GALAXY FORMATION

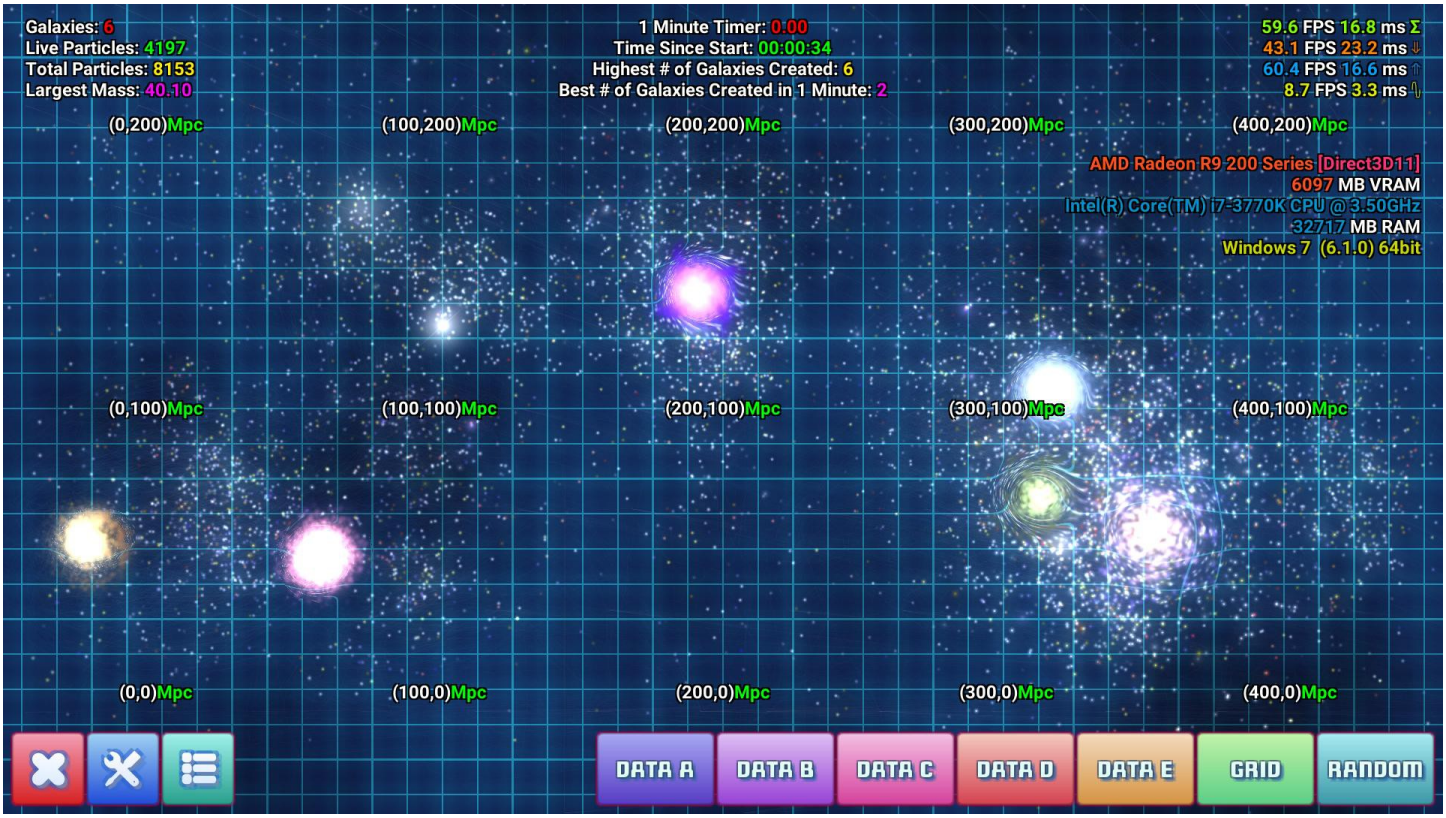
Galaxy Formation is a multi-platform educational app depicting how dark matter particles in the universe clump together over billions of years to form things like stars, planets and galaxies. The app does this with a lite, real-time simulation of thousands of n-body particles that are attracted by gravitational forces that form galaxies when combined.

