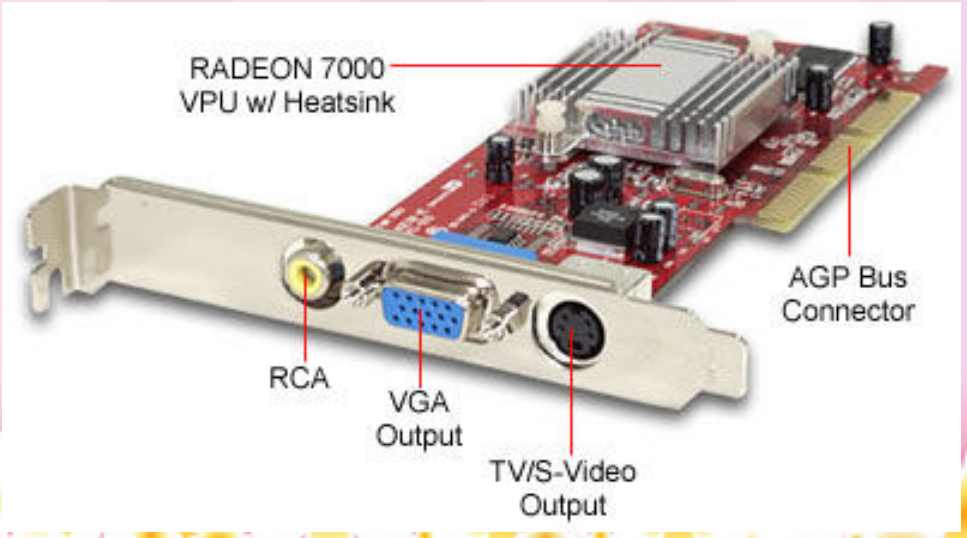
CS195V Week 1

Introduction



Welcome!

- This is CSCI1950V: Advanced GPU Programming
- Prerequisite: CSCI1230: Introduction to Computer Graphics
  - CSCI2240: Interactive Computer Graphics may be helpful, but not required
- In general, we plan to cover more advanced graphics concepts and General Purpose GPU (GPGPU) computing topics
- C++, basic GLSL skills required
- This course was originally intended to be a GISP, but was turned into a full course
  - We hope to still act like a GISP - if you want to cover a topic or are interested in anything GPU-related, we can talk about it!

Planned Topics

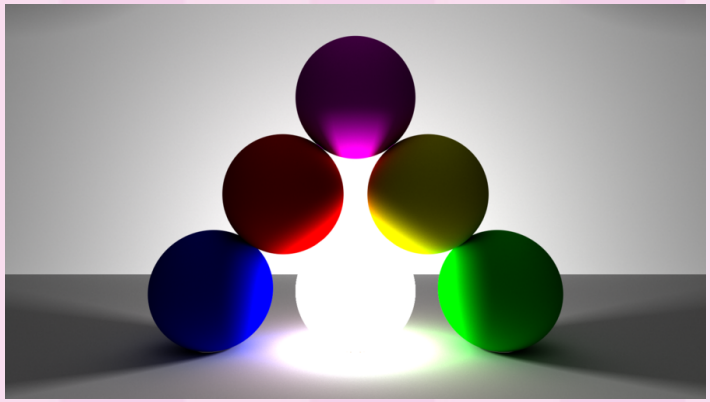
- GPU Computing Overview
  - Differences with traditional programming
  - Advantages/Disadvantages
- Modern OpenGL
- Introduction to CUDA
- General GPU programming techniques/practices
- Case studies/open discussions

What we want you to get out of the course...

- A basic understanding of GPGPU program structure and paradigms
- Awareness of current trends/topics in graphics and GPU computing
- The versatility to apply GPGPU techniques to different problems
- Strong OpenGL/GLSL skills
- Basic CUDA skills
- Some cool demos to impress your friends and intimidate your enemies

Your Staff

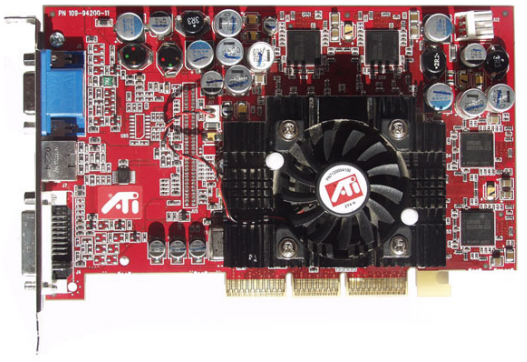
- Supervising professor: Andy van Dam (avd)
- TAs (for lack of a better term)
  - Paul Sastrasinh (psastras)
  - Justin Kim (jhk2)
- No hours planned at this time, may change based on demand



