

$$\underline{\text{PIC/FFT}} \sim O(N_g \log N_g)$$

FMM

Adaptive Fast Multipole Method (FMM) proposed by Rokhlin and Greengard. It uses adaptive subdivision of particles into small groups (clusters). ~~E~~ E-M fields of each such cluster is calculated using multipole expansion. $\sim O(N_p)$ [O(N_p²)-direct SC]

HFMM (F. Jones)

Combination of PIC/FFT for core and FMM for tails

$$\sim O(N_g)_{\text{core}} + O(N_p)_{\text{tail}}$$

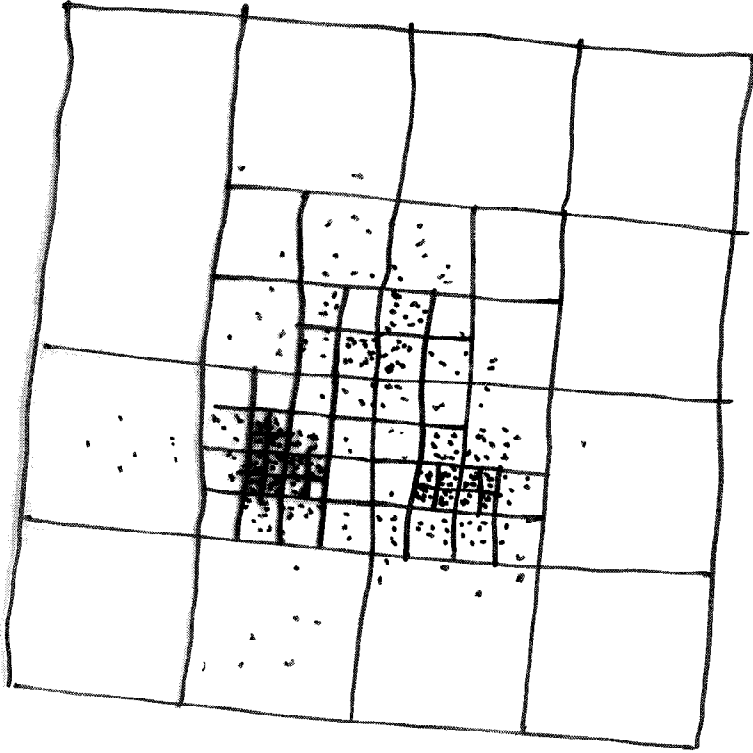
$N_p = 50,000$: PIC/FFT $\rightarrow > 5 \text{ sec}$ \swarrow (512 x 512 grid)

 H-FMM $\rightarrow 0.51 \text{ sec}$ \swarrow

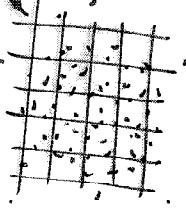
Advantages of H-FMM:

- 1) Dramatic speed increase over PIC/FFT methods.
- 2) Arbitrary grid size and shape
- 3) No hard boundary

FMM:



PIC



FMM

H-FMM