()`)

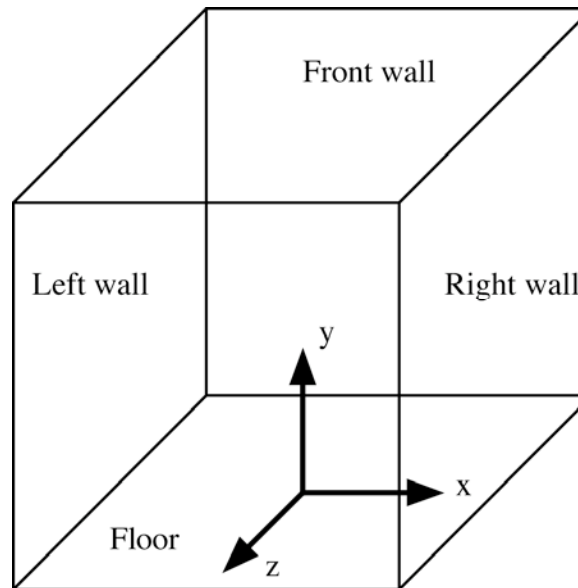


# CAVE Programming

- **CAVE library:** A library of C functions & macros to control the operation of the CAVE: keep all the devices synchronized; produce the correct perspective for each wall; & provide the applications with the current state of all the CAVE elements
- **Compiling a CAVE application:**

```
LIBS = -L/usr/local/CAVE/lib32 -lcave_ogl -lGLU -lGL -lXi -lX11 -lm  
cc -O -o ball ball.o $(LIBS)
```

- **CAVE coordinate system:**  $10^3$  with the origin at the central floor



<http://www.evl.uic.edu/pape/CAVE/prog>

# Example: ball.c

```
#include <cave_ogl.h>
#include <GL/glu.h>

void main(int argc, char **argv) {
    CAVEConfigure(&argc, argv, NULL); CAVEInit(); // Initialize the CAVE
    CAVEInitApplication(init_gl, 0); // Pointer to GL initialization function
    CAVEDisplay(draw_ball, 0); // Pointer to drawing function
    while (!CAVEgetbutton(CAVE_ESCKEY)) sginap(10); // Continue until ESC hit
    CAVEExit();}

void init_gl(void) {
    float redMaterial[] = { 1, 0, 0, 1 };
    glEnable(GL_LIGHT0);
    glMaterialfv(GL_FRONT_AND_BACK, GL_AMBIENT_AND_DIFFUSE, redMaterial);
    sphereObj = gluNewQuadric();}

void draw_ball(void) {
    glClearColor(0., 0., 0., 0.);
    glClear(GL_DEPTH_BUFFER_BIT|GL_COLOR_BUFFER_BIT);
    glEnable(GL_LIGHTING);
    glPushMatrix();
    glTranslatef(0.0, 4.0, -4.0);
    gluSphere(sphereObj, 1.0, 8, 8);
    glPopMatrix();
    glDisable(GL_LIGHTING);}
```

<http://www.evl.uic.edu/pape/CAVE/prog>

# X3D

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- **X3D is an open standards XML (extensible markup language)-enabled 3D file format for real-time communication of 3D data across applications over network**
- **With X3D browsers and plug-ins, X3D becomes immersive allowing a user to walk through the 3D scene**
- **An X3D file is publishable directly on the World Wide Web; an X3D browser acts as a helper application at the client side**
- **X3D homepage**  
`http://www.web3d.org`
- **X3D plug-ins for Windows, Macintosh, and Linux**  
`http://www.web3d.org/x3d/content/examples/X3dResources.html`

**See also Quicktime VR: [https://en.wikipedia.org/wiki/QuickTime\\_VR](https://en.wikipedia.org/wiki/QuickTime_VR)**

# Metaverse Is Coming?

**The New York Times**

October 28, 2021

## *Facebook Renames Itself Meta*

The social network, under fire for spreading misinformation and other issues, said the change was part of its bet on a next digital frontier called the metaverse.