Google image search results for avd, psastras, jhk2

History of GPU Computing

History

- The first dedicated graphics units were developed to accelerate drawing 2D shapes and images to the display
- The advancement of video games increased demand for 3D hardware acceleration
  - Consoles like the Playstation and Nintendo 64 had early examples of 3D hardware
  - APIs like OpenGL and Direct3D for PC
- New features added to these new 3D processors
  - nVidia GeForce 256 was the first consumer-level GPU with hardware accelerated transformations and lighting
  - nVidia GeForce 3 was the first card to support programmable shaders
  - ATI R300 was the first Direct3D 9 capable GPU
    - D3D9 still in wide use today
- Recently, development of specialized GPGPU languages like CUDA and OpenCL

Why do GPUs need to be fast?

- Rendering to a screen requires drawing millions of pixels at a high rate (60/75/120Hz)
- For 3D graphics, have to apply many operations for each vertex and for each fragment
- Large bandwidth requirements
  - Moving and operating on large textures needs to be fast
- More performance is always in demand

GPUs and Parallelism

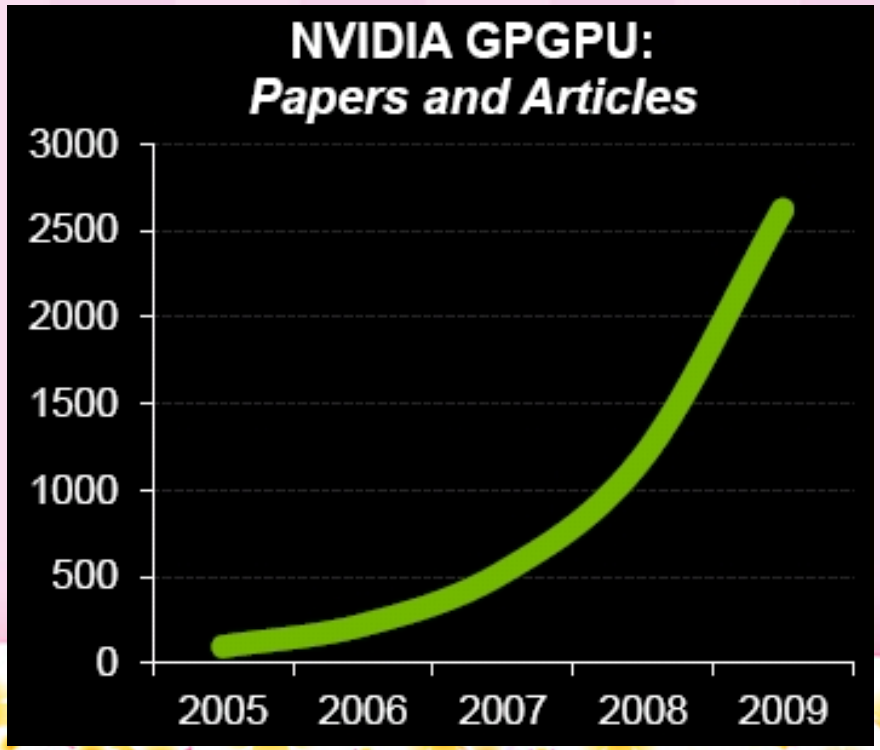
- GPU workloads are inherently parallel
  - Each vertex/pixel can be computed independently from the others
  - SIMD: single instruction, multiple data
- Focus on throughput
  - Speed of individual operations not as important
- Hardware is specially designed to maximize performance in these parallel applications
- This design makes GPUs extremely powerful for any kind of parallel computation

Early GPU Computing

- GPU programming had to be done through shaders
- Thus, people had to write all of their GPGPU applications like graphics applications
- Programming solely through graphics APIs can sometimes be cumbersome and hacky
- Even so, huge potential for performance
- This is what we will be starting with

