



Project: Asteroid field

Physically-Based Simulation 2017

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Goals

Asteroid field simulation in real time

N-Body simulation

- Parallel CPU

- ~~— FMM~~

Collision detection

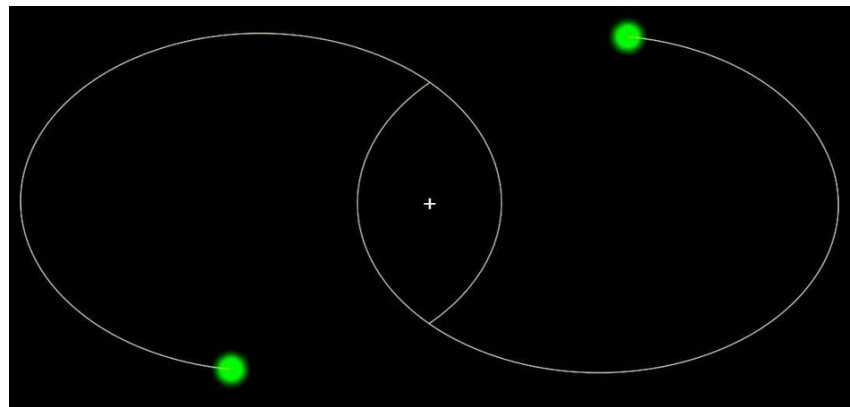
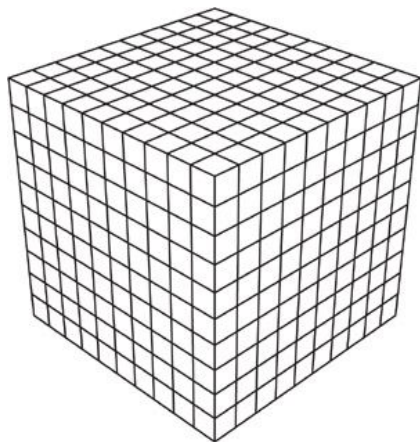
~~Fraction~~

System overview

- OpenSceneGraph:
 - Load and manage the scene and render thread
 - Interaction with OpenGL (textures, shaders, ...)
- Model preparation
 - Convex-Hull
 - Inner moment of inertia
- N-Body manager
 - Calculate interaction forces
 - Simulate objects
- Physic manager
 - Collision detection (broad and narrow phase)

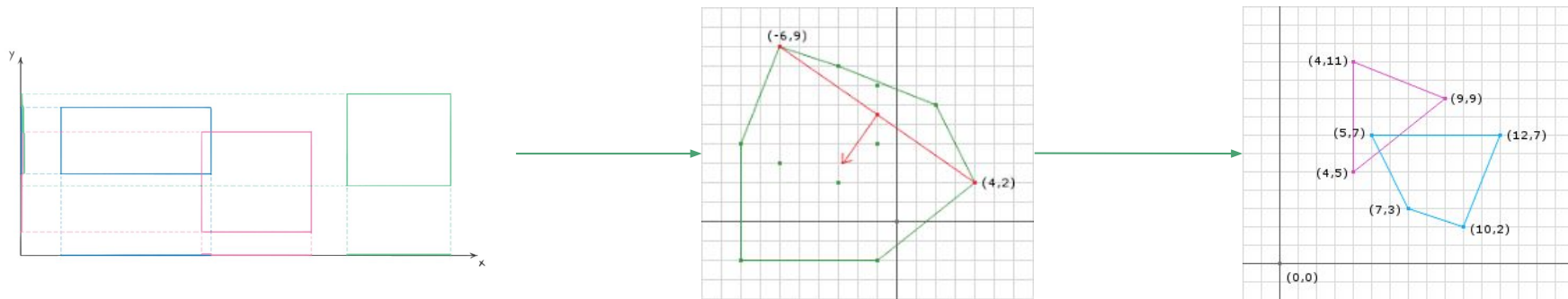
Implementation overview (N-Body)

- N-Body
 - Calculations of interaction-forces
 - Uniform spatial grid for speeding up calculations between interactions
 - Interaction-grid-size cut off by threshold
 - Simulate objects with new forces



Implementation overview (RIGID BODY)

- Collisions
 - Broad phase: detect possible collisions
 - GJK: perform accurate collision detection
 - EPA: Extract the intersection vector



A vibrant blue and cyan nebula with intricate filamentary structures against a dark starry background. The nebula features bright, glowing regions and darker, more diffuse areas, creating a complex, ethereal appearance. The text "2 Bodies circular orbit" is centered over the nebula in a bold, white font.