**Metaverse is a speculative future iteration of the Internet, made up of persistent, shared, 3D virtual spaces linked into a perceived virtual universe.**

<https://en.wikipedia.org/wiki/Metaverse>



# 3D in Hollywood

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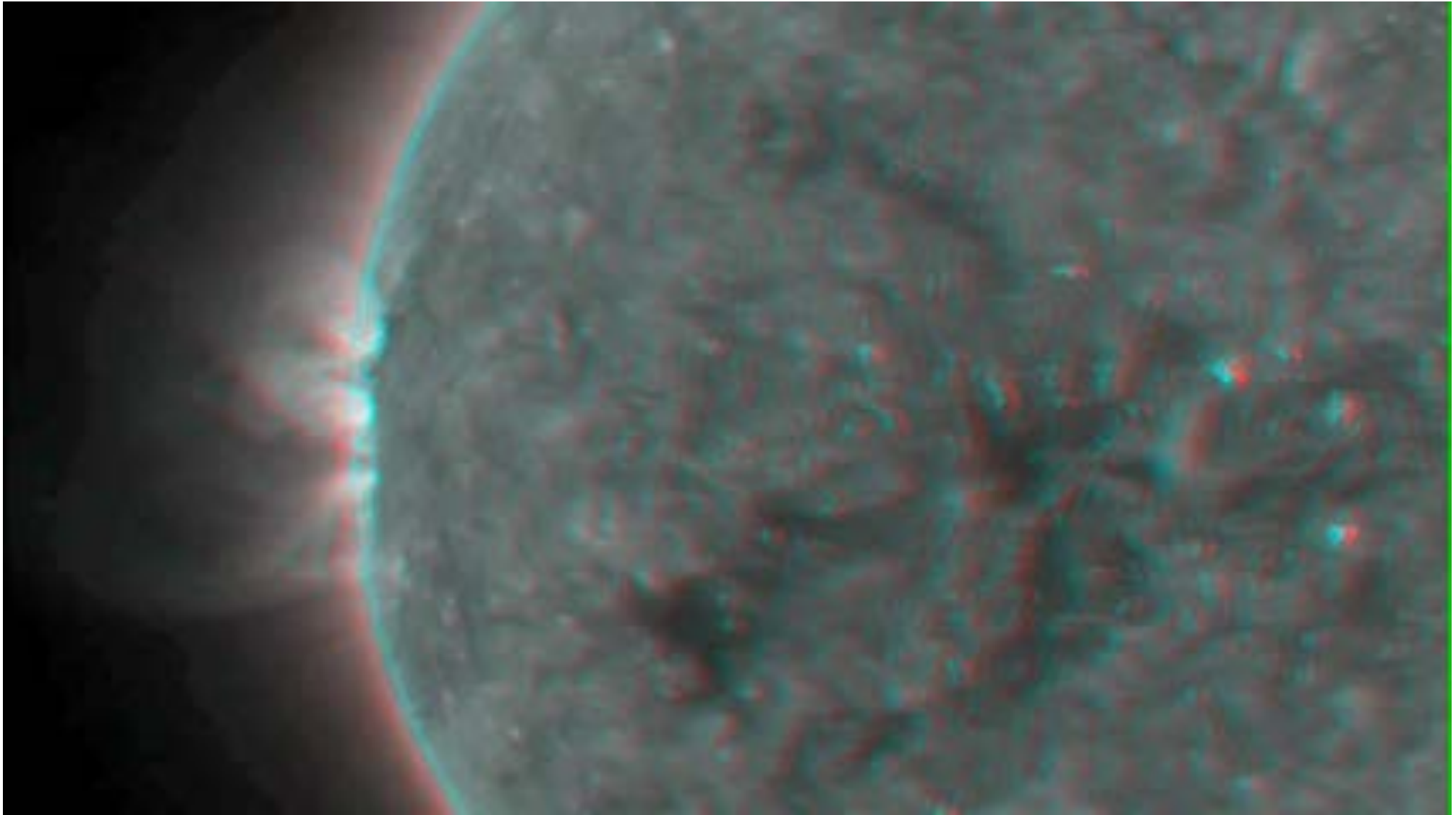


<http://www.youtube.com/watch?v=avecKPWqYqM>

# 3D in Science

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- **Anaglyph:** Stereoscopic 3D effect by means of encoding each eye's image using filters of different colors (typically red & cyan).