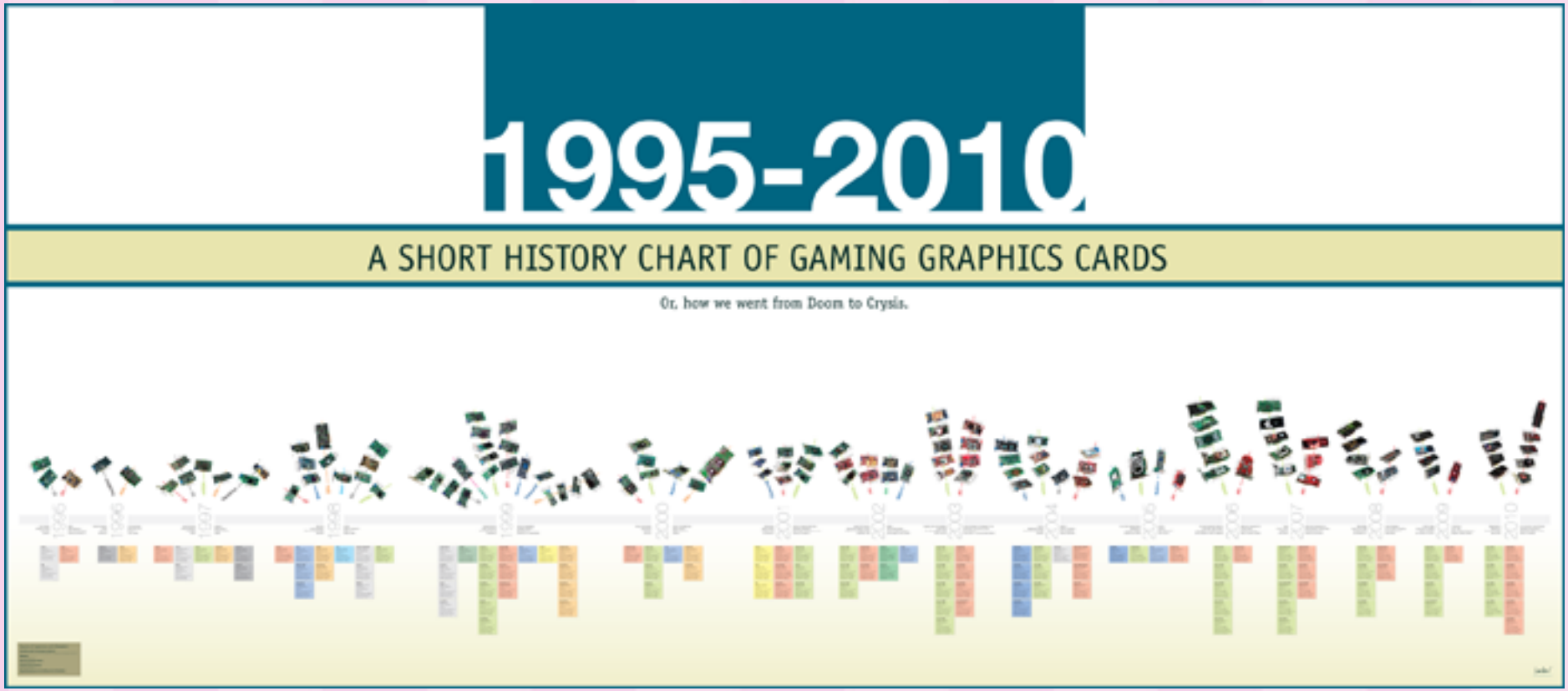
Modern GPU computing

- Languages like CUDA and OpenCL have taken off
- Newest supercomputers now featuring huge numbers of GPUs
- Specialized languages allow for more flexibility in programming for GPUs, less constrained by the "G"
- All kinds of applications
  - Graphics
  - Physics/Simulation
  - Statistics/Economics
  - Biology/Medicine
  - Much more...



Cool Chart

Check out http://www.overclockers.com/wp-content/uploads/2010/10/GPU-History-Blue.png