You can try out the live WebGL Browser version here:

- **WebGL:** https://johnchoi313.github.io/Galaxy-Formation-WebGL/

For better performance, you can download the native versions for each platform here:

- **Android:**
  https://github.com/johnchoi313/Galaxy-Formation-WebGL/blob/master/Other%20Platforms/Android.zip
- **Mac:**
  https://github.com/johnchoi313/Galaxy-Formation-WebGL/blob/master/Other%20Platforms/Mac.zip
- **Windows:**
  https://github.com/johnchoi313/Galaxy-Formation-WebGL/blob/master/Other%20Platforms/Windows.zip
- **Linux:**
  https://github.com/johnchoi313/Galaxy-Formation-WebGL/blob/master/Other%20Platforms/Linux.zip
- **WebGL:**
  https://github.com/johnchoi313/Galaxy-Formation-WebGL/blob/master/Other%20Platforms/WebGL.zip



HOW TO USE

To create dark matter particles, simply **click and hold** on the part of the screen where you want particles to appear. If you are on a mobile device or have a touchscreen, simply touch and hold on the part of the screen where you want particles to appear. Multi-touch is supported.

To create particles faster and dispersed throughout the screen, you can press any of the **colored buttons** on the lower right hand corner of the screen. They do the following:

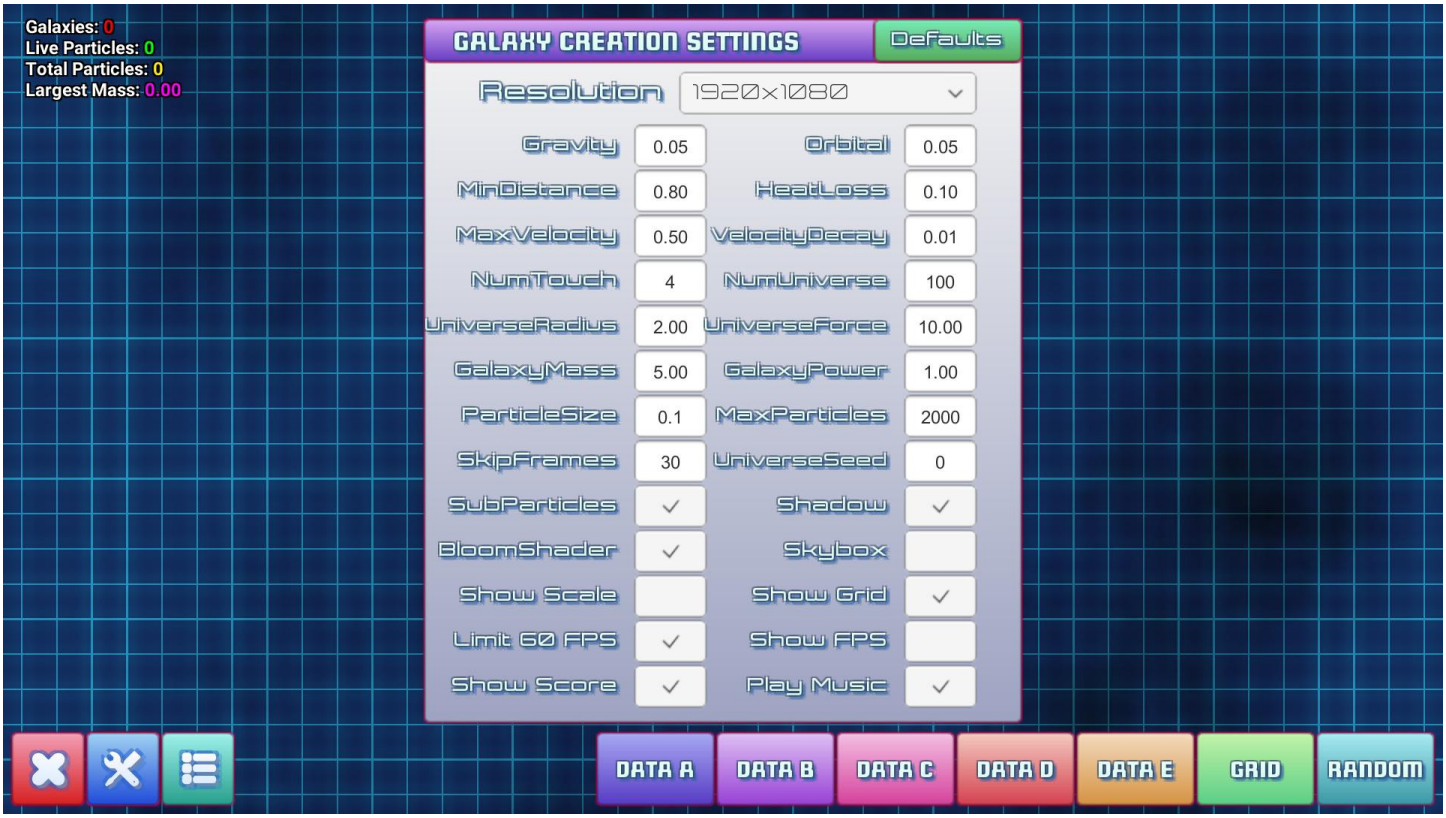
- **DATA A:** Creates a grid of particles according to list compiled in *a.dat* file.
- **DATA B:** Creates a grid of particles according to list compiled in *b.dat* file.
- **DATA C:** Creates a grid of particles according to list compiled in *c.dat* file.
- **DATA D:** Creates a grid of particles according to list compiled in *d.dat* file.
- **DATA E:** Creates a grid of particles according to list compiled in *e.dat* file.
- **GRID:** Creates an evenly distributed grid of particles.
- **RANDOM:** Creates an randomly distributed grid of particles.