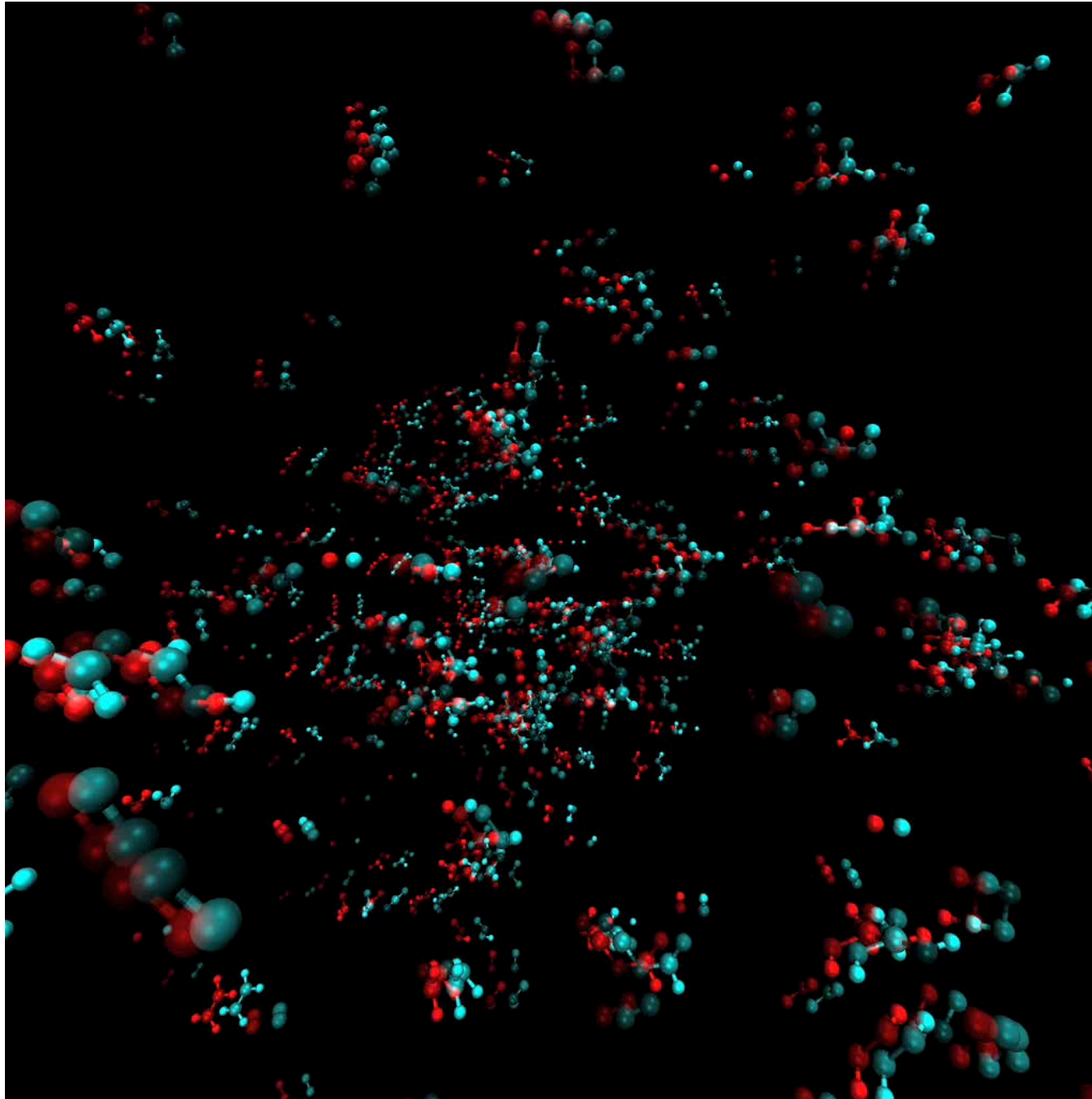


[http://www.nasa.gov/mission\\_pages/stereo/news/stereo3D\\_press.html](http://www.nasa.gov/mission_pages/stereo/news/stereo3D_press.html)



