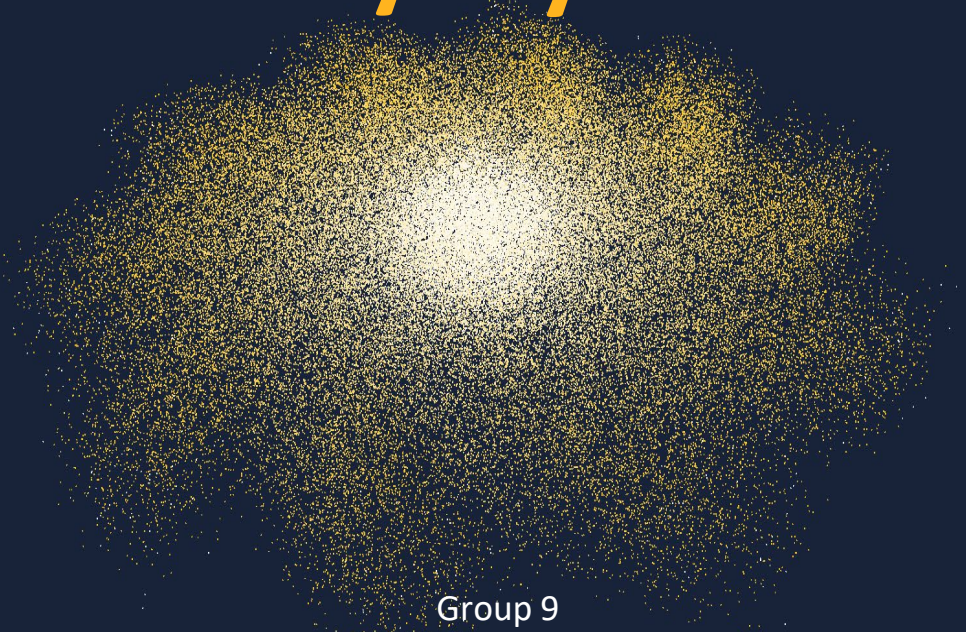
# Physically-Based Simulation

## N Body Simulation



Group 9

*Tatiana Gerth, Tamara Gini, Lucas Habersaat*

# Milestones

minimal

1. Gravitational forces acting between any objects
2. Collision detection & response

desired

3. Scenes of stable solar systems
4. ~~Brittle Fracture using FEM~~
   Fast N-Body Simulation

bonus

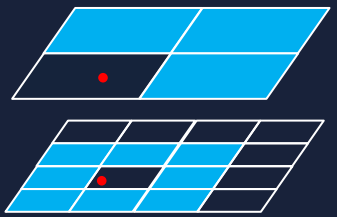
5. Renderings
   with texture, light, env maps, sound, …

# Method

- Naïve Gravitation Loop: $O(n^2)$
- Fast Multipole: $O(nlogn)$
  - Using multi-level grid
  - Based on: https://github.com/davidson16807/fast-multipole-method

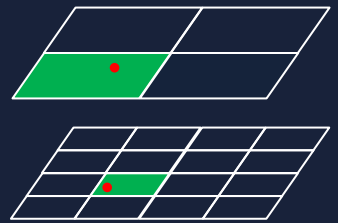
1. Add Forces to Grid

For each body and level
- Compute force that body causes
- Add force to each cell in certain vicinity