Projects

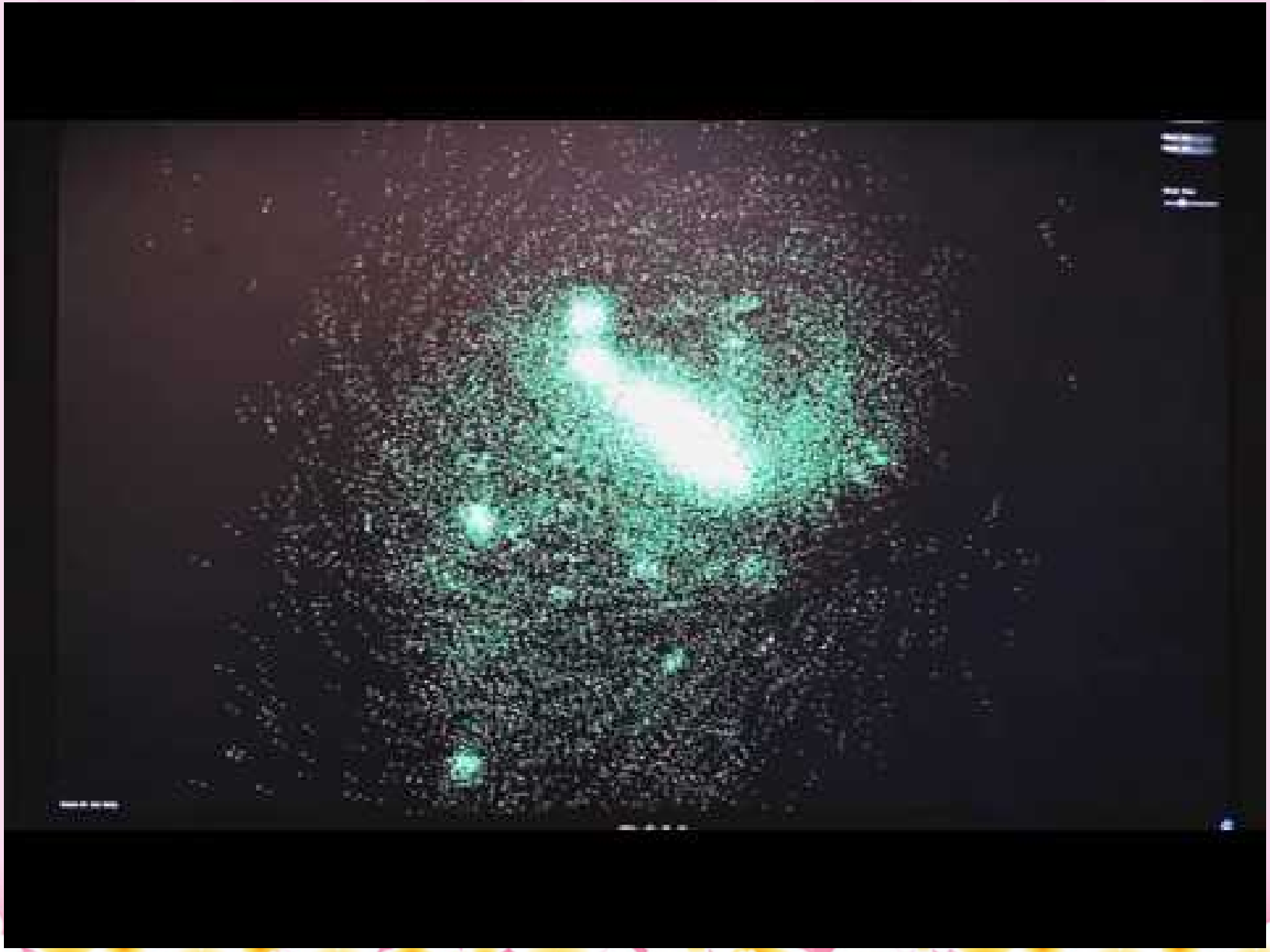
- The work for this course will be about 6-7 projects total with a final project if time permits
  - The projects guidelines are simply suggestions of what you should do and are very open ended
- Each project will consist of a computation portion and a graphical portion
  - You must complete the computational portion according to the project guidelines
  - The graphical portion and how you visualize what has been computed is up to your imagination - we expect you to be creative and learn new graphics techniques (your projects should not use the same graphics / look the same every single time)
  - Ex. one project you may want to try DoF, and another project you may want to try SSAO