# 3D in Molecular Dynamics (1)

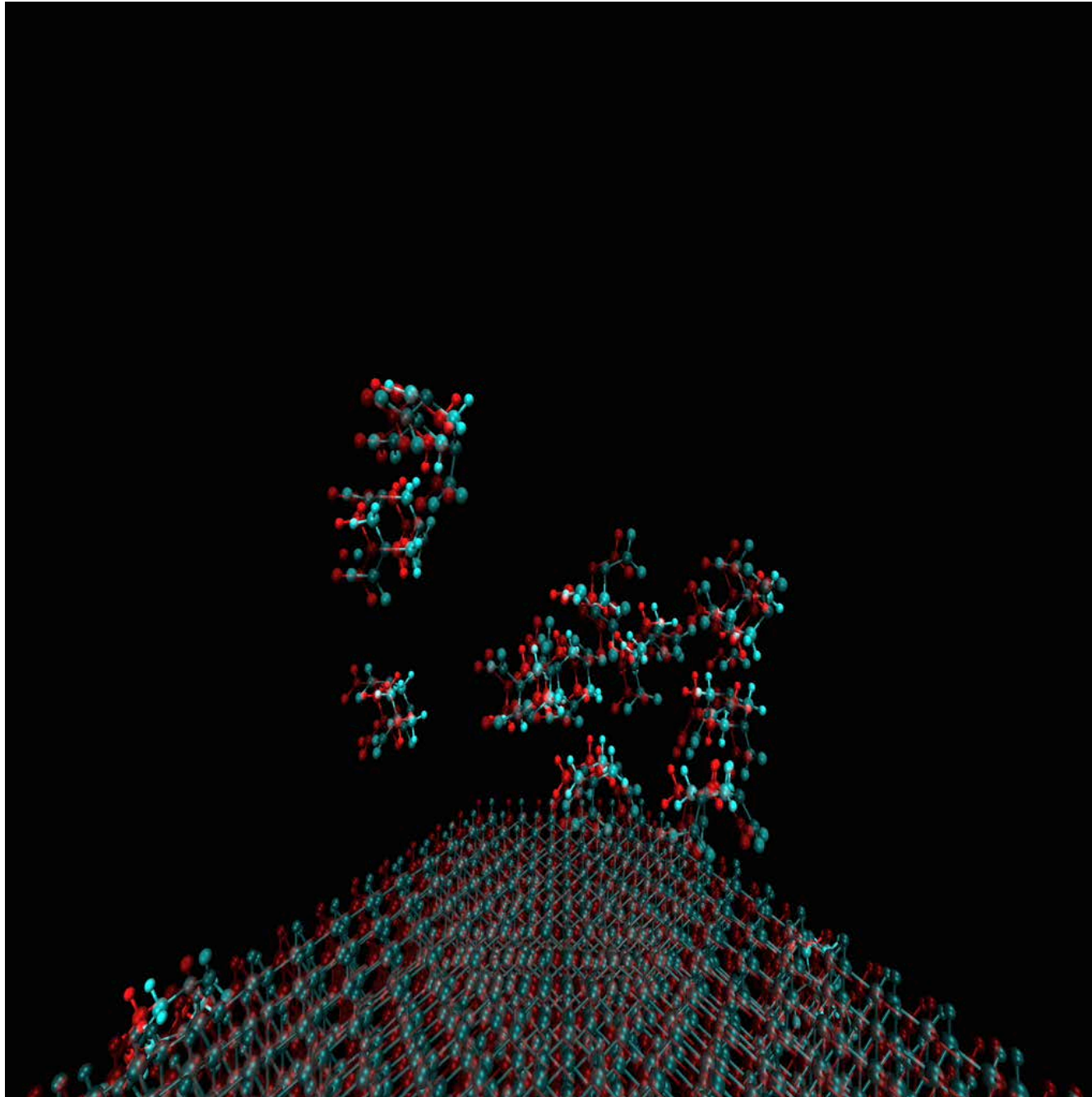
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K. Nomura *et al.*,  
*Phys. Rev. Lett.*  
**99**, 148303 ('07)

