GPGPU Applications

1. Graphics pipeline. Fixed and programmable components, shaders, rasterization, depth test and blending.

2. Hardware architecture of modern GPUs. Difference between CPUs and GPUs. The OpenCL platform and memory model.

3. OpenCL execution and program model, possibilities for synchronization.

4. Parallel programming basics: Amdahl's law, Gustafson's law, work complexity and step complexity.

5. Parallel primitives: Map, Reduce and Scan.

6. Parallel primitives: Gather and Scatter, Compact.

7. Parallel sorting algorithms: bubble sort, radix sort, merge sort.

8. Parallel GPU implementations of matrix-vector multiplication.

9. Monte Carlo (MC) integration. Idea behind MC integration, convergence rate. Parallel implementation of a basic MC integrator.

10. Random numbers. Real, quasi and pseudo random generators, examples. Properties of random generators, discrepancy.

11. Monte Carlo scattering simulation. Radiative transport equation. Parallel GPU implementation: random path generation, gathering.

12. Volume rendering. Volume representation, marching cubes, direct volume rendering, isosurface and transparency. GPU implementation.

13. Navier-Stokes equations. How do different physical phenomena influence the movement of fluids.

14. The interpretation of the nabla operator on vector fields. Numerical approximations of the derivative.

15. OpenCL textures, samplers, addressing modes, interpolation.