2 Bodies circular orbit



The background of the slide is a deep space image featuring a large, glowing nebula. The nebula is primarily composed of blue and cyan filaments and clouds of gas, with some darker, denser regions. It is set against a black background filled with numerous small, distant stars. The overall effect is a sense of vastness and cosmic beauty.

2 Bodies elliptic orbit



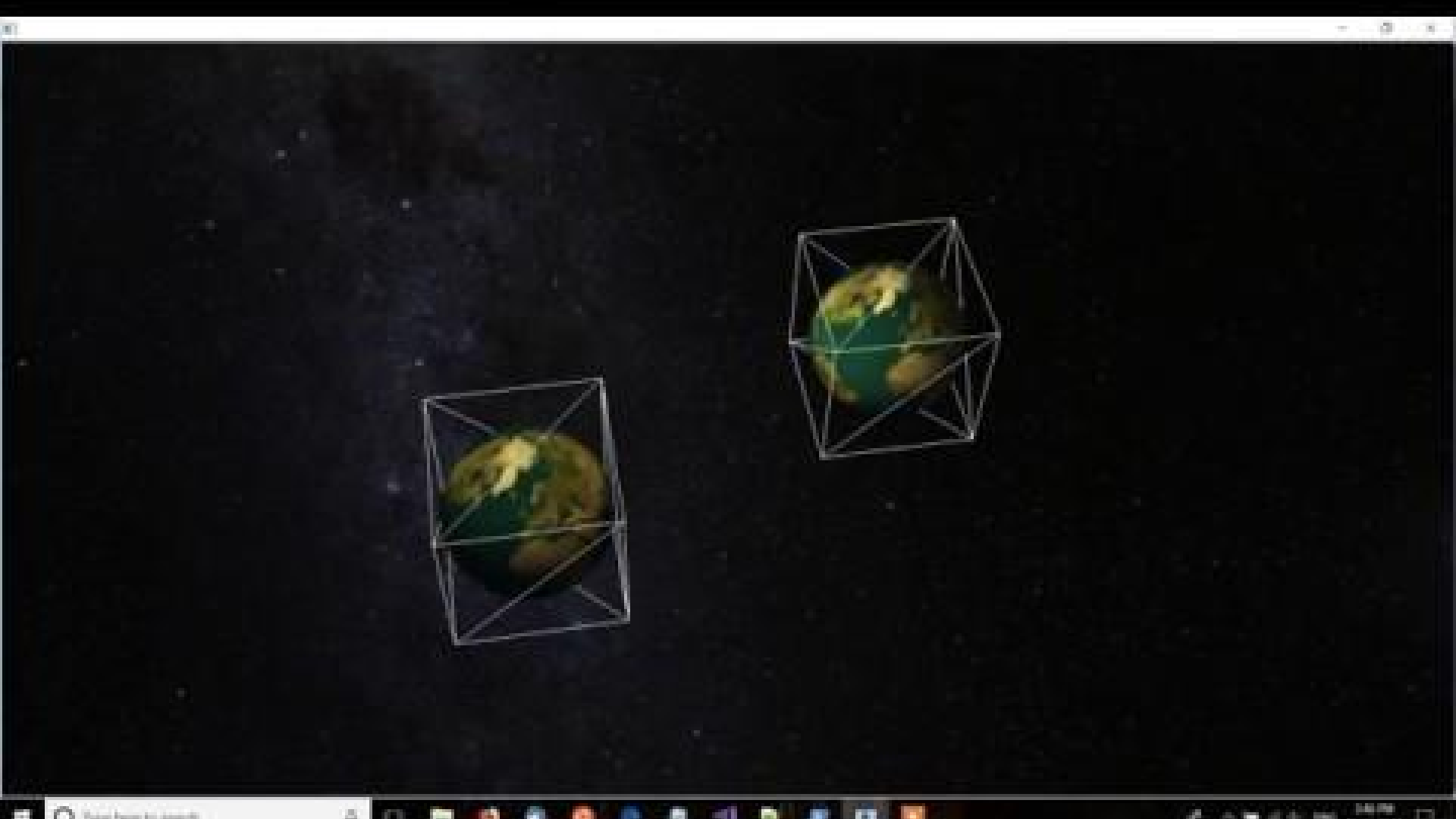


3 Bodies figure eight



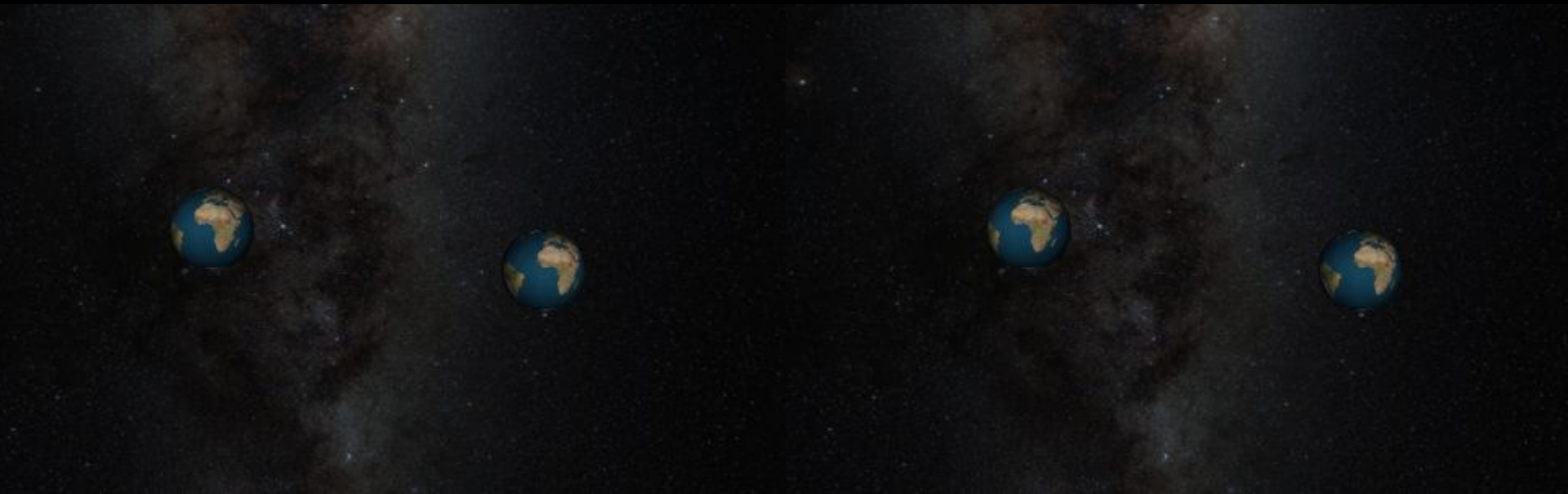
The background of the slide is a deep space image featuring a large, glowing nebula. The nebula is primarily composed of blue and cyan filaments and clouds of gas, with some darker, more complex structures visible within the brighter regions. The overall effect is a sense of vastness and cosmic beauty.

Collision detection Prune and Sweep



The background of the image is a deep black space filled with numerous small, distant stars. A large, glowing blue nebula dominates the center, featuring complex, wispy, and filamentary structures. The blue light varies in intensity, with some areas appearing as bright, concentrated jets or knots, while others are more diffuse and ethereal. The overall effect is one of dynamic cosmic energy and vast scale.