On the bottom left corner of the screen, there are three buttons, from left to right:

- **DELETE:** This will delete all particles on the screen.
- **SETTINGS:** This will open up the Settings menu.
- **CREDITS:** This will open up the Credits slide.

On the top of the screen, there are some **helpful informational overlays**, from left to right:

- **TOP LEFT:** Displays the number of galaxies, particles, and the largest mass so far.
- **TOP MIDDLE:** A score showing how many galaxies were created in a minute.
- **TOP RIGHT:** Displays framerate and hardware information of the device.

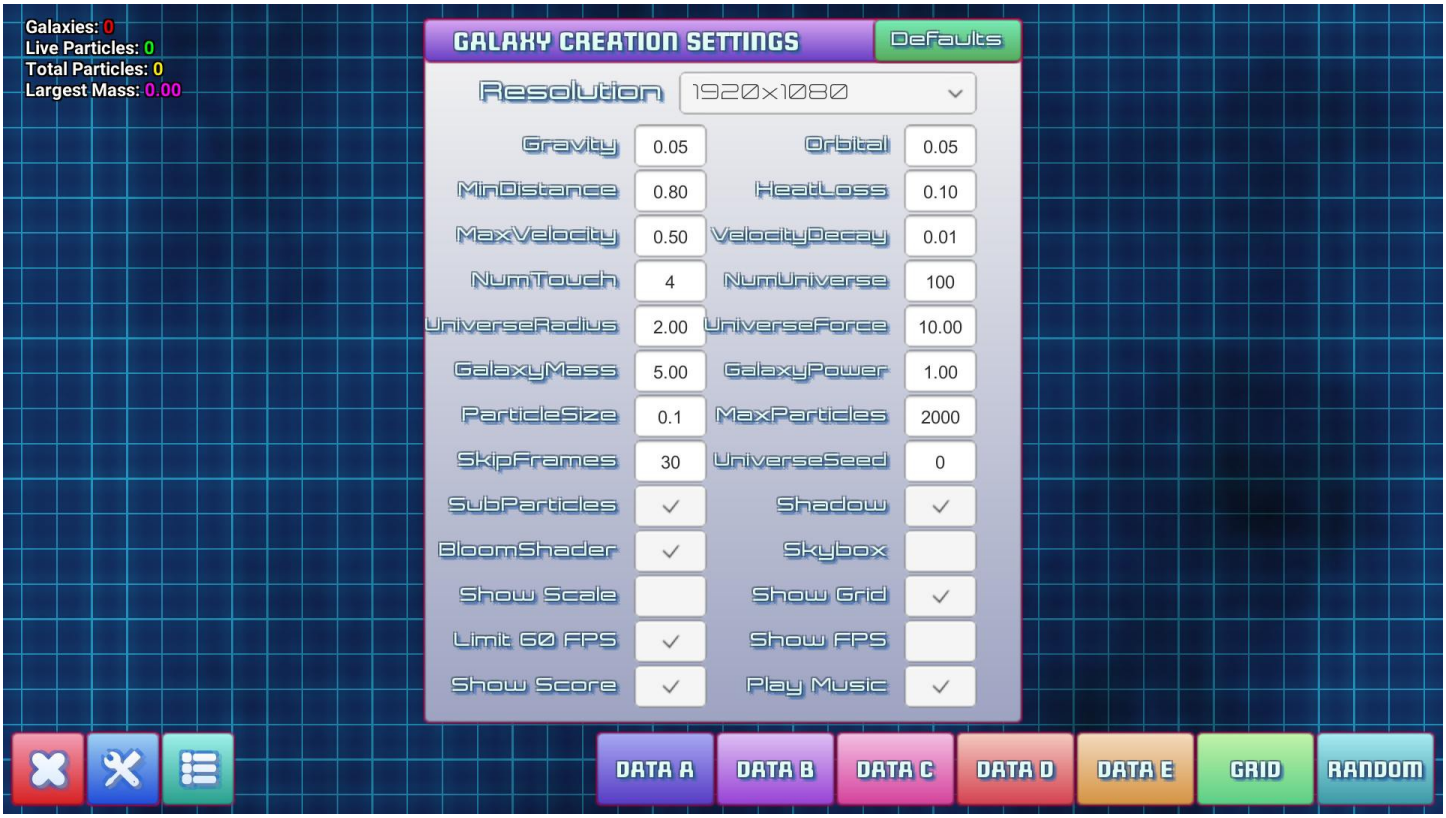


GALAXY FORMATION SETTINGS

There are a wide variety of settings that the user can tweak to change the appearance of the simulator and optimize for better real-time performance on the user's target device.

From left to right, top bottom, here are all the **numeric settings** the user can change:
*(Note: Settings that have a high impact on performance are highlighted in **orange.**)*

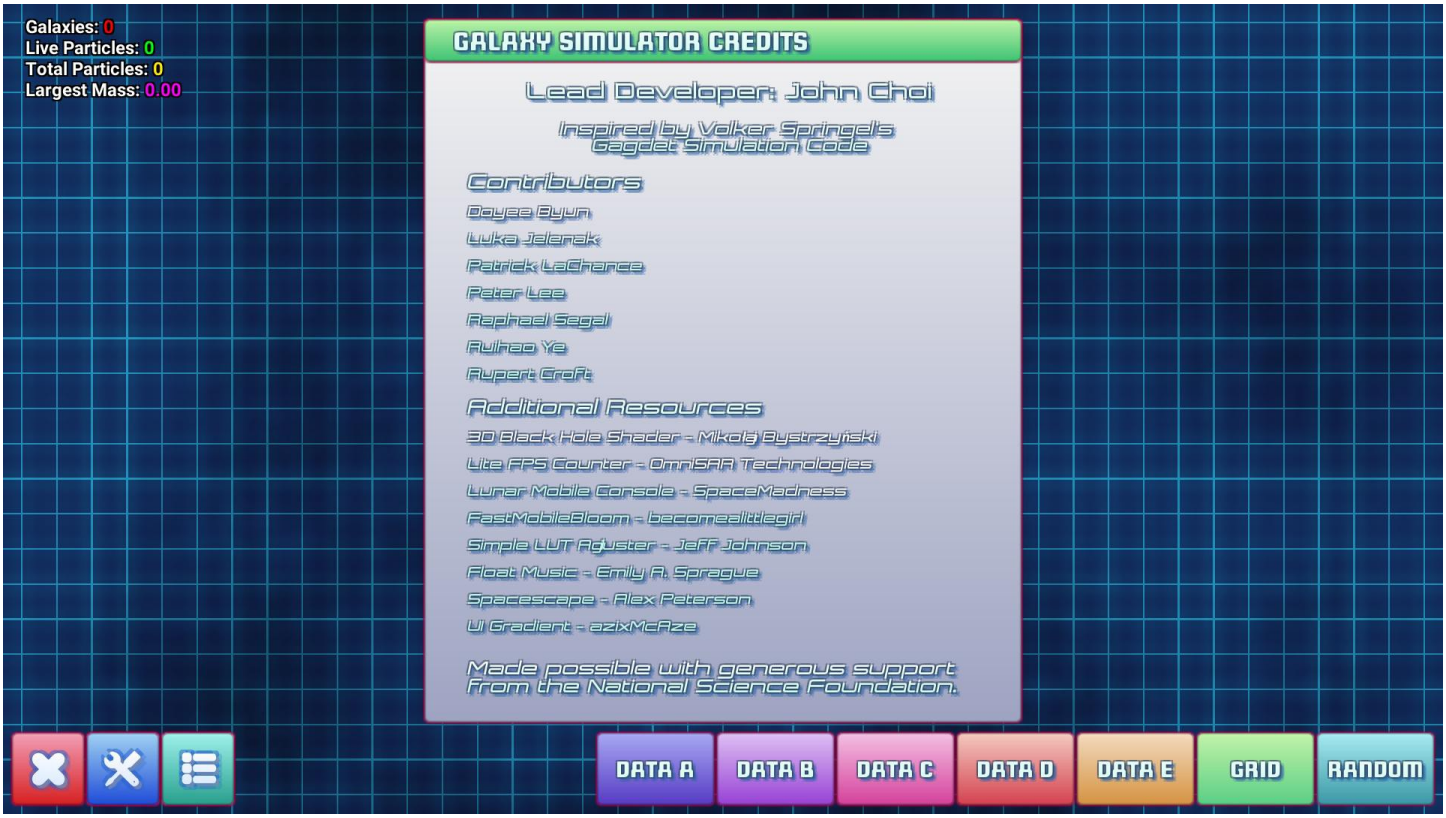
- **RESOLUTION:** This controls the width and height of the in-game render resolution.
- **GRAVITY:** This controls how strongly particles are attracted to each other.
- **ORBITAL:** This affects the gravitational spin of particles and galaxies.
- **MIN DISTANCE:** This controls how close particles have to be to collide.
- **HEAT LOSS:** This controls how much mass is converted to heat after a collision.
- **MAX VELOCITY:** This limits how fast particles and galaxies can go.
- **VELOCITY DECAY:** This slows down particle velocity over time (like air resistance).
- **NUM TOUCH:** This sets how many particles are generated after a touch/click.
- **NUM UNIVERSE:** This sets how many particles are generated after pressing a button.
- **UNIVERSE RADIUS:** This create the width of the universe when a "Spiral" is generated.
- **UNIVERSE FORCE:** This sets the force of the particles when a "Big Bang" is generated.
- **GALAXY MASS:** This sets the minimum mass required to spawn a galaxy.
- **GALAXY POWER:** This controls the gravitational power of galaxies.
- **PARTICLE SIZE:** This sets the initial particle size / mass.
- **MAX PARTICLES:** This sets the maximum number of particles allowed on the screen.
- **SKIP FRAMES:** This sets how many frames are skipped before updating particle physics.
- **UNIVERSE SEED:** This changes the seed value when pressing any of the DATA buttons.