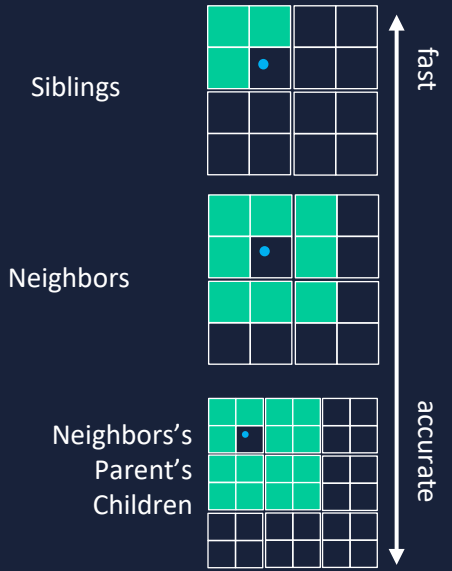


2. Apply accumulated Forces

For each body and level
- Apply forces from cell where body lies in

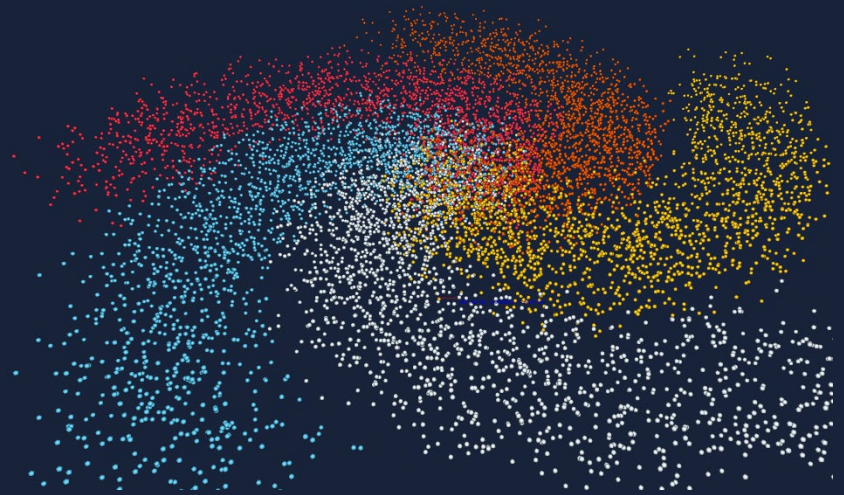


Vicinities

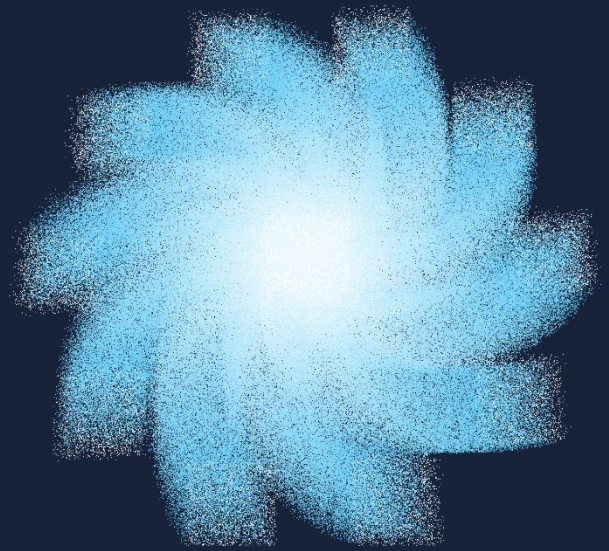


# Particle System

Meshes too expensive to render in great number



Unusable for 10k objects



1 million particles without lags

# Fast Multipole Speedup

Results

# 100k Particles

## Results

50x speedup
(framework sc

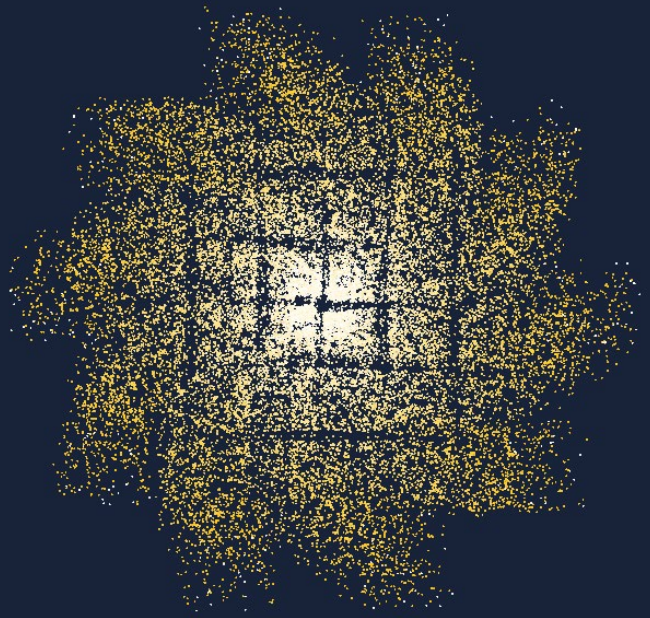
, 330 frames
ores, i7 4GHz)

~100s/frame

# Grid Artefact



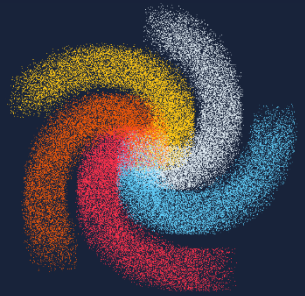
for low initial velocities

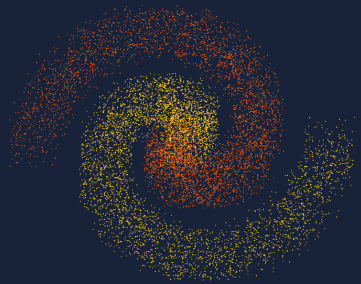


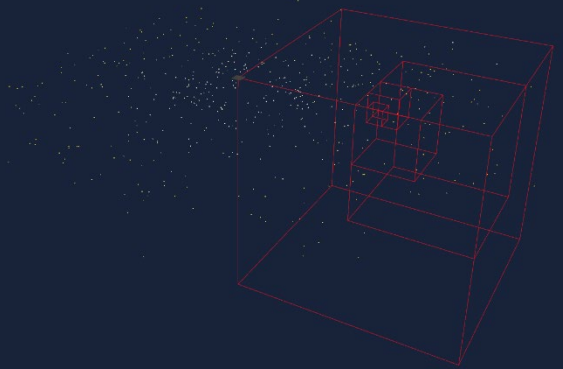
# Other Features



- Runtime Scene Swap
- Procedural Galaxy Generator
- Parallelization for further Speedup
- Debug Grid







# Questions?