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Title: SpAMM - The Power of N

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SpAMM – The power of N

Sparse/Irregular

- Linear scaling complexity, $O(N)$
- **With scalable parallelism, increasing core count yields proportional capability gains**

SpAMM – The power of N

- Sparse Approximate Matrix Multiply (SpAMM) for matrices with decay
 - Linear scaling electronic structure (FreeON)
 - N-Body learning
 - General alternative to incomplete matrix algebra (“sparsification”)
 - On the fly dropping of product contributions can lead to better accuracy than GEMM, and $O(N)$ execution time for matrices with decay.

SpAMM – The power of N

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Molecule

Space Filling Curve

Matrix/Quadtree

0000	0001	01
0010	0011	
10		11

Convolution/Octree

A) Exponential decay, B) Algebraic decay

SpAMM – The power of N

- Linked list on top tiers → recursive execution
- Linear quadtree on bottom tiers
 - Hashtables/Linear index
 - Handcoded assembly kernel for multiply
- Task parallelism with OpenMP 3.0 on top
- High performance serial execution on bottom
- Dropping is applied all the way down to 4x4
- Non-contiguous, dynamic allocation

SpAMM – The power of N

- Effective serial performance of SpAMM relative to SGEMM
- For 2×10^{-8} the max-norm error matches SGEMM

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Goals for MIC

- Achieve close to ideal speedup on MIC with task parallel paradigm
- Improve data prefetch on fine granularity multiply kernel

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