# High Degree Vertices, Eigenvalues and Diameter of Random Apollonian Networks

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**Abstract**

Upon the discovery of power laws, a large body of work in complex network analysis has focused on developing generative models of graphs which mimick real-world network properties such as skewed degree distributions, small diameter and large clustering coefficients. Despite the fact that planar graphs arise in numerous real-world settings, e.g., in road and railway maps, in printed circuits etc., comparably less attention has been devoted to the study of planar graph generators. In this work we analyze basic properties of Random Apollonian Networks a popular stochastic model which generates planar graphs with power law properties.

Specifically, let $k$ be a constant and $\Delta_1 \geq \Delta_2 \geq .. \geq \Delta_k$ be the degrees of the $k$ highest degree vertices. We show that at time $t$, for any function $f$ with $f(t) \to +\infty$ as $t \to +\infty$, $\frac{t^{1/2}}{f(t)} \leq \Delta_1 \leq f(t)t^{1/2}$ and for $i = 2, \ldots, k = O(1)$, $\frac{t^{1/2}}{f(t)} \leq \Delta_i \leq \Delta_{i-1} - \frac{t^{1/2}}{f(t)}$ with high probability. Then we show that the $k$ largest eigenvalues of the adjacency matrix of this graph satisfy $\lambda_k = (1 \pm o(1))\Delta_k^{1/2}$ with high probability. Finally, we investigate other properties of the model such as the diameter.

Based on joint work with Alan Frieze.