**Methods to check out:**

* Fast Multiple Method !
* Verlet integration !
* Book Archie roy orbital motion

**Relevant Papers:**

* Barnes, J., Hut, P. (1986) ‘hierarchical O(N log N) force-calculation algorithm’. Nature 324, pp. 446– 449. <https://doi.org/10.1038/324446a0>
* Winkel, M. et al. (2012) ‘A massively parallel, multidisciplinary Barnes–Hut tree code for extreme-scale N-body simulations’, Computer physics communications, 183(4), pp. 880–889. doi:10.1016/j.cpc.2011.12.013.
* Zhu, Q. (2021) ‘A momentum-conserving N-body scheme with individual time steps’, New astronomy, 85, p. 101481. doi:10.1016/j.newast.2020.101481.
* Boutsikakis, P. Fede, O. Simonin (2022) ‘Quasiperiodic boundary conditions for hierarchical algorithms used for the calculation of inter-particle electrostatic interactions’, Journal of Computational Physics, p. 38. doi:10.1016/j.jcp.2022.111686
* P. Hut and M. Trenti (2008) ‘Gravitational N-Body Simulations’, Scholarpedia, 3(5):3930, p. 13. arXiv:0806.3950
* Winkel, M. (2013) ‘The Barnes-Hut Tree Algorithm and its highly scalable parallel implementation PEPC’, Julich Supercomputing Centre, p.27, id: <http://hdl.handle.net/2128/5876>
* Brent Shapiro-Albert et al. (2010-present) Universe Sandbox Development Blog Available at: https://universesandbox.com/blog/category/developm ent/ (Accessed: 18 October 2022).

**Videos:**

<https://www.youtube.com/watch?v=JPKFCv9VprM>

^ skybox

**Helpful websites:**

* <https://www.semanticscholar.org/paper/A-hierarchical-O(N-log-N)-force-calculation-Barnes-Hut/fce7fd98928ab9bf3e4e919e108c48fc1040f569?sort=is-influential&page=2>
  + important citations – relevant further research
* <https://ssd.jpl.nasa.gov/horizons/app.html#/>
  + got all the mass and positions and velocities there
* <https://physics.stackexchange.com/questions/112461/astronomical-constant-in-astronomical-units>
  + Unit issue
* <https://universesandbox.com/blog/2016/02/n-body-problem/>
  + universe sandbox tackling N-body = OLD 6 YRS
* <https://universesandbox.fandom.com/wiki/N-Body_Simulation#Models>
  + fandom but really good!
* <https://echorand.me/posts/c_cplus_scientific_programming/>
  + scientific c++ libraries
* <https://www.reddit.com/r/gamedesign/comments/7ze7xq/finished_game_design_document_examples/>
  + Finished Game Design Docs (Diablo, gta, bioshock)