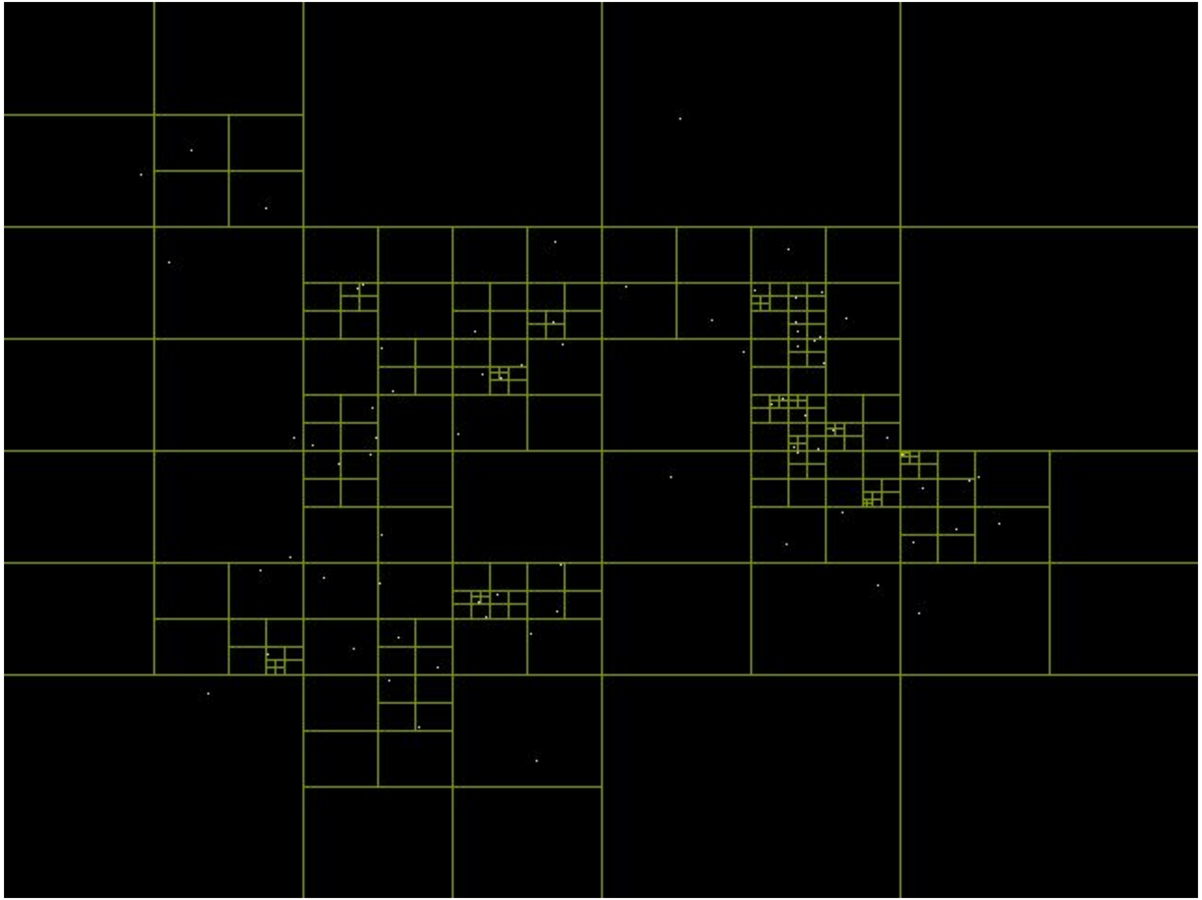
Jorge Arellano



Developed in 1987 by Leslie Greengard & Vladimir Rokhlin Jr., FMM was originally developed as a fast algorithm for approximating the N-body problem

$O(N^2)$ to $O(N)$

Motivation

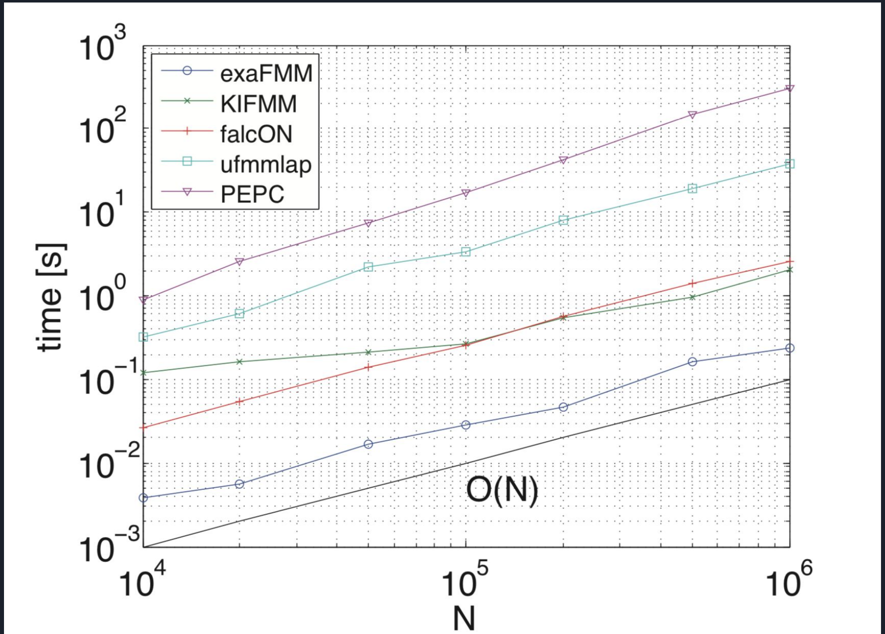
“Complexity Trumps Hardware.”

The current trend in computer architecture is moving towards multi-core processors and many-core processors where the Byte/flop ratio is decreasing with every generation.

Simulation of Celestial Bodies

https://youtu.be/W04TzMMpp9A

Benchmarks



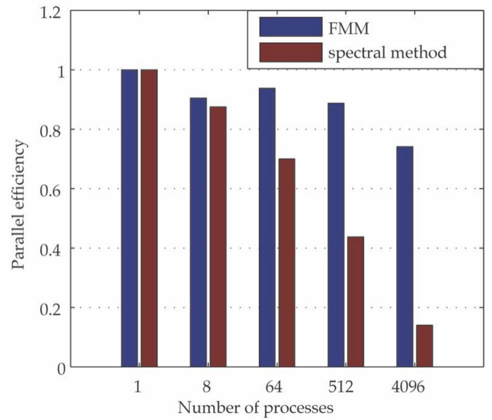


Figure 2. Weak scaling from 1 to 4096 processes of two parallel application codes for fluid turbulence, one using an FMM-based solver on GPUs (one GPU per MPI process), the other an FFT-based solver on CPUs. Figure used under CC-BY license; doi:10.6084/m9.figshare.92425.

Conclusion

FMM works!

But only useful when the problem can be parallelized

Low byte/flop (dense lin-alg) tend to have high complexity O(N) and algorithms with low complexity (FFT, Sparse Lin-alg) have high Byte/flop. FMM has an impressive combination of O(N) complexity and a Byte/flop that is even lower than matrix-matrix multiplication.

A possible alternative more PDE solvers.

references

https://sinews.siam.org/Details-Page/how-will-the-fast-multipole-method-fare-in-the-exascale-era

https://sites.google.com/site/rioyokota/research/fmm

http://adl.stanford.edu/cme342/Lecture_Notes_files/lecture13-14_1.pdf

https://pdfs.semanticscholar.org/360d/20e6f65d43ff1482d553e4249c6334dedd76.pdf