# 3D in Molecular Dynamics (2)

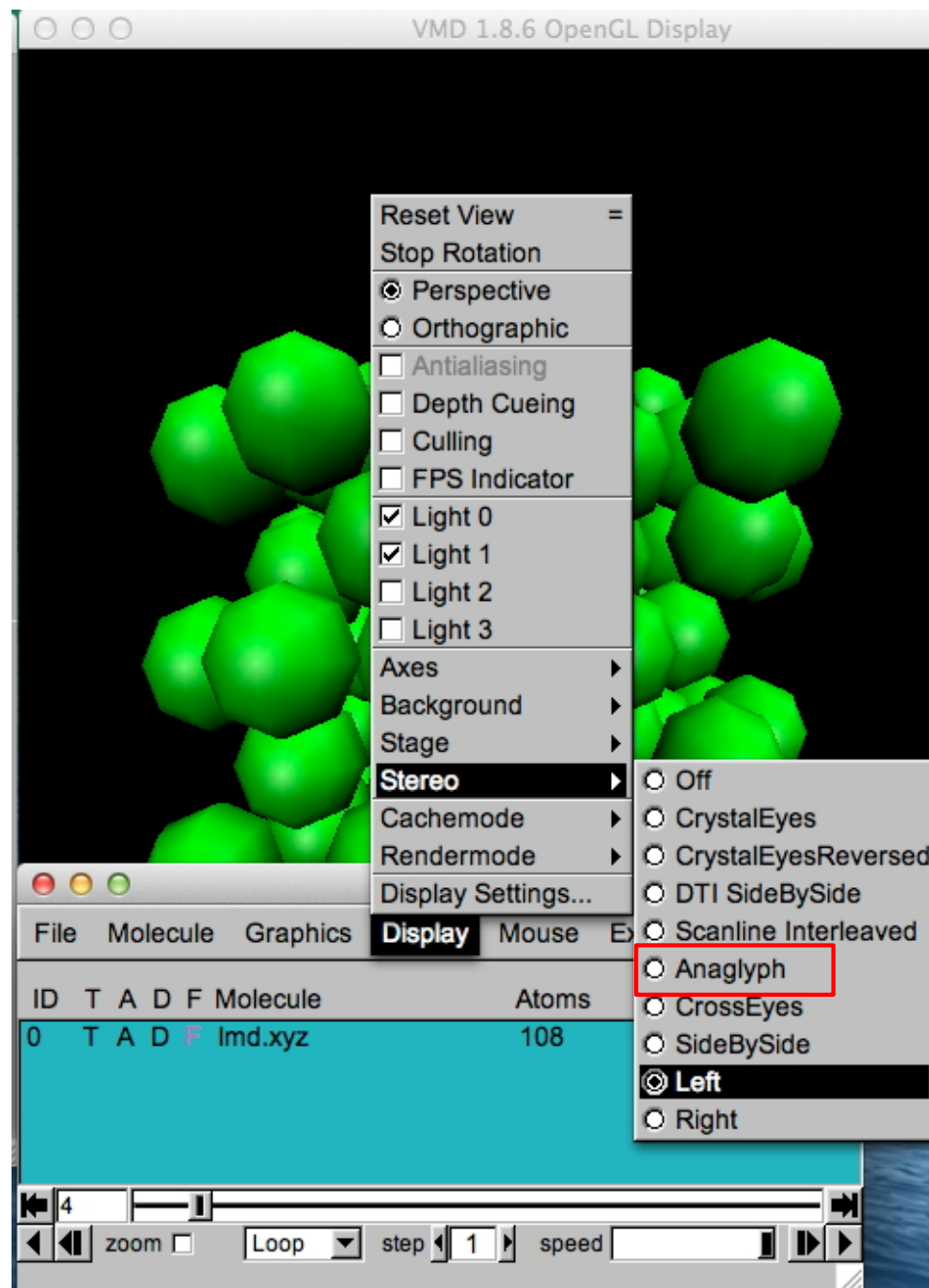
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Y. Chen *et al.*,  
*Appl. Phys. Lett.*  
**93**, 171908 ('08)

