An $(\epsilon, \phi)$-expander decomposition of a graph $G=(V,E)$ with $m$ edges is a partition of vertices into clusters such that (1) each cluster induces subgraph with conductance at least $\phi$, and (2) the number of inter-cluster edges is at most $\epsilon m$. This decomposition has a wide range of applications including approximation algorithms for the unique game, fast algorithms for flow and cut problems, and dynamic graph algorithms.

I will describe a new algorithm for constructing $(\sim O(\phi), \phi)$-expander decomposition in $\sim O(m/\phi)$ time. This is the first nearly linear time algorithm when $\phi$ is at least $1/polylog(m)$, which is the case in most practical settings and theoretical applications. Previous results either take $\Omega(m^{1+o(1)})$ time, or attain nearly linear time but with a weaker expansion guarantee where each output cluster is guaranteed to be contained inside some unknown expander.

Our technique can be easily extended to the dynamic setting where the graph undergoing updates. This talk is based on joint work with Di Wang [Saranurak Wang SODA’19].