Plenary Talks

J.Chuzhoy (Toyota Technological Institute at Chicago)
Polynomial Bounds for the Grid-Minor Theorem
Abstract: One of the key results in Robertson and Seymour's seminal work on graph minors is the Grid-Minor Theorem (also known as the Excluded Grid Theorem). The theorem states that any graph of treewidth at least k contains a grid minor of size $f(k)$ for some function f. This theorem has found many applications in graph theory and algorithms. The best current quantitative bound, due to recent work of Kawarabayashi and Kobayashi, and Leaf and Seymour, shows that $f(k) = \Omega(\sqrt{\log k / \log\log k})$, while the best known upper bound implies that $f(k) = O(\sqrt{k/\log k})$. In this talk, we present the first polynomial relationship between treewidth and grid-minor size, by showing that $f(k) = \Omega(k^\delta)$ for some fixed constant $\delta > 0$, and also describe an efficient algorithm to construct such a minor.
Joint work with Chandra Chekuri.

N.Harvey (University of British Columbia)
Spectrally Thin Trees
Abstract: Thin trees are intriguing objects in graph theory that relate to foundational topics, such as nowhere-zero flows and the asymmetric traveling salesman problem (ATSP). A spanning subtree T of a graph G is called α-thin if every cut in T contains at most an α-fraction of G's edges in that cut.

Asadpour, et al., gave an algorithm that constructs an $O(\log n/k \log\log n)$-thin tree in any graph with n vertices and edge-connectivity k. Improving this to $O(1/k)$ would imply a constant-factor approximation algorithm for ATSP.

We define a stronger notion of thinness that is naturally motivated by spectral sparsification of graphs. A spanning subtree T of G is called α-spectrally-thin if T's Laplacian matrix is upper-bounded by α times G's Laplacian matrix in the Lowner ordering.

We give a deterministic, polynomial-time algorithm to construct an $O(\log n/c \log\log n)$-spectrally thin tree in any graph with n vertices and for which the effective conductance across each edge is at least c.

Remarkably, this can be improved to $O(1/c)$ if one does not require an efficient algorithm.The recent breakthrough results of Marcus, Spielman and Srivastava imply the existence of a $O(1/c)$-spectrally-thin tree.
This is joint work with Neil Olver (MIT / Vrije Universiteit).

L.C.Lau (The Chinese University of Hong Kong)
Analysis of Spectral Partitioning Through Higher Order Spectral Gap
Abstract: Let $\phi(G)$ be the minimum conductance of an undirected graph G, and let $0 = \lambda_1 \leq \lambda_2 \leq \cdots \leq \lambda_n \leq 2$ be the eigenvalues of the normalized Laplacian matrix of G. We prove that for any graph G and any $k \geq 2$, $\phi(G) = O(k)\lambda_2/\sqrt{\lambda_k}$, and this performance guarantee is achieved by the spectral partitioning algorithm. This improves Cheeger's inequality, and the bound is optimal up to a constant factor for any k. The result shows that the spectral partitioning algorithm is a constant factor approximation algorithm for finding a sparse cut if λ_k is a constant for some constant k. This provides some theoretical justification to its empirical performance in image segmentation and clustering problems. The analysis can be extended to other graph partitioning problems, including multi-way partition, balanced separator, and maximum cut.

T.Rothvoss (Massachusetts Institute of Technology)
Approximating Bin Packing within $O(\log OPT \log\log OPT)$ bins
Abstract: For bin packing, the input consists of n items with sizes $s_1, \ldots, s_n$ in $[0, 1]$ which have to be assigned to a minimum number of bins of size 1. The seminal Karmarkar-Karp algorithm from 1982 produces a solution with at most $OPT + O(\log^2 OPT)$ bins.

We provide the first improvement in now 3 decades and show that one can find a solution of cost $OPT + O(\log OPT * \log\log OPT)$ in polynomial time. This is achieved by rounding a fractional solution to the Gilmore-Gomory LP relaxation using the Entropy Method from discrepancy theory. The result is constructive via algorithms of Bansal and Lovett-Meka.