# How to Make Anaglyph Stereo

- In the main window of the VMD software, go to the **Display** menu, then the **Stereo** submenu
- Select the **Left** view & save the image as an image file
- Next select the **Right** view & save the image as another image file
- Use software such as **Photoshop** to make an anaglyph by image processing
- Or, simply select **Anaglyph** option

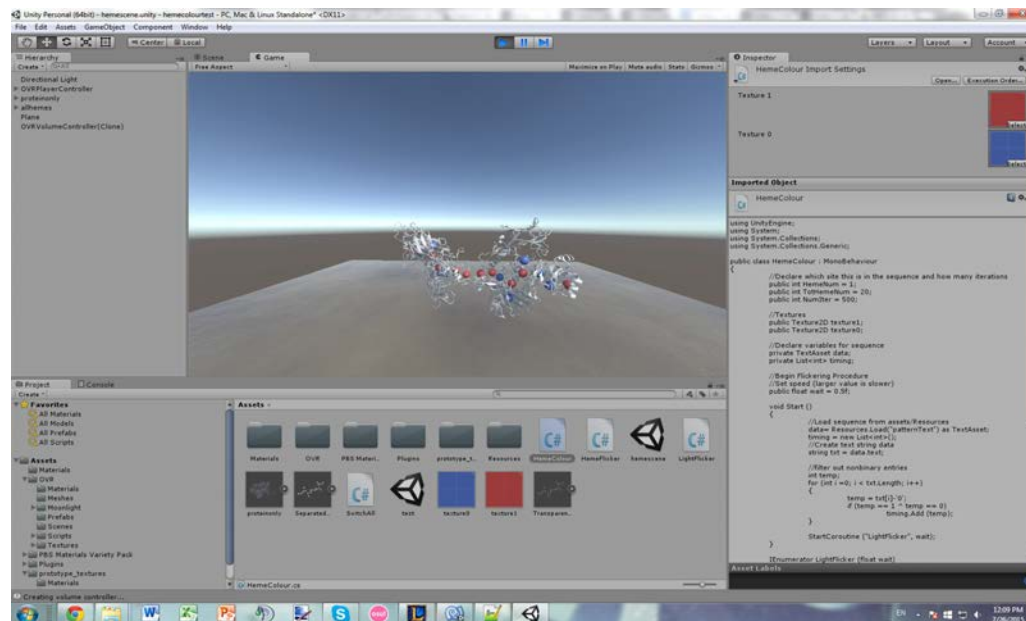
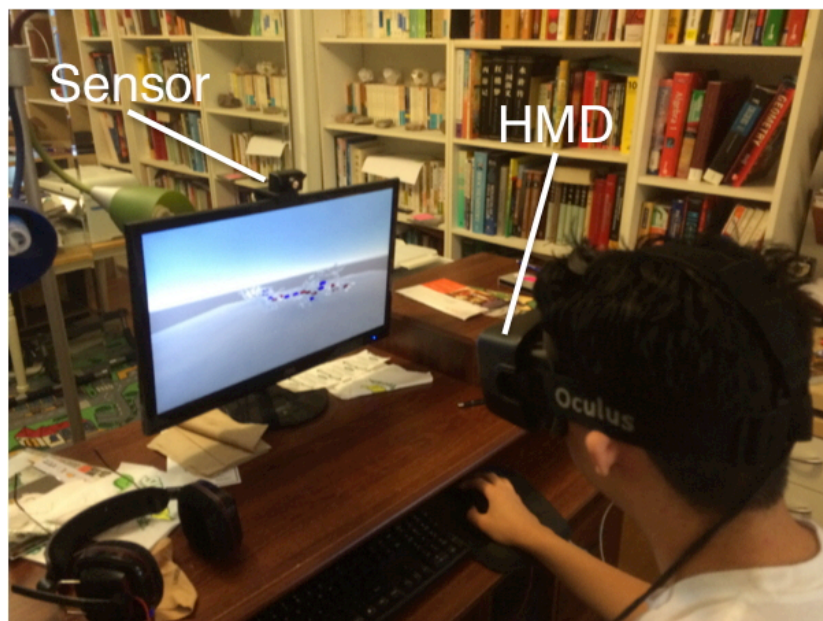