Collision detect Sphere vs. Sphere



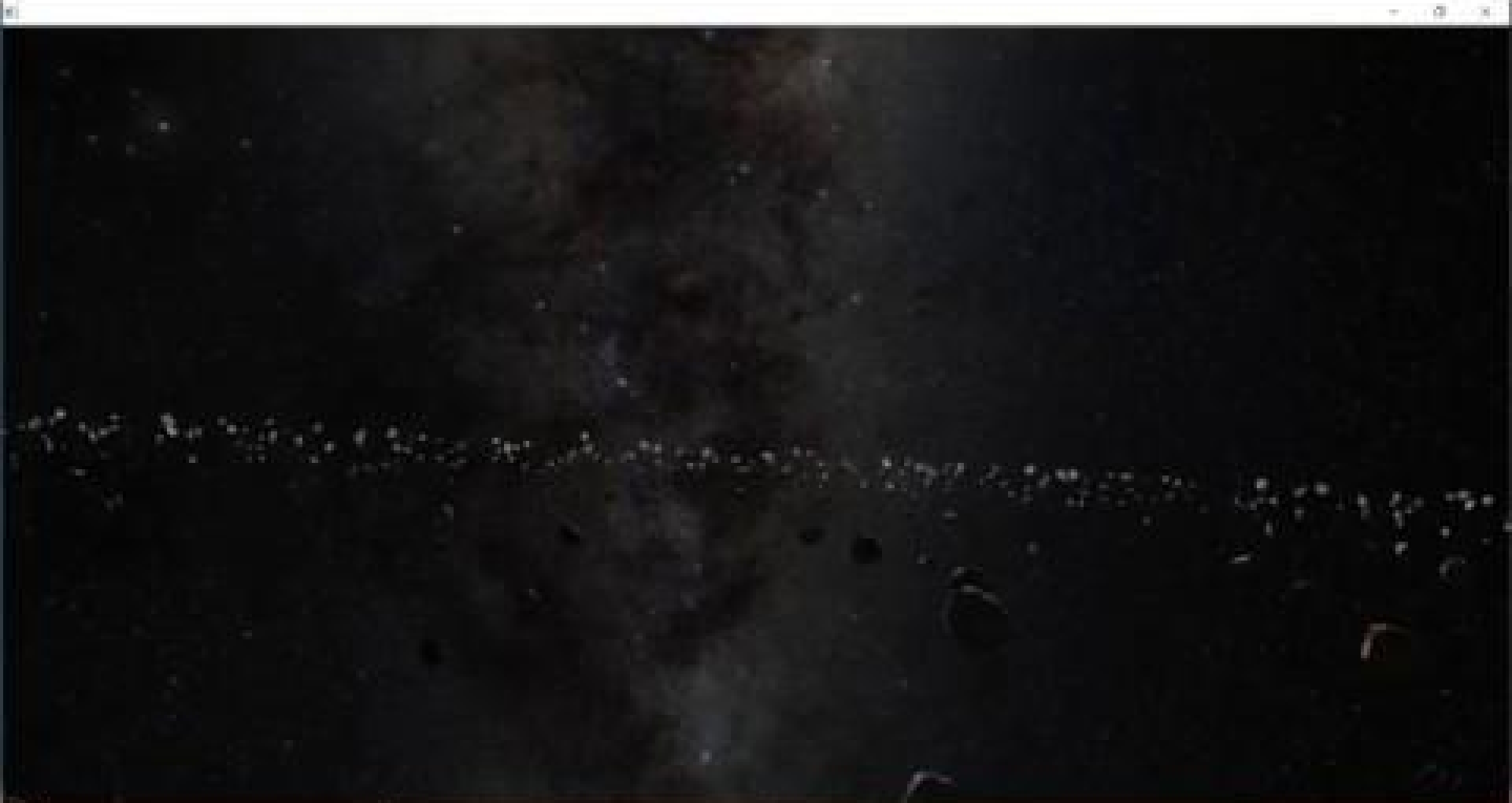
A vibrant blue nebula with wispy, glowing structures against a dark starry background. The nebula features intricate filaments and knots of gas, with some brighter, more concentrated regions. The overall color palette is dominated by various shades of blue, from deep cerulean to bright cyan, set against the black void of space filled with distant stars.

Collision detect: asteroid vs. asteroid

ADD video

A deep space image featuring a large, glowing nebula with a prominent spiral pattern. The nebula is composed of intricate, filamentary structures of gas and dust, illuminated in shades of bright cyan and blue. These filaments swirl and curve across the frame, creating a dynamic and complex visual texture. The background is a deep black, densely populated with numerous small, distant stars of varying brightness. The overall composition is centered, with the most intense part of the spiral pattern located slightly below the middle of the image.

Spiral pattern



A deep space image featuring a complex nebula with glowing blue and cyan filaments and knots of gas. The background is a dark field filled with numerous small, distant stars. The word "Saturn" is centered in a bold, yellow-green font.

Saturn





Game play!

Challenges

- Data Structure for handling N-Body systems
- Support function for GJK for not computing the Minkowski-Sum
- Apply correct collision response

Libraries

- OSG (Open Scene Graph)
- CGAL
- Boost
- EIGEN
- JSON for Modern C++

Rendering

Geometry processing (Convex Hull)

Start-Options

Physic-calculations

Scene-File parsing

Sources

- Documentations of the libraries
- Collision Detection

- Broad Phase

<https://www.toptal.com/game/video-game-physics-part-ii-collision-detection-for-solid-objects>

- GJK (Gilbert–Johnson–Keerthi distance algorithm)

<http://programyourfaceoff.blogspot.ch/2012/01/gjk-algorithm.html>

- EPA (Expanding Polytope Algorithm)

www.dyn4j.org/2010/05/epa-expanding-polytope-algorithm/