Fast Fourier Transform on Hexagonal Lattices

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In this talk, we first introduce the concept of the lattice discrete Fourier transform (lattice DFT). Then we build a theory of matrix-vector division with remainder to represent multi-dimensional integer indices. As an application, a divide-and-conquer technique is developed for fast evaluation of the hexagonal lattice DFT, which is finally reduced to a variety of the Cooley-Tukey algorithms. Besides, based on the stretch-repeat properties of the lattice DFT, the stretch and the repeat algorithms are also proposed for the fast Fourier transform (FFT) on hexagonal lattices. Compared to the traditional FFTs, the hexagonal lattice FFT is essentially non-tensorial, and it can not be implemented by applying one-dimensional FFTs successively along each direction owing to its lack of linear separability. Nevertheless, our algorithms for hexagonal lattice FFTs possess the same computational complexity $O(M \log M)$ as the tensorial ones. Finally, numerical results, which are in agreement with the theoretical analysis, are presented.