<http://www.ks.uiuc.edu/Research/vmd/>



# Commodity Virtual Reality

- **Immersive visualization to every scientist's desktop:**  
Exported VMD animation to a VR platform — Oculus Rift head mounted display (HMD) — using Unity game engine to increase the perceptive depth



- In VMD, File → Render as wavefront object & material (texture) files; then, use Blender (3D editor software, <https://www.blender.org>) to make it compatible with Unity

[https://en.wikipedia.org/wiki/Alex\\_McDowell](https://en.wikipedia.org/wiki/Alex_McDowell)

C. M. Nakano, E. Moen, H. Byun, H. Ma, B. Newman, A. McDowell, T. Wei, & M. Y. El-Naggar,  
iBET: Immersive visualization of biological electron-transfer dynamics,  
*Journal of Molecular Graphics & Modelling* **65**, 94 ('16)

# GEARS: VR to Every Scientist's Desktop

**GEARS (Game-engine-assisted research platform for scientific computing)** allows scientists to develop & perform immersive & interactive simulations within commodity virtual reality (VR) platforms



Oculus Rift + Leap Motion

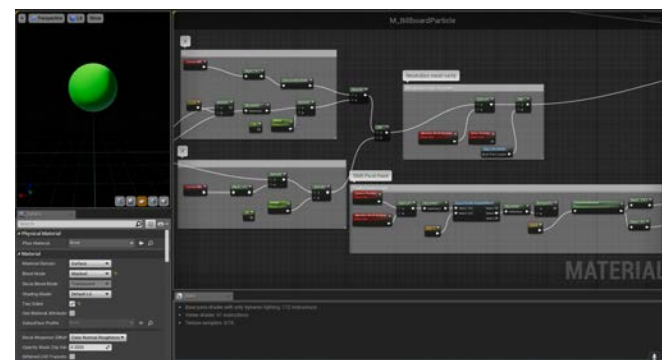


HTC Vive



Exfoliation of MoS<sub>2</sub>

- Implemented simulation workflows in VR-capable Unity & Unreal game engines
- Enhanced interaction utilities, *e.g.*, virtual confocal microscopy
- Developed an interface with community MD software, LAMMPS, & demonstrated immersive & interactive 250K-atom simulations on desktop



LammpsVR editor



<https://github.com/USCCACS/GEARS>

B. Horton, E. Moen, K. Nomura *et al.*, [SoftwareX 9, 112 \('19\)](#)



# New Model



THE NEW OCULUS  
QUEST 2. NO WIRES.  
NO LIMITS. NEXT-LEVEL  
GAMING.