Projects

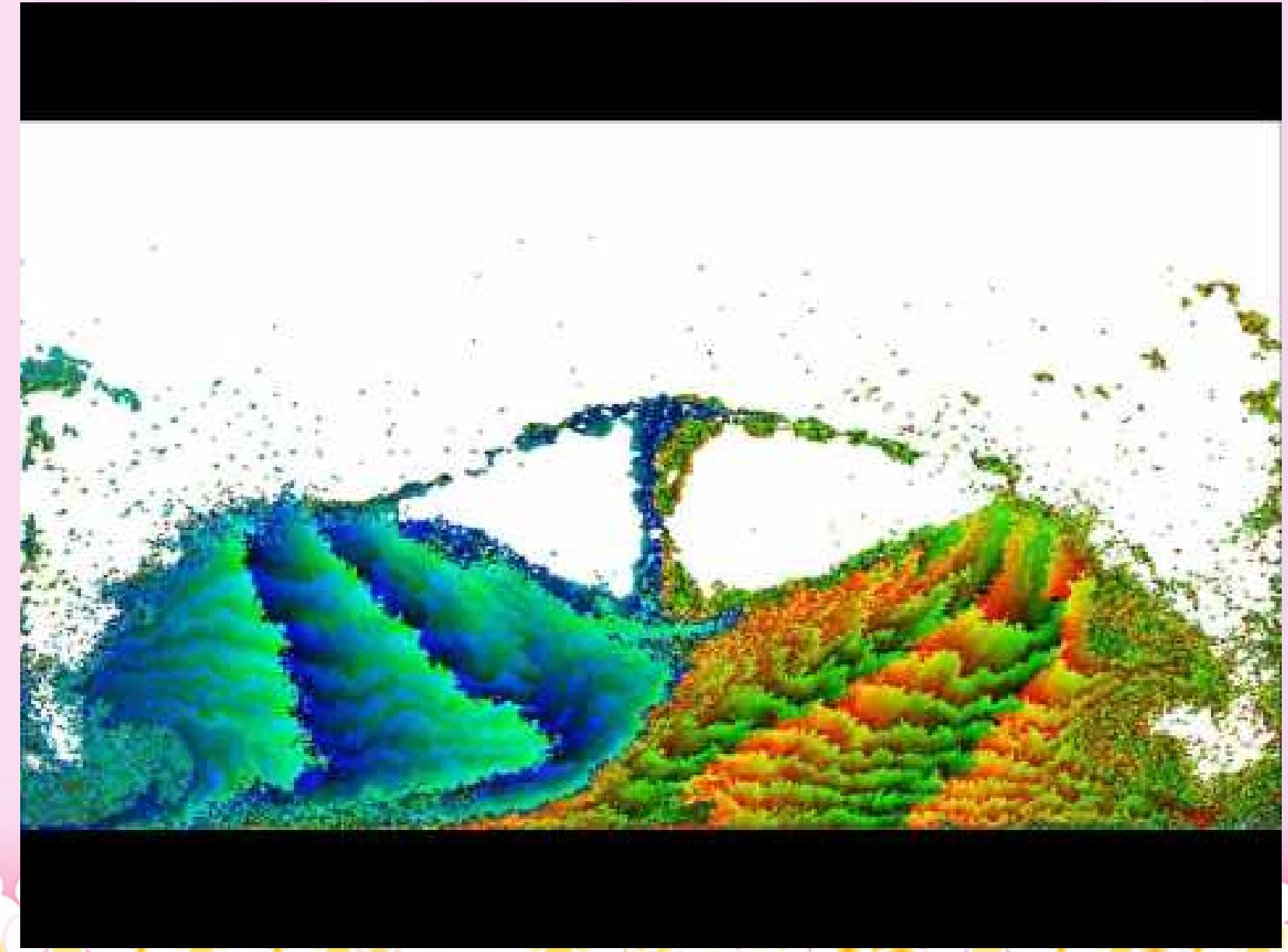
- Project 1: Life
  - Intro project - this project is relatively easy, you should use it to familiarize yourself with OGL/GLSL 4
- Project 2: Domain Warping
  - This should be an easy project after project 1
- Project 3: Tessellation
  - Introduction to the new shader stages introduced in OGL4 and DirectX 11
- Project 4: Galaxy
  - Implement CS32's galaxy on the GPU
- Project 5: Smoothed Particle Hydrodynamics
  - Simulate fluids by slightly modifying the code in the previous project...
- Project 6: CUDA Project 1
- Project 7: CUDA Project 2

Project 2 : Domain Warping

Project 4 : NBody / Galaxy



Project 5 : Smoothed Particle Hydrodynamics



What Time to Meet?

Image sources

- Slide 1
  - http://gadgetsteria.com/2010/04/26/results-are-in-quad-sli-gtx-480s-waste-of-money-side-benefit-heater/
  - http://www.eshopmalta.com/img/i_img/1691.jpg
  - http://media.bestofmicro.com/T/4/304312/original/gtx480%20ac%20extreme%2000.jpg
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- Slide 11
  - http://www.theregister.co.uk/2010/09/21/nvidia_gpu_tech/print.html