From left to right, top bottom, here are all the **toggle settings** the user can change:
*(Note: Settings that have a high impact on performance are highlighted in **orange.**)*

- **SUB PARTICLES:** This toggles whether or not to display additional non-physics particles.
- **SHADOW:** This toggles whether or not to display a universe fog effect.
- **BLOOM SHADER:** This toggles whether or not to use the "bloom" glow effect.
- **SKYBOX:** This toggles whether or not to use the background "skybox" effect.
- **SHOW SCALE:** This toggles whether or not to show Mpc tick marks.
- **SHOW GRID:** This toggles whether or not to show blue grid lines.
- **LIMIT 60 FPS:** This toggles whether to limit render speed to 60 frames per second.
- **SHOW FPS:** This toggles whether or not to show frame rate and hardware information.
- **SHOW SCORE:** This toggles whether or not to show the one-minute timer score.
- **PLAY MUSIC:** This toggles whether or not to play background music.

*Note: To reset the game to use default settings, press the green **Defaults** button on the upper right corner of the Settings menu.*



GALAXY FORMATION CREDITS

Lead Developer: John Choi.
Learn more about me here: https://www.johnchoi313.com/

Inspired by Volker Springel's Gadget Simulation Code.
Learn more about Gadget here: https://wwwmpa.mpa-garching.mpg.de/gadget/

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Additional Resources

- 3D Black Hole Shader - Mikołaj Bystrzyński
- Lite FPS Counter - OmniSAR Technologies
- Lunar Mobile Console – SpaceMadness
- FastMobileBloom – becomealittlegirl
- Simple LUT Adjuster - Jeff Johnson
- Float Music - Emily A. Sprague
- Spacescape - Alex Peterson
- UI Gradient – azixMcAze

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