 Pick up today

Oculus Quest 2 -  
All-In-One VR  
Headset - 128 GB

**\$299.00**

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★★★★★ (14,684)



CURBSIDE

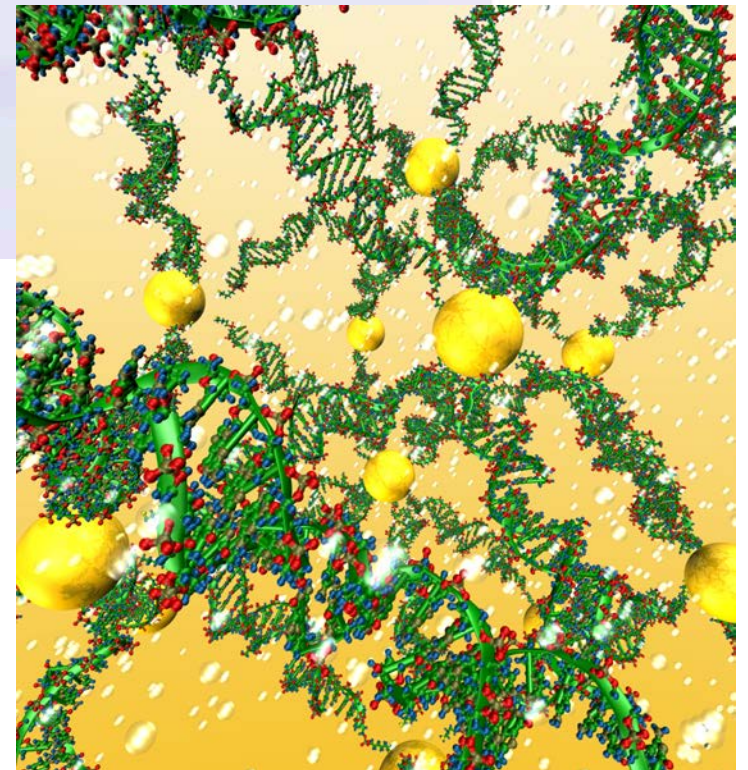
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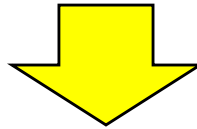
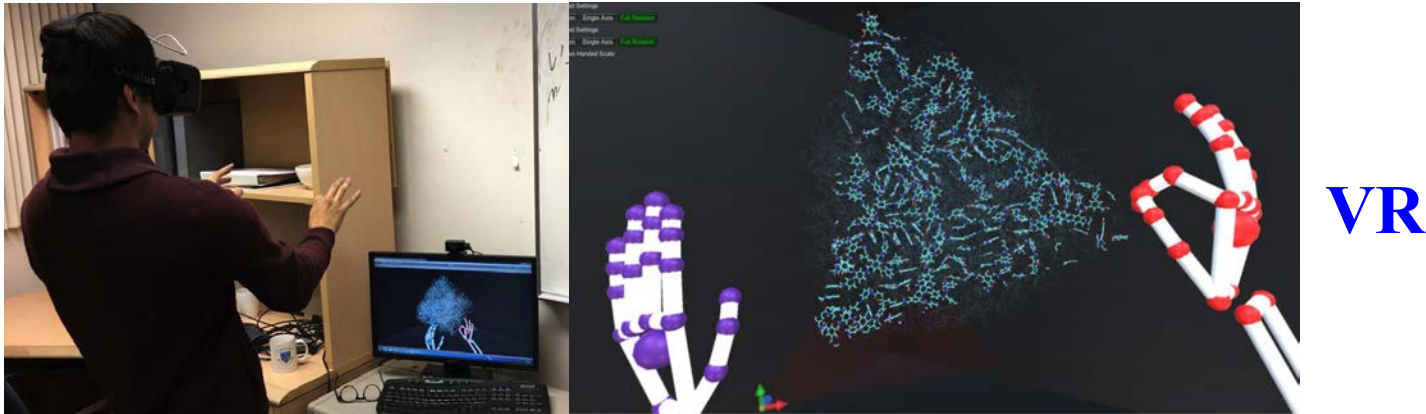
**\$299.00**

[Best Buy](#)

★★★★★ (14,684)



# Scientific Augmented Reality?



MR



**Microsoft mixed reality (MR) academic seeding program at USC**  
**“Million-atom shared immersion?”**

cf. CSCI 538: Augmented, Virtual and Mixed Reality